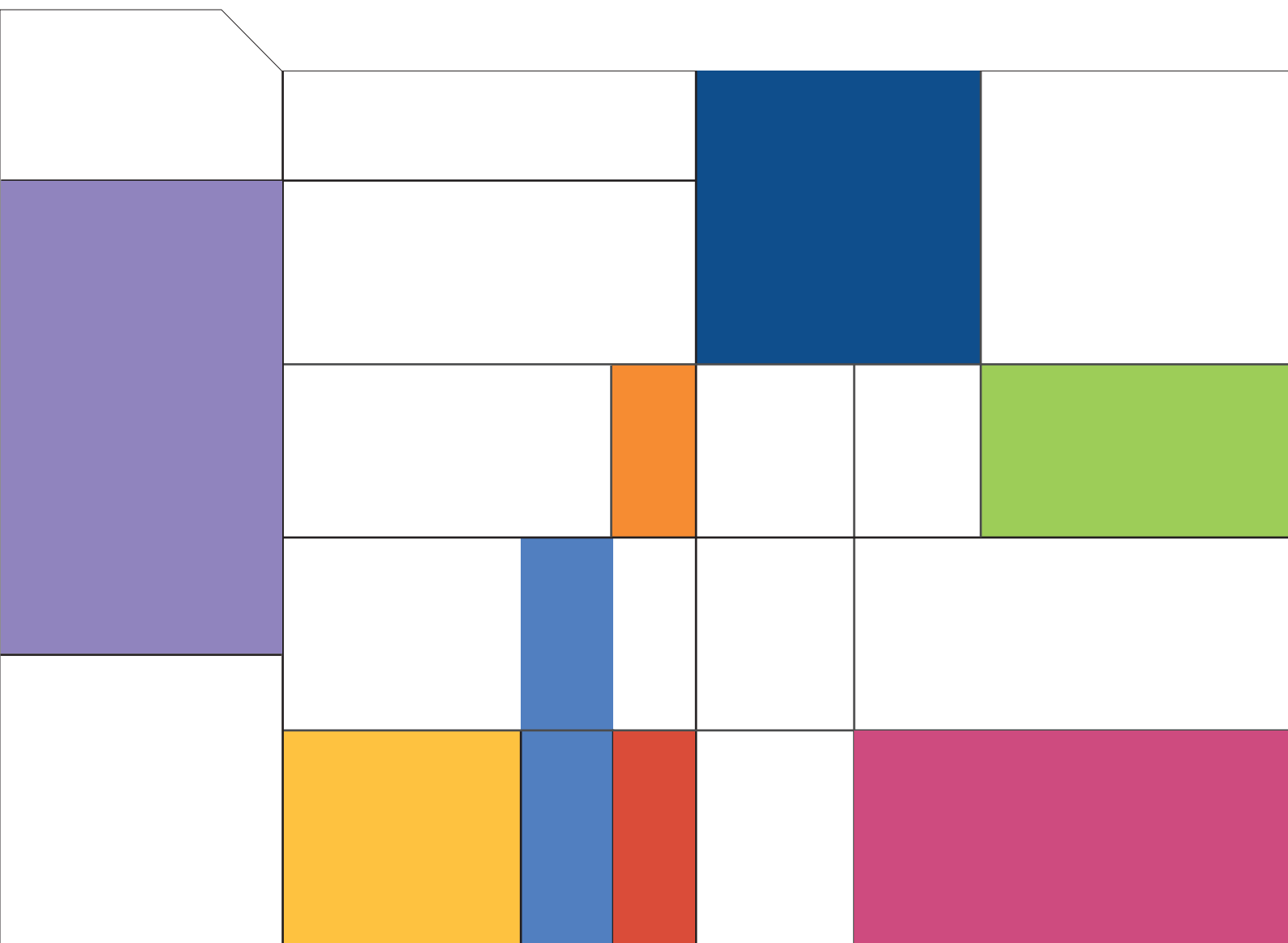




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Foreword

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The determinants of earnings inequality – evidence from quantile regressions

by

Jean-Marc Fournier and Isabell Koske*

Unconditional and conditional quantile regressions are used to explore the determinants of labour earnings at different parts of the distribution and, hence, the determinants of overall labour earnings inequality. The analysis combines several household surveys to provide comparable estimates for 32 countries. The empirical work suggests that, in general, a rise in the share of workers with an upper-secondary or post-secondary non-tertiary degree and a rise in the share of workers on permanent contracts are associated with a narrowing of the earnings distribution. By contrast, a shift in the sector composition of the economy is not found to have a large impact on overall earnings inequality. As for tertiary education, the impact remains ambiguous as there are several offsetting forces.

JEL classification codes: D31, C21, I24, J41, J45

Keywords: Income inequality, labour income, quantile regressions, education, temporary work contract, public employment

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Although many countries have seen labour earnings inequality rise over the past decade, there are marked cross-country differences with respect to both the extent and timing of this increase. In addition, there are notable cross-country differences in the current level of earnings inequality. Since all OECD economies face the same global environment and have essentially benefited from the same technological advances, globalisation and skill-biased technological change should have led to broadly similar shifts in labour demand. Even though countries have differed with respect to supply shifts, a relative supply-demand shift story is unlikely to fully account for the marked cross-country differences in both the level and the evolution of labour earnings inequality. This hints at a possible role for differences in policy and institutional settings.

Against this background, this article aims at shedding further light on the factors that shape the distribution of labour earnings. Specifically, it tries to answer questions such as: How does the educational composition of the workforce influence the distribution of labour earnings? Does the sector composition of employment matter for the distribution of labour earnings? Do the share of fixed-term work contracts and the share of self-employment play a role in shaping the distribution of labour earnings? Since many of the factors that are found to be relevant for how labour earnings are distributed among the working population can be influenced by policy makers, the article also draws some tentative policy conclusions from the empirical results.

The analysis is carried out for a cross-section of 32 countries using household survey data. As far as possible, the analysis is based on comparable individual data for this wide set of countries, providing a unique country-by-country assessment of the drivers of earnings inequality. The empirical analysis mainly makes use of the unconditional quantile regression technique proposed by Firpo *et al.* (2009). This method allows estimating the effect of the potential determinants on all parts of the earnings distribution and is thus better suited to answer questions about the drivers of earnings inequality than standard least squares techniques that only allow estimating effects on mean earnings. The unconditional quantile regressions are complemented by conditional quantile regressions (Koenker and Basset, 1978). While this technique has been widely used in empirical applications – in contrast to the unconditional quantile regression technique which is still fairly new – it does not allow drawing conclusions about the impact of a variable on overall earnings inequality but rather provides insights about the dispersion of earnings within different subgroups of the population. To complete the analysis, the unconditional quantile regression results are used to decompose cross-country differences in the level of earnings inequality into differences in population characteristics (*e.g.* education) and differences in the returns to these characteristics (*e.g.* returns to education). This decomposition helps to get a better understanding of cross-country differences in earnings inequality.

This article is structured as follows. Section 1 presents the empirical methodology, focusing on the specification of the earnings equation, the estimation and interpretation of

conditional and unconditional quantile regressions and the methods used to decompose differences in earnings inequality across countries. Section 2 briefly discusses the benefits and drawbacks of the dataset that is employed in the empirical analysis before presenting the estimation results.¹ The article is complemented by an annex which provides further details on the dataset and the empirical results.

1. The empirical methodology

1.1. The earnings equation

The empirical analysis makes use of household survey data for 32 countries.² It relates individual gross labour earnings to personal and employer characteristics, focusing on individuals aged between 15 and 64 who work either part-time or full-time and have positive labour earnings during the reference year.^{3, 4} The choice of explanatory variables is inspired by the seminal work of Mincer (1958, 1974), who developed a parsimonious model of labour earnings, first using only schooling and later also age and working time as explanatory factors. Mincer-type earnings functions have since been estimated by a large number of studies, including, among others, Fortin (2006), Heckman *et al.* (2006) and Firpo *et al.* (2009) in more recent years. Numerous supplementary variables have since been added to earnings functions, including gender, ethnicity and union membership, among others (*e.g.* Polachek, 2007). Following this literature and keeping the model simple to ensure comparability across countries, this article starts by estimating a baseline model which relates the logarithm of an individual's gross monthly labour earnings to the logarithm of working hours, gender, age and age squared, and the highest education level attained. The level of education is captured by two dummy variables, the first one being equal to one for individuals who have at least finished upper-secondary education, and the second one being equal to one for individuals who have finished tertiary education.⁵ While this measure is rather simple, it is the only measure that is available for all countries covered in the study.⁶ Hence, the coefficient on the first dummy variable gives the impact of an upper-secondary or post-secondary non-tertiary education relative to lower-secondary education or less, and the coefficient on the second dummy variable gives the impact of tertiary education relative to upper-secondary or post-secondary non-tertiary education.⁷

Several additional drivers of labour earnings are of interest but are excluded from the baseline because they exist only for a subset of countries and/or cause potential endogeneity bias.⁸ These are dummy variables for the sector of employment and the occupation, the number of years of work experience, the number of years of education, and dummy variables for having a temporary as opposed to a permanent work contract, for being self-employed, for having foreign citizenship, for being born in a foreign country, and for having a PhD. These variables are added on top of the baseline in a number of alternative specifications, the details of which are set out in Section 2.

1.2. Going beyond mean effects with quantile regressions

The impact on earnings of the variables listed above is likely to differ across individuals. For example, a tertiary degree may be more valuable for high-income workers as their jobs require such an education, whereas it goes beyond the needs of most jobs of low-income workers (*e.g.* Hartog *et al.*, 2001). Standard OLS techniques ignore this heterogeneity and only provide an estimate of the mean effect of a given variable. As this would severely weaken the analysis (Koenker and Bassett, 1978), this article makes use of

two alternative techniques that allow estimating the impact of explanatory variables on different parts of the earnings distribution (nonetheless simple OLS results are also shown for the sake of comparison). These are the conditional quantile regression (hereafter CQR) technique proposed by Koenker and Bassett (1978) and the unconditional quantile regression (hereafter UQR) technique proposed by Firpo *et al.* (2007a, 2009). While the former has been widely used in the literature, the latter is fairly new and applications are thus still scarce. In general, the estimation of the effects of a given set of variables on the distribution of another variable is still an active area of research and no preferred method has yet emerged from the literature. The choice made here of the methodology by Firpo *et al.* (2007a, 2009) over alternative techniques such as the non-parametric approach proposed by Rothe (2010) is mainly motivated by its ease of computation.

Conditional quantile regressions focus on the conditional quantile of an individual, which is his/her position in a virtual distribution in which all individuals are assumed to have the same observed characteristics. For example, if individuals differ only with respect to their education level, the conditional quantile of a low-educated person would be his/her earnings quantile among all low-educated individuals, whereas the conditional quantile of a highly-educated person would be his/her earnings quantile among all highly-educated persons. Unconditional quantile regressions, by contrast, focus on the unconditional quantile of an individual, which is his/her earnings quantile in the overall earnings distribution, abstracting from (*i.e.* not controlling for) observed and unobserved characteristics. In the example above, the unconditional quantiles of the two individuals with respectively low and high education would be their earnings quantiles among all individuals in the population.

Given the different focus of the two approaches, the types of questions they can answer differ. Conditional quantile regressions – which have often been simply referred to as “quantile regressions” – provide an estimate of the return to a certain characteristic (such as having a tertiary degree), where the return varies across individuals based on the conditional quantile into which they fall (Koenker and Hallock, 2001). The method can thus be used to answer questions such as: what is the impact on an individual’s earnings of increasing the education level by one year, holding everything else constant? The technique assumes in particular, that the conditional quantile of an individual remains the same when his/her characteristics change. Since this assumption may well not hold in practice, the results of conditional quantile regressions must be interpreted with caution (Koenker, 2005). Unconditional quantile regressions, by contrast, allow estimating the effect of a small change in workers’ characteristics on each quantile of the overall distribution. They thus provide answers to questions such as: what is the impact on median earnings (or the earning of any particular quantile) of increasing everybody’s education by one year, holding everything else constant?^{9, 10}

Since the unconditional quantile of an individual is simply the share of individuals in the sample population whose earnings are lower than the earnings of the individual of interest, the results of UQRs are easier to interpret than those of CQRs. Since UQRs allow assessing the impact of a particular variable on overall earnings inequality, they are also more suitable than CQRs in the context of this article and are thus used as the baseline method. CQRs are computed for two purposes. First, this widely used method remains a robustness check if the unconditional quantile is likely to remain quite close to the quantile conditional on the variable of interest. Many results are indeed relatively similar

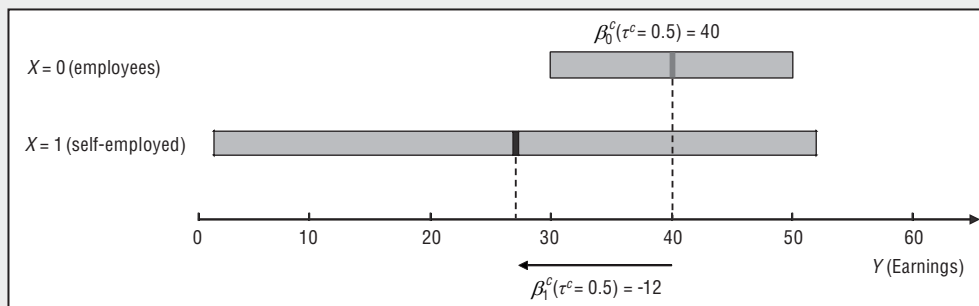
with these two methods. Second, it provides insights about the comparison of the dispersion of earnings within different groups, which helps to understand the mechanisms at work. Further details on how to interpret conditional and unconditional quantile regressions are provided in Box 1.

Box 1. How to interpret the results of conditional and unconditional quantile regressions

To illustrate the interpretation of conditional and unconditional quantile regressions, assume that there are only two explanatory variables, a constant and a dummy variable X , which takes value one if an individual is self-employed and zero otherwise. Assume further that earnings are higher on average and less dispersed among employees. In Figures 1 and 2 below, the grey rectangles show the distribution of earnings in the two sectors, with the length of the rectangles indicating the range of earnings and their thickness – assumed here to be the same across the whole distribution for simplicity – indicating the number of persons with a certain earnings level.

The coefficient $\beta_1^c(\tau^c)$ on the union membership dummy obtained from a *conditional quantile regression* gives the change in earnings associated with becoming self-employed, assuming that the position of the individual among all individuals with the same characteristics does not change. For example, if the individual had the median earnings among all employees before the job change ($\tau^c = 0.5$), he will have the median earnings among self-employed after the job change, so that his earnings rise by 12 units in Figure 1. The constant $\beta_0^c(\tau^c)$ obtained from a CQR gives the quantile of the individual among the subsample of individuals with a 0-value for the dummy variable, i.e. among all employees, which here is 40 for the median.

Figure 1. Interpreting conditional quantile regressions

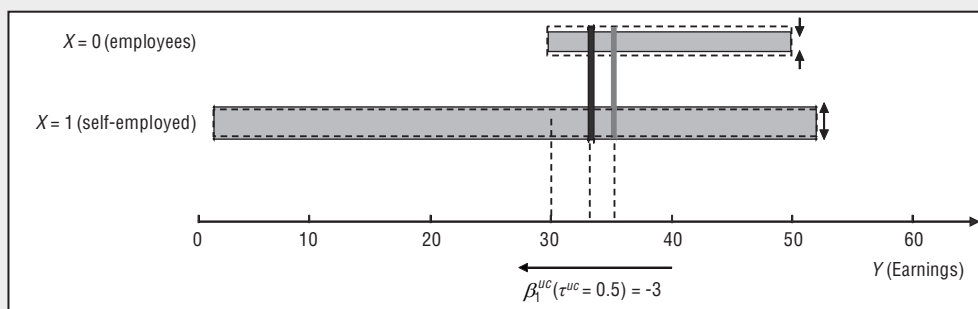


The CQR results can also be used to draw conclusions about the dispersion of earnings within certain subgroups of individuals. In the example above, the coefficient of the dummy variable increases along the earnings distribution. This reflects that earnings are more dispersed among self-employed than among employees.¹ While conclusions about the dispersion of earnings among certain subgroups of workers could also be derived from simple summary statistics such as the variance, CQRs have the advantage that they can control for other determinants of earnings.

Box 1. How to interpret the results of conditional and unconditional quantile regressions (cont.)

The coefficient $\beta_1^{uc}(\tau^{uc})$ on the self-employment dummy obtained from an *unconditional quantile regression* gives the change in a certain earnings quantile of the observed distribution – say, the median – associated with an increase in the share of self-employed by 1 percentage point. As shown in Figure 2, the size of the two groups is affected by such a change with the group of self-employed increasing and the group of employees shrinking in size.² As there are now more individuals in the economy that earn the lower earnings of self-employed, the median earnings of the entire population decrease. In the example shown in Figure 2, median earnings decrease by 3, from 36 to 33. The constant cannot easily be interpreted in the case of UQRs and is therefore not shown in the figure.

Figure 2. Interpreting unconditional quantile regressions



1. This is strictly true when there are no control variables. As soon as control variables are added (e.g. a dummy variable that takes value one if an individual is highly educated and value zero otherwise) the interpretation is slightly different. Let's assume for the sake of demonstration that earnings depend not only on self-employment and education dummies, but also on an unobserved determinant. If the coefficient on the self-employment dummy increases along the earnings distribution, this solely reflects that the dispersion that is due to the unobserved determinant is higher among self-employed since the impact of education is picked up by the education dummy.
2. In the CQR example, the size of the two sectors was hardly affected as only one person was assumed to change employment status.

Both conditional and unconditional quantile regressions are estimated by breaking up the $[0,1]$ interval of quantiles into 10 intervals of equal length so as to be able to simultaneously estimate nine quantile regressions for the quantiles 0.1 to 0.9. As a result, for each year and country, the estimation procedures do not yield a single coefficient for each variable of interest, but nine different coefficients, one for each conditional or unconditional quantile in the range 0.1 to 0.9.¹¹ In the estimation each observation is weighted by the sampling weight of the individual to correct for imperfections in the representativeness of the sample.¹² The standard errors around the estimated parameter values are obtained using a bootstrap procedure with 200 replications in the case of UQRs, whereas for CQRs an analytical solution exists and is used.¹³ The homogeneity hypothesis is rejected in most cases for both CQRs and UQRs, confirming the need to go beyond the mean and the usefulness of quantile regressions.

1.3. Decomposing labour earnings inequality

Earnings differences between two individuals can have two main sources: i) differences in personal characteristics such as the level of education and ii) differences in the returns to these characteristics. Similarly, cross-country differences in earnings inequality can be decomposed into: i) differences in the *composition* of the population (for example, inequality should be higher in countries with a more unequal distribution of education endowment) and ii) differences in *rates of return* (for example, inequality should be higher in countries with a larger wage gap between highly- and low-educated workers).

Several methods have been developed to decompose cross-country differences in inequality which go beyond the decomposition of mean effects proposed by Oaxaca (1973) and Blinder (1973) (for a recent survey, see Fortin *et al.*, 2011). This article adopts a methodology that is close to the one proposed by Firpo *et al.* (2007b) and builds on the UQRs discussed above.¹⁴ The United States is used as the reference country so that each country's level of earnings inequality is compared with the level of inequality in the United States.¹⁵

An important choice is the measure of earnings inequality to be decomposed. Many studies use the Gini index of the logarithm of earnings because their underlying models consider the logarithm of earnings as the dependent variable. A major drawback of this measure is that the scale independence assumption does not hold, meaning that the value of the measure changes when all earnings are multiplied by a certain scale factor. In addition, by putting less weight on the upper part of the earnings distribution, the Gini index of the logarithm of earnings may yield a country ranking that differs from that of the Gini index. The logarithm of the 90/10 percentile ratio does not have these two weaknesses and is therefore preferred in this article. The main limitation of this measure is that it only builds on the estimated effect of explanatory variables at the 10th and 90th percentiles, and leaves aside effects on the middle class.

For each explanatory variable k , the composition effect $C_k^{90/10}$ relies on a comparison of the estimated effects in the two countries (i.e. the United States and the country of interest i) at the 10th percentile and the estimated impact at the 90th percentile. If the rise of, say, the proportion of tertiary-educated workers from the US level to the level observed in country i is relatively small, the effect can be linearised. To get the effect on the 90/10 percentile ratio, the variation of the 90th percentile, i.e. $(E(X_{k,i}) - E(X_{k,USA}))\beta_{k,i}^{90}$ is compared with that of the 10th percentile, i.e. $(E(X_{k,i}) - E(X_{k,USA}))\beta_{k,i}^{10}$:

$$C_k^{90/10} = (E(X_{k,i}) - E(X_{k,USA}))(\beta_{k,i}^{90} - \beta_{k,i}^{10}) \quad (1)$$

where $\beta_{k,i}^{90}$ ($\beta_{k,i}^{10}$) is the coefficient estimate on the variable k at the 90th (10th) unconditional quantile for the country of interest i (the country to be compared with the United States) and $E(X_{k,i})$ is the expectation of the variable X_k conditioned on the fact that the worker belongs to country i (proxied here by the empirical mean within the country).¹⁶

The rate-of-return effect $R_k^{90/10}$ for variable k is computed by running two separate UQRs – one on the United States and another on the country of interest – and then comparing the coefficients at the 10th and 90th percentiles obtained from the two regressions:

$$R_k^{90/10} = E(X_{k,USA})[(\beta_{k,i}^{90} - \beta_{k,i}^{10}) - (\beta_{k,USA}^{90} - \beta_{k,USA}^{10})] \quad (2)$$

This rate-of-return effect can also be regarded as the difference between the rate-of-return effect for high-income earners $E(X_{k,USA})(\beta_{k,i}^{90} - \beta_{k,USA}^{90})$ and the rate-of-return effect for low-income earners $E(X_{k,USA})(\beta_{k,i}^{10} - \beta_{k,USA}^{10})$. The method yields more accurate results for the size of the composition effects than for the size of the rate-of-return effects. In fact, the composition effects strongly rely on differences between the means of the explanatory variables which are known with relatively high precision. By contrast, the rate-of-return effects strongly rely on differences between the estimated rates of return which are intrinsically less accurate. For this reason, solely qualitative conclusions are drawn below regarding the rate-of-return effects.

2. Empirical results: labour earnings inequality and its main determinants

2.1. Benefits and drawbacks of household survey data

Household surveys provide a unique source to investigate the determinants of earnings inequality. They allow exploiting information on individual workers, thus involving substantially more variation in the data than aggregate cross-country information. Moreover, they contain specific information on the linkages between earnings and various personal characteristics that cannot be inferred from aggregate data. Compared with administrative data, survey data have the advantage that individuals' answers to survey questions about earnings should pick up all types of labour earnings that are of interest to this study, whereas data from administrative sources often omit some categories such as non-taxable earnings (in the case of fiscal data), or earnings from additional jobs (in the case of firms' compulsory statements on wages and benefits). Moreover, the household surveys used in this study are designed to cover a representative sample of the whole population, while administrative sources may ignore some sub-samples of the population such as non-taxable workers.

However, the use of household survey data also entails a number of drawbacks that need to be kept in mind when interpreting the results. First, although the surveys are designed to ensure that the sample population is representative of the entire population in terms of its major characteristics, this is not fully the case for some population characteristics that are of particular importance for the present study (such as the share of temporary workers, for example). Second, the number of non-responses can be substantial, not only for the dependent variable but also for some of the explanatory variables (in particular information on the sector of employment or the type of work contract is missing for a larger number of individuals). The analysis assumes that the decision not to respond to a survey question is independent from both the dependent variable and all explanatory variables. To the extent that this assumption is violated, the regression results could be biased. Third, it cannot be ruled out that individuals provide wrong answers to some of the questions or that some of the questions are interpreted differently by different individuals. This problem is likely to be negligible in the present study since the quantile regression technique is fairly robust to outliers, as far as these measurement errors are quite rare. Fourth, in contrast to some administrative data sources (such as tax data), household surveys do not allow the observation of the most extreme parts of the distribution, such as top income earners.

Another issue is the comparability of household survey data across countries. The depth of information varies across surveys, as does the classification of variables and the way in which questions are phrased and thus interpreted by respondents. This article deals

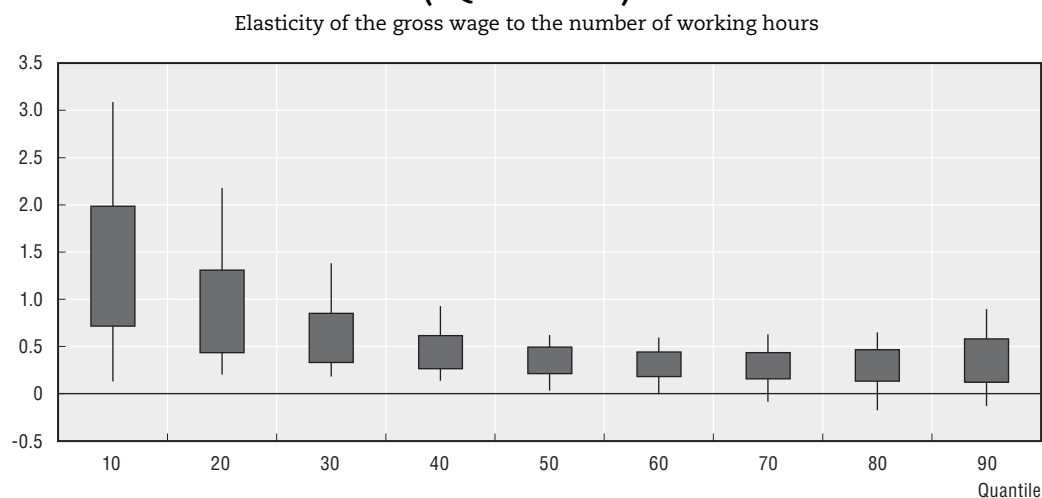
with these problems by starting with the European Union Survey of Income and Labour Dynamics (EU-SILC), which provides a unified framework for 23 OECD countries. For the other nine countries for which household survey data could be collected (Australia, Canada, Chile,¹⁷ Israel,¹⁸ Japan, Korea, Switzerland, the United States and Brazil), all the variables are then chosen and, if necessary, recoded so as to ensure maximum comparability with the EU-SILC dataset. Details on variable manipulation can be found in the Annex.

2.2. The determinants of labour earnings – results from quantile regressions

2.2.1. Hours worked

An important determinant of earnings inequality among the working population is the number of hours worked (generally captured by the number of hours worked per week in all jobs).¹⁹ Unconditional quantile regression results indicate that the marginal returns to increasing the working time by 1% vary substantially across countries, especially at lower quantiles, which may reflect different labour market policy settings and practices, in particular as regards the role of overtime pay (Figure 3 and Table A1 in the Annex). However, one common observation in almost all countries is that the reward for working more is highest for workers at the lower end of the earnings distribution. This could be due to differences in the extent to which time spent at work is recorded, i.e. lower-income workers may be more likely to benefit from overtime pay whereas extra hours by middle and high-income workers may be compensated as part of the basic remuneration package.²⁰ The results suggest that a general decrease in the number of hours worked,

Figure 3. **Estimated effect across countries of increasing the working time by 1% (UQR estimates)**



Note: The thick bars depict the cross-country mean of the estimated effect $\pm$ 1 standard deviation across countries, while the thin bars depict the cross-country maximum and minimum of the estimated effect. The standard deviation, the minimum and the maximum thus provide an indication of the variation of the estimated effect across countries.

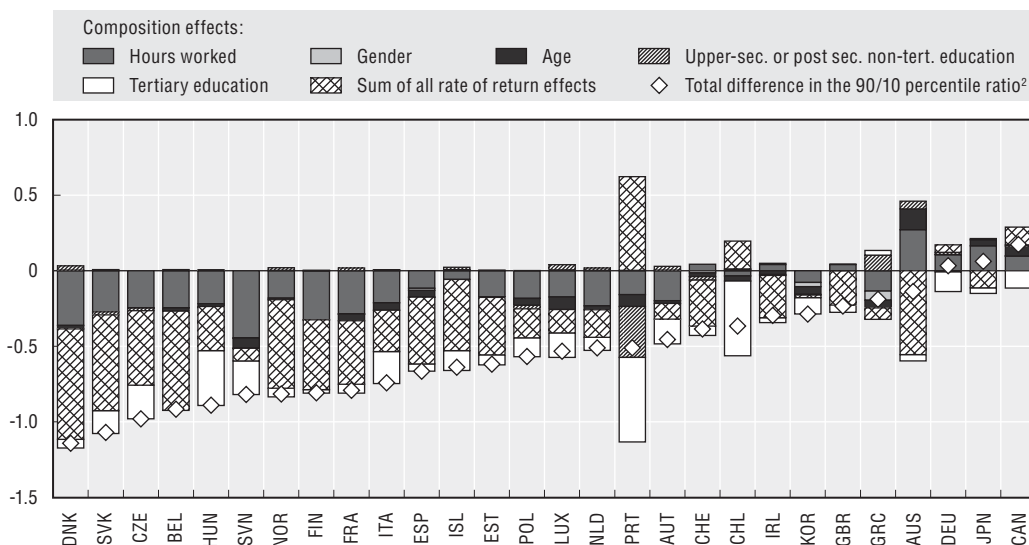
Source: UQR estimates for employed individuals using data from the Household Income and Labour Dynamics in Australia Survey (HILDA) for Australia, the Survey of Labour and Income Dynamics (SLID) for Canada, the National Socioeconomic Characterization Survey (CASEN) for Chile, the Korean Labour and Income Panel Study (KLIPS) for Korea, the Luxembourg Income Study (LIS) for Brazil and Israel, the Japan Household Panel Survey (JHPS) for Japan, the Swiss Household Panel (SHP) for Switzerland, the Panel Study of Income Dynamics (PSID) for the United States, and the European Union Statistics on Income and Living Conditions (EU-SILC) for 21 EU member countries as well as for Iceland and Norway.

triggered for example by an economic recession, would thus particularly hurt lower-income workers through a fall in overtime pay.

The key role played by the numbers of hours worked in shaping the distribution of earnings is confirmed by two other findings. First, the hypothesis of a unit elasticity, and hence a model in which the dependent variable would be the hourly earnings, is rejected for all countries. Second, the contribution of cross-country differences in the average number of hours to cross-country differences in earnings inequality is substantial (Figure 4 and Table A1 in the Annex). Hours worked are very unevenly distributed across the working population in the United States, Australia and Japan, thus contributing to higher earnings inequality in these countries, while the opposite appears to be the case for most European countries.

Figure 4. **Decomposition of cross-country differences in the logarithm of the 90/10 percentile ratio**

The United States is used as reference country, 2007¹



1. 2008 for Canada; 2009 for Chile and Japan.

2. 90/10 percentile ratio of the country shown on the horizontal axis minus 90/10 percentile ratio of the United States.

Note: A negative (positive) contribution of a factor means a lower (higher) dispersion of that factor in the country considered relative to the United States, so that the factor drives inequality down (up) relative to the United States. The decomposition is based on the UQR results. To better capture the contribution of hours worked, a set of dummies is created, with each dummy capturing a bracket of five hours (Sweden is an exception since a dataset of that country only distinguishes between full-time and part-time workers). The results of the decomposition analysis need to be interpreted with care due to cross-country differences in survey designs and very small samples for several countries, most notably Iceland, Ireland, Luxembourg and Portugal.

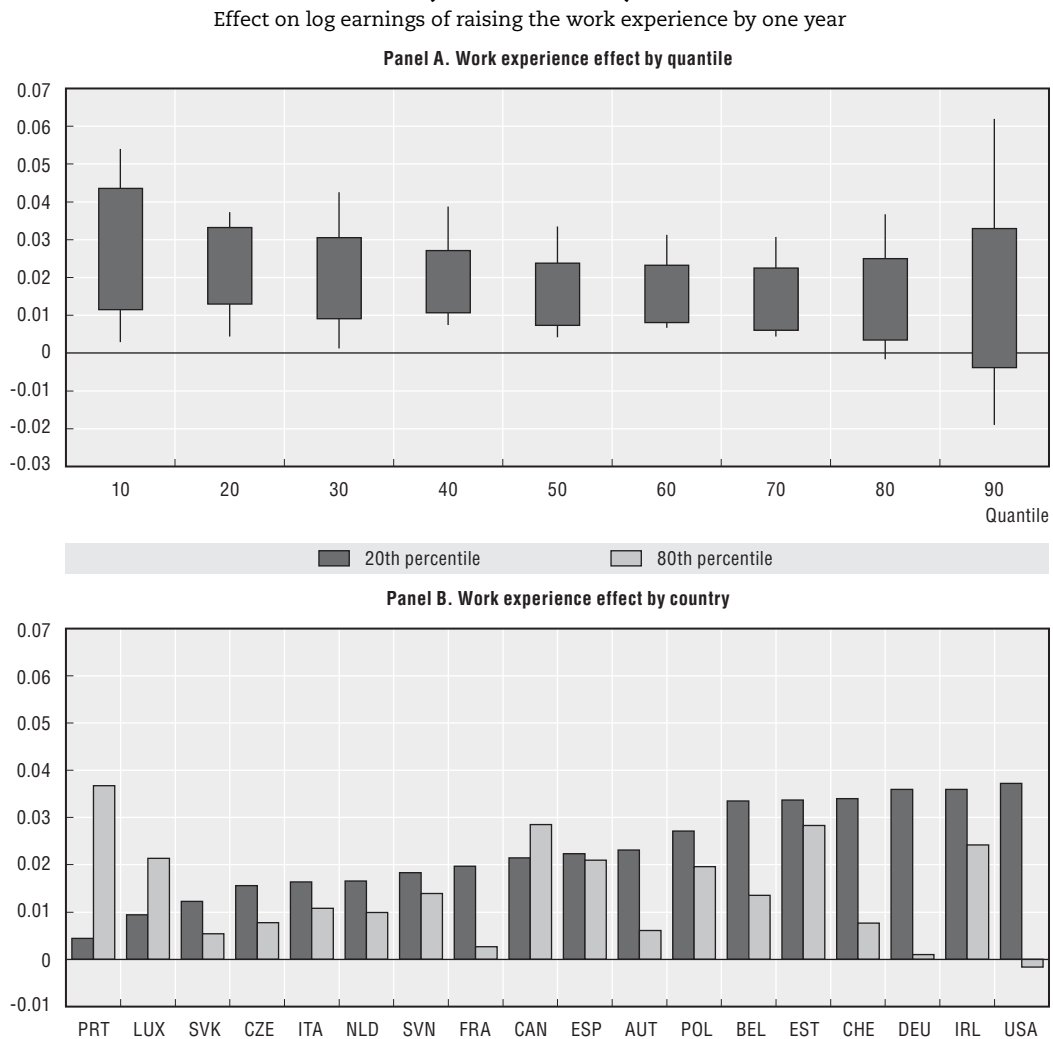
Source: Panel Study of Income Dynamics (PSID) for the United States; Household Income and Labour Dynamics in Australia Survey (HILDA) for Australia; Survey of Labour and Income Dynamics (SLID) for Canada; National Socioeconomic Characterization Survey (CASEN) for Chile; Korean Labour and Income Panel Study (KLIPS) for Korea; Japan Household Panel Survey (JHPS) for Japan; Swiss Household Panel (SHP) for Switzerland; and European Union Statistics on Income and Living Conditions (EU-SILC) for the other countries.

2.2.2. Work experience

The coefficient estimates for the linear and quadratic age terms included in the baseline UQR specification indicate that countries differ widely with respect to the returns to age. In about one-third of the countries returns to age are higher at lower quantiles, whereas the opposite can be observed in another third of the countries. In the remaining

countries the difference is either very small or depends on age. Since the age terms may capture work experience, the baseline specification is augmented with a variable directly measuring individuals' work experience for all countries for which this information is available (both the variable itself and its square are included in the regressions).²¹ The results from this augmented specification reveal that in many countries returns to experience are larger at the lower end of the earnings distribution (Figure 5 and Table A1 in the Annex). Potential explanations are that work experience plays a larger role in lower-paid jobs or that seniority pay is more prevalent in these types of jobs. The coefficients on

Figure 5. **The effect on earnings of having one additional year of work experience (UQR estimates)**



Note: In Panel A, the thick bars depict the cross-country mean of the estimated effect ± 1 standard deviation across countries, while the thin bars depict the cross-country maximum and minimum of the estimated effect. The standard deviation, the minimum and the maximum thus provide an indication of the variation of the estimated effect across countries. The specification includes the number of years of work experience and its square. The chart shows the effect for a worker with 20 years of work experience. In Panel B, each bar depicts the UQR estimate for a given country and quantile.

Source: UQR estimates for employed individuals using data from the Survey of Labour and Income Dynamics (SLID) for Canada, the Swiss Household Panel (SHP) for Switzerland, the Panel Study of Income Dynamics (PSID) for the United States, and the European Union Statistics on Income and Living Conditions (EU-SILC) for 15 EU member countries.

the age terms become smaller after controlling for work experience, as could be expected, but remain significant in half of the countries. There thus seems to be an age-specific reward that goes beyond the pure work experience effect.

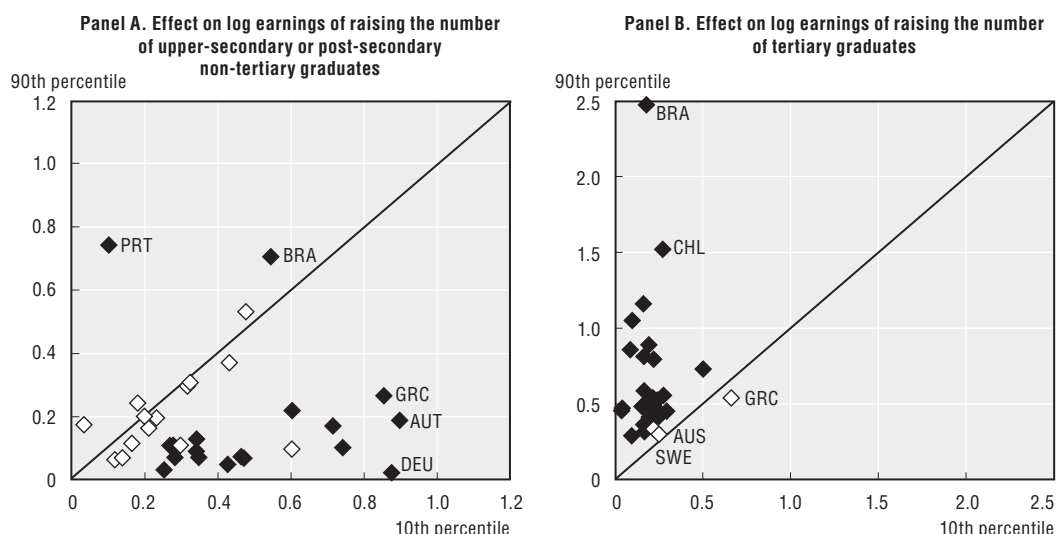
2.2.3. Education

Theory suggests that the link between education and labour earnings inequality is far from straightforward. The impact of a change in the educational composition of the workforce can be thought of as the sum of two separate effects (Knight and Sabot, 1983): i) a composition effect, whereby a rise in the share of highly-educated (high-wage) workers raises earnings inequality up to a certain point, but will then lower it as fewer less-educated (low-wage) workers remain; and ii) a rate-of-return effect, whereby a rise in the share of highly-educated workers alters the returns to education. The direction of the change in (relative) returns depends on many factors such as the substitutability or complementarity between low-educated workers, highly-educated workers and capital, the interplay between innate ability and schooling (Dur and Teulings, 2004), and the signalling role of education (*e.g.* Hendel *et al.*, 2005).

The composition effect of a change in the educational level of the workforce depends on: i) the variance of wages among highly-educated workers relative to the variance of wages among low-educated workers; ii) the average wage gap between highly- and low-educated workers; and iii) the initial share of highly- and low-educated individuals in the total workforce. Specifically, if earnings are more dispersed among highly-educated individuals, then an increase in the share of highly-educated individuals raises earnings inequality, *ceteris paribus*. A second inverted-U-shaped effect is then superimposed on this monotonic first effect, whereby (starting from zero) a rise in the share of highly-educated individuals initially raises earnings inequality as the earnings of some workers now differ from that associated with a low education level, but eventually inequality declines as more and more individuals have higher education and heterogeneity in education attainment is reduced.

The unconditional quantile regressions provide an estimate of the returns to education for nine different earnings quantiles. The results suggest that, on average across countries, an upper-secondary or post-secondary non-tertiary degree is associated with an earnings premium of 700 USD per month (relative to a lower-secondary degree) and a tertiary degree is associated with a further premium of more than 1100 USD per month. The variation in the rates of return across quantiles can be interpreted as the composition effect of a change in the educational composition of the workforce.^{22, 23} For upper-secondary or post-secondary non-tertiary education, the UQR estimates show that the returns fall along the earnings distribution for most countries (in Panel A of Figure 6 almost all countries with a significant difference between the impact on the 10th and the 90th percentile are located below the 45-degree line), meaning that the dispersion of earnings would fall as more individuals get upper-secondary or post-secondary non-tertiary degrees – a result that is to be expected as the majority of individuals in the countries considered already have upper-secondary education.^{24, 25} By contrast, a rise in the number of tertiary graduates changes the composition of the workforce in such a way that earnings become more dispersed (in Panel B of Figure 6, all countries but Greece are located above the 45-degree line): the rate of returns to a tertiary degree rises along the earnings distribution. For the four countries, for which more detailed information on education are available (Australia, Korea, Switzerland and the United States), splitting up

Figure 6. The impact of education on the distribution of earnings (UQR estimates)



Note: The horizontal axis shows the impact of a 1 percentage point increase in the proportion of workers with, respectively, upper-secondary or post-secondary non-tertiary (Panel A) and tertiary (Panel B) education on the log earnings of the 10th quantile. The vertical axis shows the impact of the same change on the log earnings of the 90th quantile. A data point below (above) the 45 degree line indicates that the change in the educational composition of the workforce is associated with a fall (rise) in earnings inequality. The equality test is performed at the 5% level. Source: UQR estimates for employed individuals using data from the Household Income and Labour Dynamics in Australia Survey (HILDA) for Australia, the Survey of Labour and Income Dynamics (SLID) for Canada, the National Socioeconomic Characterization Survey (CASEN) for Chile, the Korean Labour and Income Panel Study (KLIPS) for Korea, the Luxembourg Income Study (LIS) for Brazil and Israel, the Japan Household Panel Survey (JHPS) for Japan, the Swiss Household Panel (SHP) for Switzerland, the Panel Study of Income Dynamics (PSID) for the United States, and the European Union Statistics on Income and Living Conditions (EU-SILC) for 21 EU member countries as well as for Iceland and Norway.

the tertiary education dummy into a dummy for bachelor and master degrees and a dummy for PhD degrees shows that a rise in the share of workers with a PhD is associated with a rise in earnings inequality and that this effect is concentrated on the top part of the earnings distribution.²⁶

Using the UQR estimates to decompose cross-country differences in the 90/10 percentile ratio suggests that differences in the educational composition of the workforce play an important role (Figure 6 and Table A1 in the Annex). *Ceteris paribus* (i.e. assuming in particular that the relative rates of return to education remain unchanged), the high shares of workers with tertiary education in countries such as Ireland and the United States imply a high 90/10 percentile ratio relative to other countries, while low tertiary education attainment in Portugal, Chile and Hungary implies the opposite. The share of workers with an upper-secondary or post-secondary non-tertiary degree does, in general, not play a major role in explaining cross-country differences in earnings inequality, reflecting first that most countries do not differ much in the share of workers holding such a degree and second the smaller impact of this factor in shaping the distribution of earnings in most countries.²⁷

The impact of changing the educational composition of the workforce on earnings inequality, as inferred from the UQRs, reflects only a composition effect that assumes unchanged returns to education. However, as discussed above, a change in the educational composition of the workforce may alter the relative returns to education. The resulting repercussions on earnings inequality may strengthen or weaken the composition effect as

estimated by the UQRs. A simple cross-country time series regression of the average returns to a certain education degree (obtained from an OLS estimation of the baseline specification) on the share of individuals holding such a degree and country fixed-effects tentatively indicates that a rise in the number of tertiary graduates significantly lowers the relative returns to tertiary degrees,²⁸ while the returns to upper-secondary and post-secondary non-tertiary degrees are not influenced by the share of workers with such degrees. This means that the impact of a rise in the share of tertiary educated workers on earnings inequality is likely to be smaller than estimated with UQRs (and may even be negative),²⁹ while for upper-secondary and post-secondary non-tertiary education, the UQR results can be regarded as the total effect.

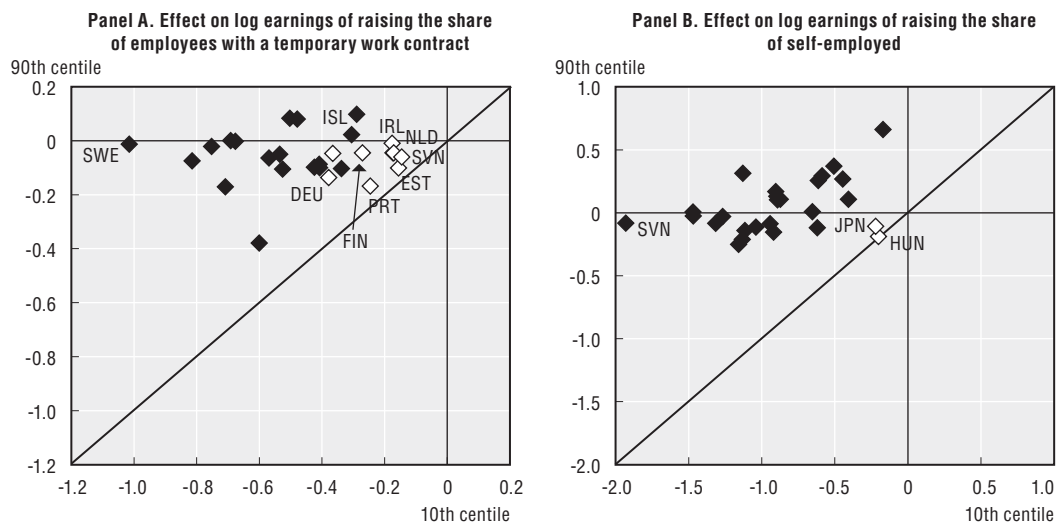
An individual's earnings may not only be influenced by his own education but, through spillover effects, also by the education level of individuals with whom he interacts. To investigate this issue, the baseline UQR specification for the United States is augmented with three additional variables which measure the proportion of workers in an individual's state of residence who hold an upper-secondary or post-secondary non-tertiary, a tertiary or a PhD degree. For the majority of quantiles, the three additional variables are not significant, suggesting that the spillover effects are at best small. This is in line with the findings of Acemoglu and Angrist (1999) who conclude that spillovers are significant but small.

2.2.4. *Type of employment*

The impact of the type of employment on labour earnings inequality is assessed by augmenting the baseline UQR specification with a dummy variable for being self-employed and a dummy variable for holding a temporary work contract (therefore employees with a permanent work contract serve as the reference group). UQR results provide robust evidence that employees on temporary contracts earn less than those on permanent contracts (Panel A of Figure 7) – a loss that comes on top of the intrinsic lack of job stability. At the median, the earnings penalty amounts to more than 500 USD per month, on average across countries. The difference in earnings is particularly large for workers at the bottom of the earnings distribution. Only the earnings of high-income employees are less dependent on the type of work contract: in almost all countries the coefficient on the contract dummy is smaller in absolute magnitude at the 90th quantile than at the 10th quantile and in about two-thirds of them it is not significantly different from zero.³⁰

Being self-employed also generally entails an earnings penalty (relative to being employed with a permanent work contract) at lower quantiles according to unconditional quantile regression estimates (Panel A of Figure 7). The effect is particularly sizeable in Slovenia and, to a lesser extent, Poland, Finland, Greece and Sweden, whereas it is relatively small (though still statistically significant) in Hungary and Japan. Also at the median, there is still an earnings penalty for being self-employed. On average across countries, this penalty amounts to around 650 USD per month. For higher quantiles, the regressions yield more diverse results. In about one-half of the countries, earnings at the 90th quantile do not depend on whether the worker is self-employed or employees with a permanent contract. In a quarter of the countries, self-employed workers earn significantly more than their counterparts on permanent work contracts (potentially driven by self-employed in the professional services sectors) and in the remaining quarter of the countries they earn less. According to the CQR results the magnitude of this earnings gap at the 90th quantile is rather small (relative to the gap at the 10th quantile) in all countries

Figure 7. **The impact of the type of employment on the distribution of earnings (UQR estimates)**



Note: The horizontal axis shows the impact of a 1 percentage point increase in the proportion of workers who are respectively dependent-employed with a temporary work contract (Panel A) or self-employed (Panel B) on the log earnings of the 10th quantile. The vertical axis shows the impact of the same change on the log earnings of the 90th quantile. A data point below (above) the 45 degree line indicates that the change in the composition of the workforce as regards the type of employment is associated with a fall (rise) in earnings inequality. The equality test is performed at the 5% level.

Source: UQR estimates for employed individuals using data from the Household Income and Labour Dynamics in Australia Survey (HILDA) for Australia, the Survey of Labour and Income Dynamics (SLID) for Canada, the National Socioeconomic Characterization Survey (CASEN) for Chile, the Korean Labour and Income Panel Study (KLIPS) for Korea, the Japan Household Panel Survey (JHPS) for Japan, the Swiss Household Panel (SHP) for Switzerland, and the European Union Statistics on Income and Living Conditions (EU-SILC) for 19 EU member countries as well as for Iceland and Norway.

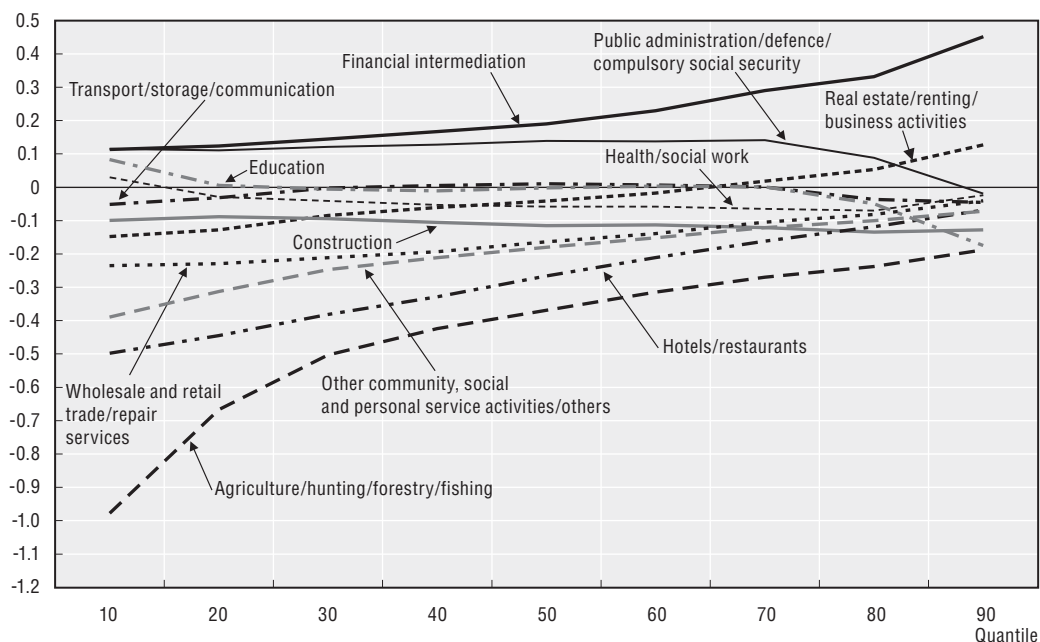
considered, implying that the earnings among self-employed individuals are more dispersed than those of employees who have a permanent work contract.

2.2.5. Sector of employment

To explore whether the sector composition of the economy has an influence on earnings inequality, the baseline specification is augmented with eleven dummy variables, one for each of the following sectors: “Agriculture/hunting/forestry/fishing”; “construction”; “wholesale and retail trade/repair services”; “hotels/restaurants”; “transport/storage/communication”; “financial intermediation”; “real estate/ renting/ business activities”; “public administration/defence/compulsory social security”; “education”; “health/social work”; “other community, social and personal service activities/others”.³¹ The omitted sector “mining/quarrying/manufacturing/electricity, gas and water supply” serves as the reference sector. The UQR results suggest that a shift in the sector composition would not in general have a large impact on the distribution of earnings. As shown in Figure 8, for most sectors the earnings effect is roughly constant along the earnings distribution. Four sectors, that show some variation along the earnings distribution, are “agriculture/hunting/forestry/fishing”, “hotel/restaurants”, “other community, social and personal service activities/others” and “financial intermediation”. A rise in the share of the first three sectors is associated with a decrease of earnings at the lower end of the earnings distribution. A rise of the share of financial intermediation implies higher inequality for a different reason: the earnings gain is concentrated at the

Figure 8. The impact of the sector composition on the distribution of earnings (UQR estimates)

Effect on log earnings of increasing the share of a certain sector by 1 percentage point (relative to “mining & quarrying/manufacturing/electricity gas & water supply”), unweighted cross-country average



Note: While standard errors are not reported in the figure for the simplicity of the exposure, the UQR results show that the effect of working in the financial sector (in the agriculture/hunting/forestry/fishing sector) differs significantly between the 10th and 90th quantile in about half (two-thirds) of the countries

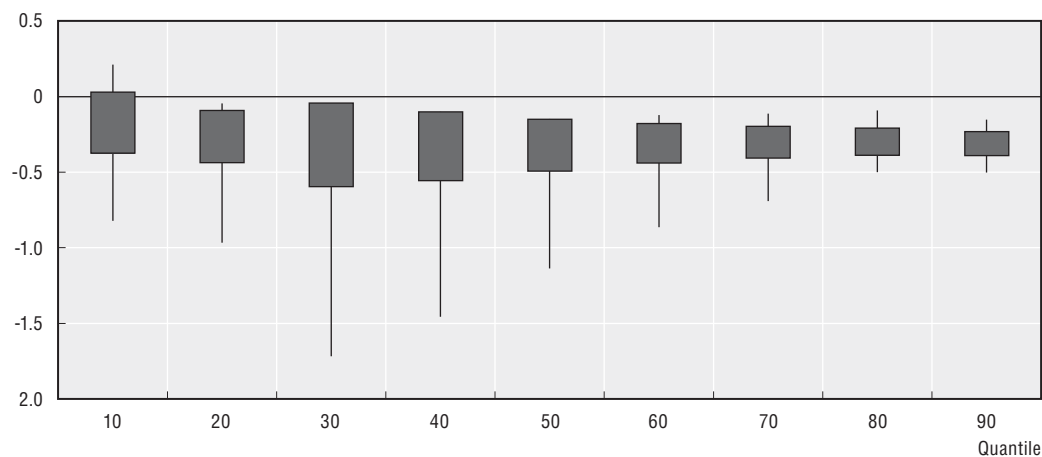
Source: UQR estimates for employed individuals using data from the Household Income and Labour Dynamics in Australia Survey (HILDA), the Korean Labour and Income Panel Study (KLIPS), the Luxembourg Income Study (LIS) for Brazil and Israel, the Japan Household Panel Survey (JHPS), the Swiss Household Panel (SHP), the Panel Study of Income Dynamics (PSID) for the United States, and the European Union Statistics on Income and Living Conditions (EU-SILC) for 21 EU member countries as well as for Iceland and Norway.

higher end of the earnings distribution. In line with the rather small role played by the sector of employment in driving the distribution of earnings, the contribution of cross-country differences in the sector composition to cross-country differences in earnings inequality is in general fairly limited (Figure 4).

2.2.6. Gender inequality

Despite some decline over the past decades, gender differences in labour market performance are still striking in most OECD countries. Women are less likely to be employed than men and those who work typically earn less than their male counterparts (OECD, 2010). For all countries considered, the unconditional quantile regression estimates confirm that women earn less than men – the coefficient on the gender dummy in the baseline specification is significantly negative for almost all quantiles (Figure 9) – even after controlling for factors such as education and the number of working hours. On average across countries, the earnings difference amounts to 750 USD per month at the median. While this might be due to factors that are not controlled for in the estimation, it may also reflect discrimination.³² While the present analysis does not point to significant differences in the size of the gap along the earnings distribution (linked in part to the rather large standard errors) other studies show that the gap is more pronounced at the upper tail of the distribution (e.g. Christofides et al., 2010).

Figure 9. **The gender earnings gap (UQR estimates)**
Effect of being female relative to being male on the log earnings



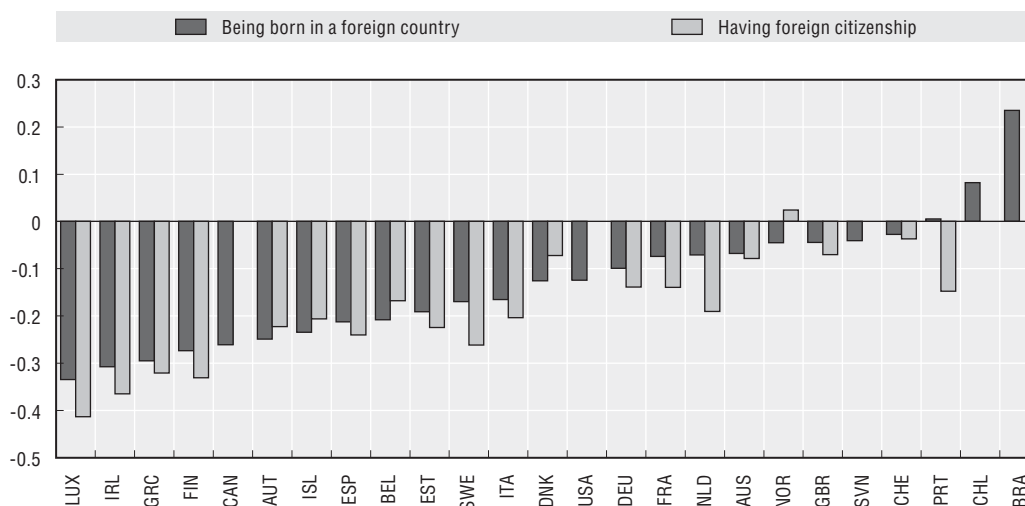
Note: The thick bars depict the cross-country mean of the estimated effect ± 1 standard deviation across countries, while the thin bars depict the cross-country maximum and minimum of the estimated effect. The standard deviation, the minimum and the maximum thus provide an indication of the variation of the estimated effect across countries.

Source: UQR estimates for employed individuals using data from the Household Income and Labour Dynamics in Australia Survey (HILDA) for Australia, the Survey of Labour and Income Dynamics (SLID) for Canada, the National Socioeconomic Characterization Survey (CASEN) for Chile, the Korean Labour and Income Panel Study (KLIPS) for Korea, the Japan Household Panel Survey (JHPS) for Japan, the Swiss Household Panel (SHP) for Switzerland, the Panel Study of Income Dynamics (PSID) for the United States, and the European Union Statistics on Income and Living Conditions (EU-SILC) for 19 EU member countries as well as for Iceland and Norway.

2.2.7. Migration

Migration may influence labour earnings inequality both because immigrants alter the labour market outcomes of natives and because immigrants may fare differently in the labour market (Borjas, 1999).³³ The latter issue is investigated here by augmenting the baseline specification with two alternative dummy variables, capturing whether a person has foreign citizenship and whether he/she was born in a foreign country, respectively.^{34, 35} The unconditional quantile regression results point to a substantial cross-country variation in the earnings gap between foreigners and natives (Figure 10).³⁶ Focusing on the country-of-birth dummy, there is no significant earnings gap between natives and foreigners for most parts of the earnings distribution in eight out of the 21 countries considered (Chile, Hungary, Netherland, Norway, Portugal, Slovenia, Switzerland and the United Kingdom).^{37, 38} In the remaining countries foreigners typically earn less than natives, with the exception of Brazil where they tend to earn more – even controlling for other factors such as education. Whether the size of this earnings gap differs across quantiles depends again widely on the country considered. The large cross-country differences in the earnings gap between natives and foreigners may reflect, in part, differences in the structure of the immigrant population (in terms of country of origin, timing of immigration or motivation) and differences in countries' policy settings such as restrictions in migrants' rights or targeted measures (Jean *et al.*, 2010).³⁹

Figure 10. The earnings gap between natives and immigrants (UQR estimates)



Source: UQR estimates for employed individuals using data from the Household Income and Labour Dynamics in Australia Survey (HILDA) for Australia, the Survey of Labour and Income Dynamics (SLID) for Canada, the Luxembourg Income Study (LIS) for Brazil, the Swiss Household Panel (SHP) for Switzerland, the Panel Study of Income Dynamics (PSID) for the United States, and the European Union Statistics on Income and Living Conditions (EU-SILC) for 21 EU member countries as well as for Iceland and Norway.

3. Conclusion

This paper has analysed the drivers of labour earnings inequality for a sample of 32 countries using quantile regressions. The empirical work has highlighted a number of features that are common among a majority of the countries considered, which allows drawing some quite general conclusions from the analysis. Specifically, the following main findings have emerged from the work:

- The number of hours worked is an important determinant not only of an individual's earnings but also of earnings inequality among the working population. In almost all countries the estimated reward for working one additional hour is highest for workers at the lower end of the earnings distribution, possibly reflecting the role of overtime pay. The number of hours worked appears to play a key role in shaping both the within-country distribution of earnings and cross-country differences in earnings inequality.
- In most countries, the returns to age are higher at lower quantiles. To the extent that the age terms capture an individual's work experience, this suggests that work experience plays a larger role in lower-paid jobs and/or that seniority pay is more prevalent in these types of jobs.
- The link between education and earnings inequality is ambiguous from a theoretical point of view. First, via a composition effect a rise in the share of highly-educated (high-wage) workers raises earnings inequality up to a certain point, but will then lower it as fewer low-education (low-wage) workers remain. Second, a rise in the share of highly-educated workers alters the returns to education, with the direction of the change depending on many factors such as the substitutability between low- and high-education workers. The empirical evidence indicates that policies to increase upper-secondary graduation rates (e.g. by providing support to pupils at risk in order to reduce drop-outs) should reduce earnings inequality. Whether similar benefits can be expected

from reforms that encourage more students to pursue tertiary studies is unclear and depends on the relative magnitudes of the different offsetting effects.

- For those at the bottom of the earnings distribution, being on a temporary rather than on a permanent contract implies lower labour earnings, even controlling for other individual characteristics. Being self-employed also generally entails an earnings penalty (relative to being employed with a permanent work contract) at lower quantiles. For higher quantiles, the type of contract and work status typically matter less.
- Labour earnings vary across different sectors of the economy, but, in general, a shift in the sector composition does not have a large impact on the overall distribution of earnings. Consequently, the contribution of cross-country differences in the sector composition to cross-country differences in earnings inequality also tends to be fairly small. The only exceptions are “agriculture/hunting/forestry/fishing”, “hotel/restaurants”, “other community, social and personal service activities/others” and “financial intermediation”, with a rise in the shares of these four sectors being associated with somewhat higher earnings inequality.

Notes

1. The discussion of the results often makes reference to the average effect across countries. It should be noted that these cross-country averages shall not be seen as the effect among the entire population in the group of countries considered in this study, but rather as the effect in a representative country. Analysing inequality effects at a more aggregate level is beyond the scope of this paper. The interested reader is referred to the paper by Bourguignon and Morrisson (2002) which investigates inequality at the world level.
2. Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, and the United Kingdom (European Union Statistics on Income and Living Conditions); Australia (Household Income and Labour Dynamics in Australia Survey); Canada (Survey of Labour and Income Dynamics); Chile (National Socioeconomic Characterization Survey); Korea (Korean Labour and Income Panel); Japan (Japan Household Panel Survey); Switzerland (Swiss Household Panel) the United States (Panel Study of Income Dynamics); Brazil and Israel (Luxembourg Income Study). Unless explicitly stated otherwise, all results reported refer to the latest available survey year. This is 2008 for all countries with the exception of Israel (2005), Brazil (2006), France, Korea and the United States (2007) as well as Australia, Chile and Japan (2009). Note that the reference year for data on earnings as well as most other variables capturing an individual's job characteristics is the preceding year.
3. Due to the different designs of the surveys used, the precise definition of this variable differs somewhat across countries, which may limit the comparability of results (see the Annex for details).
4. Descriptive statistics such as decile ratios hinge crucially on the sample population. The descriptive statistics obtained in our study may therefore differ from those obtained by studies that focus on different samples such as the total population or full-time workers.
5. For all countries covered by the EU SILC survey, this classification matches with the classification used in the survey. For all other countries the data on education had to be recoded (see the Annex for details).
6. Other recent applications of quantile regressions that use a similar dummy variable structure to capture an individual's education level include Budria and Pereira (2005), Budria and Moro-Egido (2008) and Prieto-Rodriguez *et al.* (2008).
7. The results are robust to the addition of a dummy variable for having a post-secondary non-tertiary degree and a dummy variable for having a PhD degree (for those countries for which this information is available).
8. Adding these variables to the baseline specification hardly alters the results obtained for the baseline variables.

9. Unconditional quantile regressions provide an estimate of the partial equilibrium effect of the variable of interest, assuming that the unobserved heterogeneity is independent from the observed characteristics and that there is no reverse causality. The marginal change in X is assumed to have no impact on the joint distribution of X and Y , meaning that rates of return do not vary in the case of small variations in any of the observed characteristics X . While these assumptions may not hold in practice – for instance, a worker's decision to work extra hours may depend on earnings – a comparison between estimates for low and high quantiles is still valid in that case as long as the potential bias is the same across the sample population.
10. Firpo *et al.* (2009) extend the interpretation to dummy variables. For example, the coefficient on a dummy variable that takes value zero if the person works is self-employed and value one otherwise can be interpreted as the impact on earnings of raising the probability of being self-employed by 1 percentage point.
11. Since the quantile regression estimates vary quite smoothly for small changes in the chosen quantile, the results of the analysis would be fairly similar if other quantiles were chosen. Indeed, estimating quantile regressions for 19 quantiles in the range 0.05 to 0.95 did not change the conclusions.
12. Sampling weights typically compensate for unequal probabilities of selection and non-response and adjust the sample distribution for key variables of interest (for example, age and gender) to make it conform to a known population distribution. Still, the samples might not be fully representative with respect to all characteristics that are of interest to this study and thus the results need to be interpreted with care.
13. Only when testing for the homogeneity of effects across quantiles are bootstrapped standard errors also used for CQRs, since the analytical standard errors cannot be used for such tests. The bootstrapped standard errors of the CQR procedure are based on unweighted data. While the use of weights is important to obtain correct estimates of key parameters such as the quantiles, they are not crucial for the implementation of the homogeneity test.
14. The main difference with respect to the methodology proposed by Firpo *et al.* (2007b) is that their method makes use of a regression that is run on the country of interest and assumes that all explanatory variables follow the same distribution in that country as they do in the United States. This regression is omitted in the approach adopted in this paper and the information is instead taken from a regression on the country of interest without changing the distribution of the explanatory variables. This simplified approach assumes that the probability of being above a certain quantile in the distribution is linear in the set of explanatory variables. While this assumption facilitates the derivation of the rate of return effects from the estimation results of the unconditional quantile regressions, it may not hold for countries that deviate considerably from the United States in terms of their population characteristics.
15. Although the precise estimation results depend on the choice of reference country, the general conclusions are fairly robust to this choice. Results for other reference countries are available from the authors upon request.
16. While the rates of return are assumed to be homogenous within each sub group, they are allowed to differ between the two sub groups. However, in case they differ, the results depend on the reference group, reflecting the path dependence of this decomposition.
17. The dataset for Chile is adjusted so as to match national accounts data. This may potentially alter the inequality measures used in this paper (see Bravo and Valderrama Torres, 2011).
18. The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.
19. Any cross-country comparison of the regression results for the hours-worked variable needs to be made with great caution as the survey questions used to calculate the number of working hours differ across surveys. Furthermore, special caution is needed in interpreting the price magnitudes of the estimated coefficients because the potential simultaneity bias is not addressed in this analysis which focuses on differences across quantiles.
20. While the basic wage rate may also vary with the number of working hours, this is unlikely to adequately explain the observed heterogeneity in the return to hours worked as several studies show that wage offers to part-timers are actually lower than those to full-time workers (e.g. Moffitt, 1984; Simpson, 1986; Ermisch and Wright, 1993).

21. In general, work experience refers to the number of years spent in paid work. The only exception is the United States, where it only includes the experience with the current employer.
22. In the short run this change will only affect the younger generation, but it will affect the entire population in the long run once the newly-educated generation has grown older. Because younger workers typically earn less than older ones, the short-term effect of a rise in education attainment is thus likely to be more concentrated on the lower end of the earnings distribution.
23. The unconditional quantile regression technique does not take into account selection effects associated with a potential change in labour force participation (*e.g.* when a rise in the level of education boosts participation rates of women).
24. Two notable exceptions are Portugal and Brazil, where upper secondary and post-secondary non-tertiary education is found to be more profitable for those at the top of the earnings distribution. This could be due to the lower average education level compared with the other countries in the sample. The results for Portugal are in line with existing empirical evidence (*e.g.* Machado and Mata, 2001; Hartog *et al.*, 2001).
25. The results depend somewhat on the choice of the estimator in the second step of the UQRs. When using the logistic estimator instead of the OLS estimator, the finding still holds for 12 countries, while for roughly one-third of the countries the effect at the 90th quantile is then above that at the 10th quantile. For seven countries, the hypothesis of equal coefficients across the entire range of quantiles cannot be rejected when using the logistic estimator, meaning that, a rise in the share of workers with upper-secondary or post-secondary non-tertiary degrees does not alter the distribution of earnings.
26. The regressions that make use of the logistic estimator in the second step of the UQRs can, however, not confirm this finding, potentially related to the small share of individuals with a PhD in the working population.
27. The only exception is Portugal where this factor contributes to reduce the inequality gap *vis-à-vis* the United States. This reflects the very low share of upper-secondary or post-secondary non-tertiary educated workers in Portugal combined with a strong positive link between the share of such workers and the level of earnings inequality.
28. The estimated coefficient is -0.23 with a standard error of 0.11.
29. The cross-country time-series analysis by Koske *et al.* (2012) tentatively indicates that the total effect is indeed negative, *i.e.* a rise in the share of workers with a tertiary degree is associated with a decline in labour earnings inequality.
30. The interpretation of these results requires considerable care since an individual's earnings and his type of work contract might be influenced by common causes. In that case, the negative relationship may reflect these causes, rather than a causal effect.
31. This classification is used in the surveys of all countries with the exception of Australia, Canada, Chile, Japan, Korea, Switzerland and the United States. For these countries the original sector classification had to be changed so as to approximate the classification of the other countries. As this did not lead to a satisfactory classification in the case of Canada, the variable is not calculated for this country.
32. The same result is obtained using conditional quantile regressions, suggesting that the conclusion is robust to the choice of the estimation technique.
33. At the same time, the level of earnings inequality in the destination country (relative to that in the source country) may influence migration flows (see Liebig and Sousa-Poza, 2004, for a brief overview of the theoretical underpinnings as well as empirical evidence).
34. For a discussion of the former issue see Kierzenkowski and Koske (2012) and the literature cited therein.
35. Data on the two dummy variables are only available for a subset of countries. For all countries for which the analysis is based on the SILC dataset, foreign citizenship means non-EU citizenship and being born in a foreign country means being born outside of the EU. The differences (in terms of the education system, culture, etc.) are assumed to be bigger between those born outside the EU and those born inside the EU, as compared with the differences between different EU countries. For Canada, the birth-country dummy takes value one if the individual is an immigrant and for the United States, the birth-country dummy refers to respondents that are in the immigration sample. For all other countries, the birth-country (citizenship) dummy refers to those who are born outside the country (have foreign citizenship).

36. Conditional quantile regressions yield the same conclusion.
37. The finding of significant differences for around two-thirds of the countries is rather encouraging in light of the small number of immigrants in the samples which enlarges the standard errors around the estimated coefficients.
38. In the case of the United States, being black has a negative impact on earnings that is more pronounced for higher quantiles. No evidence of an earning gap is found for other ethnic groups. In the case of Brazil, a similar pattern penalises black workers. In addition, indigenous individuals and individuals of mixed origin also suffer from lower earnings, with the impact stronger for higher quantiles.
39. The contribution of differences in personal characteristics such as education, the sector of employment and the occupation to the earnings gap between natives and foreigners is discussed in Koske et al. (2012).

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ANNEX

Further details on the empirical analysis

A1. Further details on the data set

Sample population

Unless explicitly stated otherwise, all results reported refer to the latest available survey year. This is 2008 for all countries with the exception of Israel (2005), Brazil (2006), France, Korea and the United States (2007) as well as Australia, Chile and Japan (2009). The reference year for data on earnings is the preceding year. Although this generally also applies to other variables that capture an individual's job characteristics, there are exceptions. Most notably, in the case of the SILC survey, the number of hours worked refers to the year the survey was conducted, which leads to time inconsistencies with respect to the earnings data. For simplicity, the number of hours worked in the survey year is used as a proxy for the number of hours worked in the preceding year – an assumption that appears reasonable given the strong link between the number of hours worked and the earnings variable as given by the quantile regressions.

All samples are designed to cover the employed population. Individuals of working age (defined as individuals aged between 15 and 64) are included in the analysis if their self-defined economic status is “working” and if their earnings are positive (although rare in the datasets, negative earnings may occur if self-employed individuals make a loss on their business). For instance, this includes part-time workers but excludes students that regard a job as a secondary activity. The sample covers both dependent and self-employed individuals (restricting the analysis instead to employees hardly affects the results). While some individuals cannot be included in the analysis due to lack of information for one or several of the explanatory variables or the weights, this is rare for all countries except for Israel and the United States. The data set is directly built from individual files for all countries but the United States and Japan, where family files are used, observations being split into two files (head and spouse) if applicable. In cases where descriptive statistics consider full-time workers only, the selection of individuals is generally based on their self-declared employment status. The only exceptions are Brazil, Chile, Israel and the United States, for which no variable is available stating whether a salaried worker works part-time or full-time. For this reason, individuals are considered to work part-time if they work strictly less than 35 hours a week and zero otherwise.

Labour earnings

In all regressions, the dependent variable is gross monthly labour earnings. Due to the different designs of the surveys used, the precise definition of this variable differs somewhat

across countries. For all EU-SILC countries, Australia and Korea, gross labour earnings include employees' social security contributions and overtime pay, but exclude employers' social contributions and fringe benefits. Whether stock options are included is not certain. In the case of multiple jobs, the total earnings from all jobs are considered. For Japan, data on labour earnings exclude bonuses, while bonuses are included in the case of Brazil, Israel, Switzerland and the United States. In the case of Chile, the variable used is labour income, with no further details provided on the precise definition of this variable. Finally, it is not clear whether labour earnings data for the United States include fringe benefits. For those who work only for part of a given year, self-declared labour earnings reflect the monthly earnings while working. For Canada, Japan, the United States and all countries covered by the SILC dataset, annual labour earnings are divided by the number of months worked during the year. This technical fix was not possible for Chile, Korea and Switzerland.

For all countries, earnings from both dependent employment and self-employment are included. In the case of self-employed individuals all income from self-employment is taken into account irrespective of whether it accrues in the form of labour or capital income (the data do not allow making this distinction). For earnings from self-employment in Canada, only net earnings are available, altering the comparability between earnings from self-employment and earnings from dependent employment. The coefficient on the self-employment dummy obtained for Canada is thus not fully comparable with those obtained for other countries.

Hours worked

As far as possible, hours worked are defined so as to fit with the earnings variable. For the EU-SILC survey this refers to the number of hours usually worked per week in the main job plus the number of hours usually worked per week in other jobs, including overtime work as far as this overtime work is frequent. In the cases of Australia and Canada similar concepts are considered. However, if the number of hours worked in all jobs is unknown as in the Switzerland survey, the number of hours worked in the main job is considered instead. In the case of Chile the number of hours worked is used, with no details provided on which jobs are included in this definition. The survey that is used for the United States builds the number of hours worked on several very detailed questions, and the high number of hours worked may be due to this particular set up that is not comparable with other surveys. In the case of Korea and Japan, there is no information on whether the reported working hours refer to the main job only or all jobs held by the individual. In the case of Brazil, the usual weekly hours worked in all jobs are considered which also include unpaid work. In the case of Israel, the number of hours worked refers to time spent working as an employee (excluding work as a self employed).

Education

To provide a homogenous measure across all countries, the highest education level is captured by two dummies, one for having at least upper-secondary education and another one for having tertiary education. Education in the SILC survey is coded according to the ISCED level, namely pre-primary education; primary education; lower secondary education; upper-secondary education; post-secondary non-tertiary education and tertiary education. No distinction is made between the first three levels (*e.g.* lower secondary education or less) because there are very few workers who have not reached at least lower-secondary education, and hence all workers without at least a lower-secondary degree

constitute the reference group. Since for some countries the proportion of workers with a post-secondary non-tertiary degree found in the survey differs substantially from that found in other sources, these workers are gathered together with those who have an upper-secondary education level. In the other surveys, the highest education level is not reported according to the ISCED classification and hence has to be recoded. The recoding procedure exactly follows Fournier and Koske (2012).

Birth country and citizenship

For all countries for which the EU-SILC data set is used the birth country dummy takes value one if the respondent is born outside the European Union.* Similarly, the citizenship dummy takes value one if the respondent is a citizen of a non-EU country. For Canada, the birth country dummy takes value one if the individual is an immigrant. In the case of the United States, the birth country dummy refers to respondents that are in the immigration sample (this implies a wrong coding for the particular case of individuals who are born in the United States and married to an immigrant). For all other countries, the birth country (citizenship) dummy refers to those who are born outside the country (have foreign citizenship).

Work experience

In the SILC survey, work experience refers to the number of years spent in paid work. For Canada, the concept is the same, but full-year, full-time equivalents are computed. For the United States, work experience only includes the experience with the current employer.

Sector of employment

The sector of employment is coded according to the NACE (REV 1.1) classification because this is the classification used for most countries (all countries covered by the EU-SILC survey plus Brazil and Israel). For Australia, Chile, Japan, Korea, Switzerland and the United States, the original sector classification was changed so as to approximate the classification of the other countries. As this does not lead to a satisfactory classification in the case of Canada, the variable is not calculated for this country.

Self-employment versus dependent employment and type of work contract

The analysis of the temporary contract dummy is combined with the analysis of the self-employment dummy. Whether a worker has a temporary or a permanent contract is meaningful for dependent workers only. The dummy for temporary contracts takes value one if the individual is a dependent worker with a fixed-term contract, and takes value zero otherwise (i.e. for self-employed individuals and for employees with a permanent contract). The self-employment dummy takes the value one if the individual declares in the survey that he/she is self-employed.

Weights

The analysis makes use of weighted data so as to obtain a representative picture of the entire employed population. In general, the cross-sectional weights provided in the

* Poland and the Slovak Republic are excluded from the analysis of the birth-country effect because less than 30 individuals reported being born in a foreign country.

surveys are used to weigh the data. In the case of Japan, no weights are available in the survey and, hence, unweighted data are used. In the case of Chile, the so-called regional expansion factor is used as a weight, which corrects for the share of the population that participates in the survey. In the case of the United States, the longitudinal weights that are available in the individual file are used, since no cross-sectional weights are available at the individual level.

A2. Further details on the estimation results

Table A1. **Baseline unconditional quantile regression estimates**

Variable	Quantile	AUS	AUT	BEL	BRA	CAN	CHE	CHL	CZE
Age	0.1	0.283 (0.034)	0.154 (0.021)	0.124 (0.020)	0.061 (0.004)	0.175 (0.013)	0.085 (0.035)	0.041 (0.005)	0.012 (0.006)
	0.5	0.054 (0.005)	0.054 (0.005)	0.053 (0.005)	0.090 (0.002)	0.087 (0.004)	0.065 (0.008)	0.061 (0.003)	0.040 (0.004)
	0.9	0.027 (0.006)	0.000 (0.007)	0.016 (0.008)	0.069 (0.003)	0.020 (0.004)	0.030 (0.009)	0.032 (0.007)	0.048 (0.007)
Age squared	0.1	-0.00322 (0.00042)	-0.00177 (0.00025)	-0.00140 (0.00024)	-0.00072 (0.00004)	-0.00196 (0.00015)	-0.00096 (0.00040)	-0.00044 (0.00006)	-0.00017 (0.00007)
	0.5	-0.00058 (0.00006)	-0.00057 (0.00007)	-0.00052 (0.00006)	-0.00096 (0.00002)	-0.00092 (0.00005)	-0.00067 (0.00009)	-0.00059 (0.00004)	-0.00045 (0.00005)
	0.9	-0.00025 (0.00008)	0.00017 (0.00010)	-0.00002 (0.00011)	-0.00054 (0.00004)	-0.00012 (0.00005)	-0.00022 (0.00011)	-0.00017 (0.00009)	-0.00053 (0.00008)
Sex	0.1	0.172 (0.082)	-0.146 (0.055)	-0.186 (0.049)	-0.189 (0.012)	-0.140 (0.037)	-0.440 (0.118)	-0.403 (0.032)	-0.213 (0.018)
	0.5	-0.266 (0.024)	-0.312 (0.024)	-0.234 (0.017)	-0.454 (0.007)	-0.333 (0.016)	-0.385 (0.032)	-0.322 (0.013)	-0.276 (0.013)
	0.9	-0.380 (0.028)	-0.217 (0.029)	-0.225 (0.026)	-0.501 (0.015)	-0.330 (0.019)	-0.268 (0.030)	-0.430 (0.032)	-0.285 (0.024)
Hours worked	0.1	2.455 (0.213)	1.393 (0.139)	1.167 (0.112)	1.038 (0.060)	1.494 (0.079)	2.277 (0.404)	0.893 (0.073)	0.681 (0.066)
	0.5	0.481 (0.022)	0.391 (0.030)	0.281 (0.022)	0.425 (0.007)	0.367 (0.016)	0.280 (0.029)	0.189 (0.014)	0.387 (0.029)
	0.9	0.190 (0.019)	0.293 (0.042)	0.326 (0.042)	0.296 (0.012)	0.097 (0.013)	0.146 (0.027)	0.094 (0.027)	0.801 (0.082)
Upper-secondary education or more	0.1	0.463 (0.126)	0.897 (0.114)	0.268 (0.069)	0.545 (0.028)	0.741 (0.069)	0.602 (0.344)	0.431 (0.035)	0.282 (0.047)
	0.5	0.083 (0.027)	0.391 (0.031)	0.106 (0.021)	0.708 (0.007)	0.219 (0.022)	0.261 (0.051)	0.474 (0.016)	0.283 (0.020)
	0.9	0.074 (0.025)	0.189 (0.028)	0.109 (0.026)	0.705 (0.019)	0.102 (0.019)	0.097 (0.032)	0.371 (0.025)	0.071 (0.032)
Tertiary education	0.1	0.219 (0.079)	0.041 (0.049)	0.163 (0.050)	0.178 (0.011)	0.162 (0.034)	0.195 (0.086)	0.272 (0.024)	0.164 (0.018)
	0.5	0.379 (0.026)	0.254 (0.026)	0.247 (0.017)	0.657 (0.007)	0.412 (0.020)	0.221 (0.025)	0.676 (0.020)	0.362 (0.017)
	0.9	0.335 (0.039)	0.472 (0.050)	0.364 (0.034)	2.474 (0.052)	0.492 (0.027)	0.413 (0.043)	1.521 (0.090)	0.813 (0.057)
Constant	0.1	-7.915 (1.200)	-2.198 (0.826)	0.040 (0.646)	2.774 (0.305)	-2.795 (0.422)	-2.440 (1.877)	7.485 (0.359)	2.958 (0.272)
	0.5	5.396 (0.115)	4.803 (0.161)	5.451 (0.141)	5.539 (0.041)	4.773 (0.097)	6.097 (0.216)	10.102 (0.087)	4.014 (0.137)
	0.9	7.733 (0.101)	6.850 (0.210)	6.383 (0.212)	7.404 (0.069)	7.943 (0.066)	7.837 (0.214)	11.945 (0.138)	2.997 (0.349)

Note: Standard errors in parentheses. Estimates for the latest available year.

Table A1. **Baseline unconditional quantile regression estimates (cont.)**

Variable	Quantile	DEU	DNK	ESP	EST	FIN	FRA	GBR	GRC
Age	0.1	0.140 (0.032)	0.250 (0.030)	0.068 (0.014)	-0.007 (0.010)	0.090 (0.017)	0.080 (0.016)	0.065 (0.015)	0.202 (0.045)
	0.5	0.094 (0.005)	0.043 (0.004)	0.042 (0.004)	0.020 (0.008)	0.030 (0.004)	0.047 (0.004)	0.055 (0.005)	0.113 (0.008)
	0.9	0.025 (0.005)	0.029 (0.007)	0.010 (0.006)	0.046 (0.013)	0.014 (0.005)	0.009 (0.009)	0.033 (0.008)	0.032 (0.010)
Age squared	0.1	-0.00134 (0.00034)	-0.00267 (0.00033)	-0.00080 (0.00016)	-0.00002 (0.00012)	-0.00096 (0.00019)	-0.00094 (0.00019)	-0.00079 (0.00019)	-0.00248 (0.00055)
	0.5	-0.00094 (0.00006)	-0.00043 (0.00005)	-0.00037 (0.00005)	-0.00034 (0.00009)	-0.00029 (0.00004)	-0.00043 (0.00005)	-0.00060 (0.00006)	-0.00112 (0.00009)
	0.9	-0.00020 (0.00006)	-0.00028 (0.00008)	0.00010 (0.00008)	-0.00061 (0.00015)	-0.00008 (0.00006)	0.00013 (0.00011)	-0.00033 (0.00010)	-0.00013 (0.00012)
Sex	0.1	0.211 (0.058)	-0.117 (0.054)	-0.311 (0.039)	-0.207 (0.032)	-0.105 (0.037)	-0.225 (0.040)	0.068 (0.054)	-0.822 (0.178)
	0.5	-0.322 (0.021)	-0.219 (0.015)	-0.246 (0.015)	-0.462 (0.029)	-0.267 (0.014)	-0.191 (0.015)	-0.335 (0.024)	-0.348 (0.027)
	0.9	-0.254 (0.022)	-0.260 (0.026)	-0.197 (0.023)	-0.426 (0.055)	-0.305 (0.021)	-0.290 (0.028)	-0.327 (0.036)	-0.249 (0.035)
Hours worked	0.1	3.087 (0.378)	0.812 (0.203)	1.807 (0.125)	0.976 (0.129)	1.578 (0.143)	1.413 (0.127)	2.212 (0.142)	1.212 (0.216)
	0.5	0.621 (0.028)	0.300 (0.035)	0.212 (0.020)	0.428 (0.055)	0.233 (0.017)	0.300 (0.023)	0.537 (0.027)	0.179 (0.034)
	0.9	0.246 (0.020)	0.452 (0.069)	0.192 (0.030)	0.402 (0.082)	0.226 (0.025)	0.458 (0.053)	0.311 (0.035)	0.442 (0.060)
Upper-secondary education or more	0.1	0.875 (0.145)	0.426 (0.091)	0.231 (0.047)	0.118 (0.058)	0.252 (0.068)	0.277 (0.057)	0.199 (0.093)	0.854 (0.184)
	0.5	0.164 (0.032)	0.142 (0.017)	0.171 (0.018)	0.223 (0.039)	0.070 (0.018)	0.145 (0.016)	0.282 (0.034)	0.341 (0.029)
	0.9	0.023 (0.023)	0.049 (0.029)	0.196 (0.023)	0.064 (0.074)	0.032 (0.021)	0.110 (0.029)	0.201 (0.038)	0.266 (0.037)
Tertiary education	0.1	-0.045 (0.050)	0.095 (0.050)	0.250 (0.047)	0.262 (0.031)	0.294 (0.040)	0.215 (0.038)	0.241 (0.043)	0.662 (0.132)
	0.5	0.286 (0.019)	0.189 (0.014)	0.259 (0.019)	0.380 (0.030)	0.303 (0.015)	0.303 (0.016)	0.460 (0.025)	0.463 (0.031)
	0.9	0.515 (0.027)	0.290 (0.034)	0.419 (0.033)	0.437 (0.057)	0.453 (0.028)	0.541 (0.040)	0.526 (0.042)	0.540 (0.061)
Constant	0.1	-9.072 (2.020)	-1.301 (1.114)	-1.592 (0.588)	2.284 (0.501)	-0.982 (0.705)	-0.080 (0.622)	-2.840 (0.625)	-2.750 (1.334)
	0.5	3.217 (0.178)	5.987 (0.158)	5.350 (0.126)	4.501 (0.230)	6.162 (0.094)	5.153 (0.124)	4.354 (0.158)	3.628 (0.223)
	0.9	6.777 (0.124)	6.290 (0.290)	6.509 (0.171)	4.934 (0.375)	7.040 (0.117)	5.850 (0.260)	6.463 (0.209)	5.017 (0.309)

Note: Standard errors in parentheses. Estimates for the latest available year.

Table A1. **Baseline unconditional quantile regression estimates** (cont.)

Variable	Quantile	HUN	IRL	ISL	ISR	ITA	JPN	KOR	LUX
Age	0.1	0.022 (0.005)	0.054 (0.020)	0.088 (0.017)	0.164 (0.024)	0.087 (0.011)	0.034 (0.016)	0.112 (0.026)	0.069 (0.032)
		0.038 (0.006)	0.093 (0.010)	0.053 (0.006)	0.099 (0.007)	0.047 (0.003)	0.162 (0.012)	0.115 (0.011)	0.074 (0.015)
	0.9	0.038 (0.009)	0.022 (0.013)	0.037 (0.007)	0.059 (0.010)	0.016 (0.009)	0.045 (0.009)	0.065 (0.011)	-0.054 (0.022)
Age squared	0.1	-0.00025 (0.00007)	-0.00063 (0.00024)	-0.00094 (0.00020)	-0.00182 (0.00028)	-0.00089 (0.00013)	-0.00032 (0.00017)	-0.00132 (0.00030)	-0.00074 (0.00037)
		-0.00040 (0.00007)	-0.00098 (0.00011)	-0.00054 (0.00007)	-0.00103 (0.00009)	-0.00040 (0.00004)	-0.00169 (0.00014)	-0.00131 (0.00013)	-0.00065 (0.00017)
	0.9	-0.00038 (0.00011)	-0.00004 (0.00017)	-0.00036 (0.00009)	-0.00052 (0.00013)	0.00007 (0.00011)	-0.00033 (0.00010)	-0.00042 (0.00014)	0.00107 (0.00029)
Sex	0.1	-0.002 (0.013)	0.115 (0.077)	-0.160 (0.056)	0.139 (0.064)	-0.282 (0.029)	-0.356 (0.057)	-0.311 (0.062)	-0.219 (0.056)
		-0.147 (0.017)	-0.221 (0.040)	-0.325 (0.026)	-0.284 (0.022)	-0.190 (0.011)	-1.137 (0.062)	-0.511 (0.034)	-0.319 (0.049)
	0.9	-0.291 (0.031)	-0.275 (0.058)	-0.339 (0.035)	-0.400 (0.041)	-0.265 (0.028)	-0.419 (0.032)	-0.253 (0.033)	-0.326 (0.056)
Hours worked	0.1	0.589 (0.074)	1.603 (0.168)	0.937 (0.124)	2.377 (0.177)	1.139 (0.086)	0.816 (0.071)	0.918 (0.141)	1.647 (0.360)
		0.433 (0.047)	0.486 (0.043)	0.298 (0.036)	0.561 (0.028)	0.336 (0.019)	0.324 (0.032)	0.032 (0.046)	0.563 (0.061)
	0.9	0.396 (0.066)	0.279 (0.044)	0.225 (0.041)	0.511 (0.037)	0.824 (0.072)	0.070 (0.018)	-0.130 (0.043)	0.457 (0.070)
Upper-secondary education or more	0.1	0.164 (0.027)	0.316 (0.099)	0.138 (0.060)	0.180 (0.107)	0.324 (0.032)	0.033 (0.084)	0.476 (0.092)	0.341 (0.092)
		0.291 (0.028)	0.150 (0.041)	0.144 (0.027)	0.304 (0.034)	0.247 (0.011)	0.222 (0.073)	0.450 (0.045)	0.432 (0.057)
	0.9	0.116 (0.021)	0.296 (0.060)	0.070 (0.028)	0.243 (0.034)	0.308 (0.027)	0.174 (0.044)	0.531 (0.042)	0.091 (0.049)
Tertiary education	0.1	0.098 (0.017)	0.218 (0.066)	0.228 (0.059)	0.276 (0.068)	0.220 (0.029)	-0.073 (0.045)	0.166 (0.051)	0.087 (0.057)
		0.582 (0.023)	0.476 (0.050)	0.321 (0.029)	0.310 (0.024)	0.220 (0.013)	0.311 (0.036)	0.471 (0.036)	0.525 (0.051)
	0.9	1.051 (0.061)	0.485 (0.064)	0.472 (0.051)	0.557 (0.042)	0.795 (0.068)	0.279 (0.033)	0.587 (0.052)	0.858 (0.095)
Constant	0.1	2.820 (0.303)	-0.363 (0.755)	1.774 (0.625)	-4.967 (1.026)	0.508 (0.425)	-1.610 (0.446)	0.636 (0.895)	-0.392 (1.819)
		3.402 (0.221)	3.909 (0.255)	5.777 (0.177)	4.387 (0.197)	4.972 (0.104)	-1.304 (0.307)	4.727 (0.278)	3.836 (0.411)
	0.9	4.359 (0.286)	6.588 (0.254)	7.083 (0.202)	6.404 (0.260)	4.222 (0.337)	2.515 (0.176)	6.496 (0.249)	7.422 (0.487)

Note: Standard errors in parentheses. Estimates for the latest available year.

Table A1. **Baseline unconditional quantile regression estimates (cont.)**

Variable	Quantile	NLD	NOR	POL	PRT	SVK	SVN	SWE	USA
Age	0.1	0.072 (0.021)	0.173 (0.021)	0.089 (0.014)	0.026 (0.011)	0.019 (0.009)	0.010 (0.007)	0.265 (0.027)	0.202 (0.030)
		0.080 (0.005)	0.037 (0.004)	0.080 (0.005)	0.066 (0.008)	0.032 (0.004)	0.052 (0.005)	0.046 (0.003)	0.077 (0.009)
	0.9	0.036 (0.007)	0.040 (0.007)	0.051 (0.008)	0.077 (0.016)	0.033 (0.007)	-0.002 (0.008)	0.038 (0.005)	0.083 (0.019)
Age squared	0.1	-0.00073 (0.00022)	-0.00180 (0.00023)	-0.00111 (0.00017)	-0.00033 (0.00013)	-0.00023 (0.00011)	-0.00015 (0.00008)	-0.00263 (0.00029)	-0.00220 (0.00035)
		-0.00079 (0.00006)	-0.00036 (0.00005)	-0.00085 (0.00006)	-0.00066 (0.00009)	-0.00036 (0.00005)	-0.00053 (0.00006)	-0.00045 (0.00004)	-0.00078 (0.00011)
	0.9	-0.00022 (0.00008)	-0.00038 (0.00008)	-0.00047 (0.00010)	-0.00054 (0.00020)	-0.00037 (0.00009)	0.00019 (0.00010)	-0.00035 (0.00006)	-0.00084 (0.00024)
Sex	0.1	-0.085 (0.076)	-0.233 (0.051)	-0.167 (0.036)	-0.089 (0.027)	-0.185 (0.025)	-0.032 (0.019)	-0.296 (0.069)	-0.257 (0.067)
		-0.338 (0.022)	-0.278 (0.015)	-0.252 (0.016)	-0.340 (0.029)	-0.245 (0.013)	-0.150 (0.013)	-0.227 (0.012)	-0.294 (0.029)
	0.9	-0.317 (0.026)	-0.361 (0.030)	-0.240 (0.027)	-0.372 (0.071)	-0.242 (0.024)	-0.153 (0.020)	-0.275 (0.021)	-0.414 (0.059)
Hours worked	0.1	1.597 (0.154)	1.617 (0.170)	0.995 (0.118)	0.697 (0.090)	1.287 (0.112)	0.128 (0.091)	0.816 (0.131)	1.612 (0.164)
		0.456 (0.027)	0.383 (0.025)	0.261 (0.029)	0.222 (0.047)	0.352 (0.029)	0.167 (0.032)	0.295 (0.018)	0.590 (0.038)
	0.9	0.261 (0.035)	0.386 (0.045)	0.542 (0.052)	0.487 (0.133)	0.665 (0.093)	0.362 (0.045)	0.122 (0.022)	0.897 (0.099)
Upper-secondary education or more	0.1	0.341 (0.061)	0.471 (0.082)	0.714 (0.100)	0.101 (0.036)	0.347 (0.106)	0.210 (0.035)	0.297 (0.106)	0.603 (0.136)
		0.096 (0.019)	0.147 (0.018)	0.322 (0.028)	0.319 (0.037)	0.247 (0.027)	0.366 (0.018)	0.111 (0.019)	0.319 (0.048)
	0.9	0.129 (0.021)	0.069 (0.024)	0.171 (0.025)	0.742 (0.117)	0.071 (0.031)	0.164 (0.011)	0.109 (0.026)	0.219 (0.063)
Tertiary education	0.1	0.154 (0.081)	0.167 (0.042)	0.502 (0.048)	0.161 (0.037)	0.239 (0.027)	0.192 (0.016)	0.250 (0.065)	0.037 (0.074)
		0.305 (0.021)	0.194 (0.015)	0.542 (0.021)	0.459 (0.046)	0.331 (0.016)	0.506 (0.017)	0.177 (0.012)	0.361 (0.037)
	0.9	0.483 (0.033)	0.317 (0.032)	0.731 (0.045)	1.161 (0.170)	0.418 (0.041)	0.891 (0.046)	0.301 (0.025)	0.456 (0.068)
Constant	0.1	-0.536 (0.868)	-2.746 (0.884)	-0.654 (0.578)	3.069 (0.385)	0.138 (0.461)	5.621 (0.357)	-2.420 (0.861)	-3.988 (1.110)
		4.408 (0.186)	5.866 (0.124)	3.257 (0.151)	4.396 (0.241)	4.045 (0.139)	4.890 (0.152)	5.612 (0.098)	3.748 (0.274)
	0.9	6.433 (0.208)	6.410 (0.206)	3.577 (0.251)	3.533 (0.626)	3.530 (0.370)	5.867 (0.219)	6.887 (0.122)	3.571 (0.638)

Note: Standard errors in parentheses. Estimates for the latest available year. For Sweden, the results for hours worked may be affected by the coding of the variable which only distinguishes between full-time workers and part-time workers.

Tackling income inequality: The role of taxes and transfers

by

Isabelle Joumard, Mauro Pisu and Debbie Bloch*

Taxes and transfers reduce inequality in disposable income relative to market income. The effect varies, however, across OECD countries. The redistributive impact of taxes and transfers depends on the size, mix and the progressivity of each component. Some countries with a relatively small tax and welfare system (e.g. Australia) achieve the same redistributive impact as countries characterised by much higher taxes and transfers (e.g. Germany) because they rely more on income taxes, which are more progressive than other taxes, and on means-tested cash transfers. This article provides an assessment of the redistributive effect of the main taxes and cash transfers, based on various OECD data sources, a set of policy indicators and a literature review. Using cluster analysis, it also identifies empirically four groups of countries with tax and transfer systems that share broadly similar features.

JEL classification: H2, H23, H53, I3, I38

Keywords: Income inequality, taxes, transfers, welfare systems, redistribution, progressivity, cluster analysis

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In many OECD countries, income inequality has drifted up over the past decades (OECD, 2011a). In some countries, top incomes have captured a large share of the overall income gains, while poverty remains a pressing policy issue, not least because of the increase in unemployment over the last few years. The recent financial and fiscal crises have also pushed governments to contain public spending, including cash transfers, while both fiscal consolidation and equity considerations have led some governments to raise taxes, in particular on top incomes.

Against this background, Section 2 assesses the redistributive impact of different tax and transfer policy approaches in the late-2000s. Section 3 summarises tax and transfers policy indicators in country profiles and provides an illustration of how these profiles can be used to identify reform options for two OECD countries (Australia and Germany). It also provides a typology of tax and transfer systems, identifying four groups of countries sharing broadly similar features.

This article relies on, and compares, various data sources and methods. The OECD *Income Distribution and Poverty Database* – which draws mostly on national household survey data – contains comparable cross-country information on income, public cash transfers and taxes at the household level by income decile.¹ This data source is used to derive the redistributive impact of taxes and transfers and the contribution of both size and progressivity in lowering inequality. Given the inherent limitation of these data, other indicators of the size and progressivity of taxes and transfers are presented to investigate the characteristics of specific tax and benefit schemes. A cluster analysis of 15 carefully selected policy indicators, capturing the progressivity, size and mix of taxes and benefits, is then implemented to identify groups of OECD countries sharing common redistributive approaches.

1. Main findings

1.1. The redistributive impact of taxes and transfers

Taxes and transfers have a significant redistributive impact. Inequality in income after taxes and transfers, as measured by the Gini index, was about 25% lower than for income before taxes and transfers on average in the OECD area in the late 2000s.² For the same period, poverty measured after taxes and transfers was 55% lower than before taxes and transfers for the OECD average. Various additional points are worth noting:

- Countries with a more unequal distribution of market income tend to redistribute more.
- Cash transfers reduce income dispersion more than taxes in most OECD countries. On average, three quarters of the reduction in inequality between market and disposable income are due to transfers, the rest to taxes.
- The redistributive impact of cash transfers varies widely across countries. Countries with a similar dispersion of household market income may follow different redistributive strategies. In some, cash transfers account for a large share of household

disposable income, redistributing income mainly over the life-cycle rather than across individuals. Old-age pensions often fall into this category, and their progressivity is low in many countries. Some countries with smaller cash transfers tend to rely more on targeted benefits.

- Family and housing benefits are, in most countries, the most progressive cash transfers, though their redistributive impact is limited as they are often small in size. Disability and unemployment benefits reduce income inequality although their degree of progressivity to a large extent depends on their design.
- The cross-country variation in the redistributive impact of household taxes is more limited than that of transfers, despite large differences in tax-to-GDP ratios. High-tax countries tend to have less progressive household taxes.
- The progressivity of labour taxes (including social security contributions) has increased in the majority of OECD countries. Although personal income rate schedules have often become flatter, reflecting the steep decline in top marginal tax rates, social security contributions for low-income earners have been cut or tax reliefs made more generous in some countries so as to reduce the cost of labour for groups at high unemployment risk. Furthermore, earned income tax relief has been raised to make work more attractive for low-income earners, raising the progressivity of labour income taxes.
- The personal income tax is the most progressive tax, although there are significant cross-country variations. Social security contributions, consumption taxes and real estate taxes tend to be regressive in most countries.
- Tax expenditures pertaining to personal income tax tend to benefit the well-off, a main exception being in-work tax credits.
- The taxation of capital income, wealth and inheritance has been reduced in many countries, which has reduced the redistributive impact of tax systems.

1.2. Indicators of tax and transfer policies help to identify different country models

- The redistributive impact of taxes and transfers depends on their size, mix and the progressivity of each component. A set of policy indicators has been compiled which breaks down the redistributive impact of both taxes and transfers into these three dimensions. Individual country profiles facilitate the comparison of each country with the OECD average and thus help to identify reform options.
- Four groups of countries sharing broadly comparable tax and transfer systems have been identified empirically, based on the set of policy indicators:
 - ❖ A “Nordic model” characterised by large and mostly universal cash transfers, a high level of spending on in-kind services and a tax mix which promotes redistribution (all Nordic countries and also Belgium are in this group).
 - ❖ A “Continental European model” characterised by large cash transfers with the lion’s share for old-age pensions – i.e. redistributing income mostly over the lifecycle instead of across individuals – and a tax mix which does not promote redistribution across individuals, reflecting a small role for the personal income tax (Austria, France and Germany are representative).
 - ❖ An “Anglo-Saxon model”, characterised by small cash transfers, and a tax mix which promotes income redistribution. This model can be divided in two sub-groups: those countries with transfers highly targeted on low-income groups (Australia and

New Zealand being examples) and those countries characterised by little progressivity of cash transfers which are largely spent on old-age pensions (Japan and the United States are in this sub-group).

- ❖ A lower-income group, where the welfare system is not well developed. Spending on transfers and the level of taxation are considerably below the OECD average, with a heavy reliance on consumption taxes (Chile and Turkey are in this group).

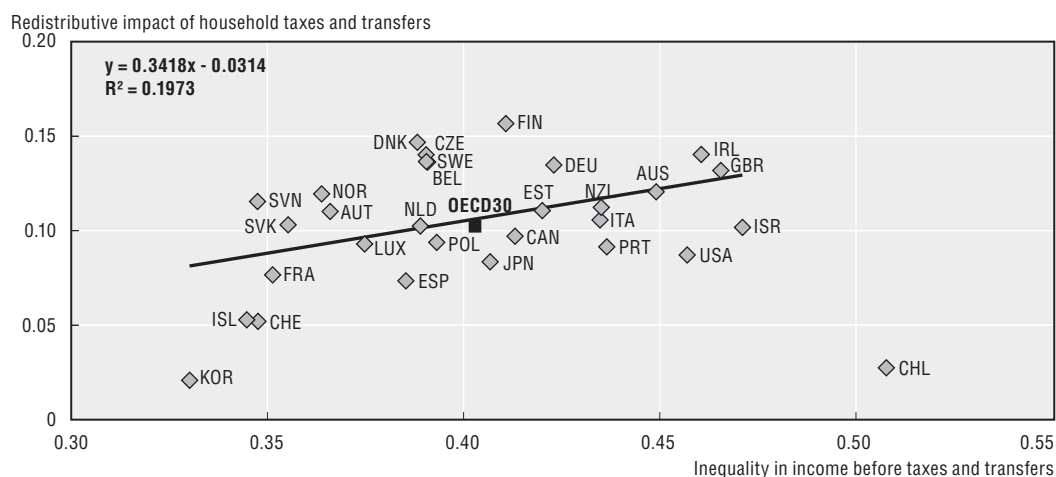
2. The redistributive impact of taxes and transfers

Taxes and transfers are key policy levers to influence distributional outcomes. Information based on household surveys suggests that OECD-wide, taxes and cash transfers reduced the market income dispersion – as measured by the concentration coefficient – by about 25% and relative poverty by about 55% in the late 2000s (Pisu, 2012).³ Their redistributive impact tends to be high in the Nordic countries (Iceland being an exception) and eastern European countries (Figure 1). It is low in Iceland, Korea and Switzerland, all characterised by little market income dispersion, and in Chile. The data suggest that there is a positive link between the redistributive impact of taxes and transfers and the level of market income inequality. Focusing on the working age population yields the same pattern.⁴

Cash transfers reduce income dispersion more than taxes (Figure 2).⁵ The United States, however, is an outlier with virtually the same redistribution achieved through taxes as cash transfers. It relies heavily on the tax code to provide support to low-income groups – the Earned Income Tax Credit is one of the largest US social programmes – while other countries rely more on cash transfers.⁶

Figure 1. **Taxes and transfers reduce income dispersion, and more so in “unequal” countries**

In the late 2000s

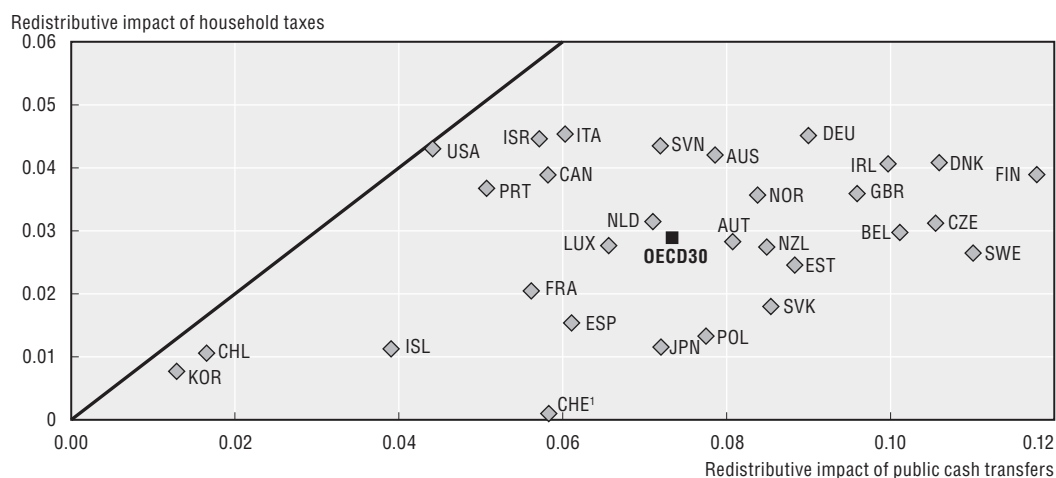


Note: Inequality in income before taxes and transfers is measured by the concentration coefficient. The redistributive impact of taxes and transfers is defined as the difference in the concentration coefficients for income before cash transfers and taxes (i.e. household market income) and after cash transfers and taxes (i.e. household disposable income). Two approaches can be used to measure the concentration of market income, i.e. by ranking households by their market income or by their disposable income. In this illustration, and throughout the article, households have been ranked by disposable income due to data limitations. Jourard et al. (2012) compares the two approaches. It also shows that the relation between income inequality before taxes and transfers and the redistributive impact of taxes and transfers is stronger when calculating the concentration of market income based on ranking households by market income. Data for France and Ireland refer to mid-2000s. The trend line shown above has been calculated excluding Chile.

Source: OECD Income Distribution and Poverty Database.

Figure 2. Cash transfers reduce income dispersion more than taxes

Point reduction in the concentration coefficients, in the late 2000s



Note: The redistributive impact of public cash transfers is measured as the difference between the concentration coefficient of market income and that of income after transfers. The redistributive impact of household taxes is measured as the difference between the concentration coefficient of post-transfer income and that of disposable income (i.e. post-tax and transfers). Data for France and Ireland refer to mid-2000s.

1. The redistributive impact of household taxes for Switzerland is slightly negative (−0.006), but has been set to zero.

Source: OECD Income Distribution and Poverty Database.

The redistributive impact of taxes does not vary widely across countries, despite large cross-country differences in the size of the tax take and progressivity of the tax system. Some countries have opted for a high tax take but, as they are constrained to tax virtually all citizens, with little progressivity. Others have a smaller but more progressive tax system. By contrast, the redistributive impact of transfers displays large cross-country differences. In Denmark, Finland and Sweden, it is more than five times higher than in Korea and about three times higher than in the United States. However, the annual income distribution data may overstate significantly the degree of redistribution across individuals as social security schemes have a – sometimes large – component that provides redistribution over the lifetime rather than redistributing across individuals (Box 1). Countries that spend the most on cash transfers tend to concentrate more on redistribution across the life-cycle (in particular through old-age pensions). In contrast, those countries that focus more on redistribution between the rich and the poor, through extensive use of targeting, spend less.

2.1. The redistributive impact of cash transfers: cross-country differences and driving forces

2.1.1. The redistributive impact of cash transfers is large but varies significantly across countries

The main features of the size and redistributive impact of cash transfers are as follows:

- On average across the OECD, cash transfers amounted to 11% of GDP and 20% of household disposable income in 2007 (Figure 3). They reduced income inequality, as measured by the fall in concentration of market income before and after transfers, by about 19% in the late 2000s. Those countries that spend the most are not always those where the redistributive impact is strongest. Cash transfers ranged from 2½ per cent of GDP in Mexico and Korea to over 17% in Austria. In Austria, however, the redistributive impact is close to the OECD average.

Box 1. Welfare systems: Beveridge versus Bismarck? Public versus private?

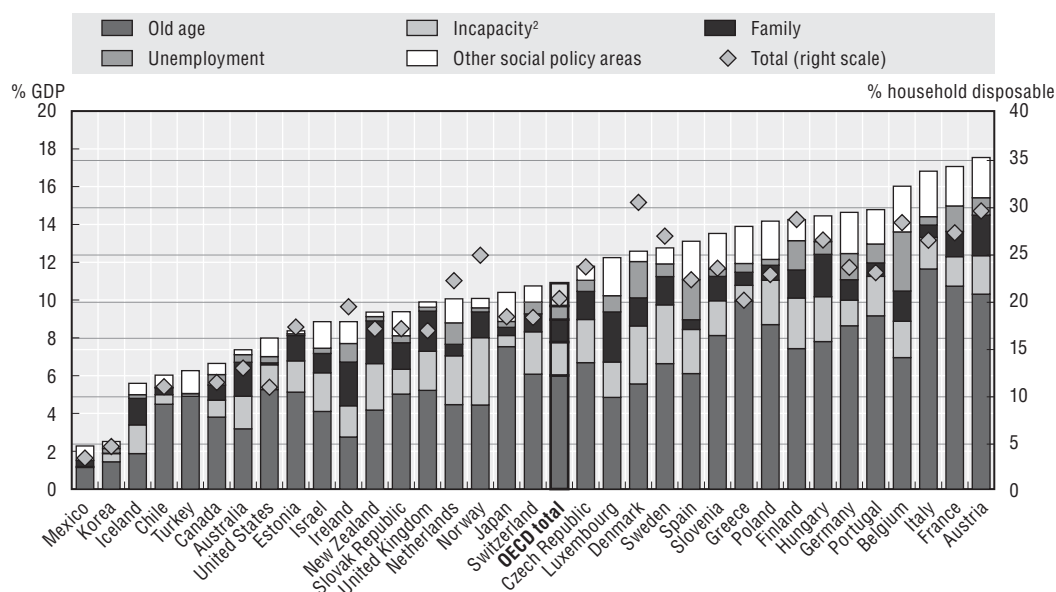
In most OECD countries, welfare systems have three main objectives:

- Redistributing income over the life-cycle (from working-age to retirement age), with public old-age pensions largely financed out of social security contributions or general taxation.
- Providing income maintenance or insurance to cope with adverse risks, such as unemployment, disability and sickness.
- Avoiding poverty or a too wide dispersion in living standards, with benefits financed mostly out of general taxation. These benefits can be either universal or means-tested.

Bismarckian-type welfare states rely on social insurance, with benefits financed out of social security contributions. They give priority to the first two objectives. Beveridgean-type welfare states give priority to the third objective with social benefits targeted on those in need and financed by tax revenues. A third welfare model, as recognised by Esping-Andersen (1990), is implemented in the Nordic countries. It involves universal benefits – involving a “de-familialisation” of welfare responsibilities, with complete coverage both for child and elderly care – and thus a high level of taxation. In practice, welfare systems involve a mix of redistribution between the rich and the poor, risk insurance and lifetime redistribution. They also often provide both means-tested and universal benefits. These features, however, differ between countries. In a comparative study, Stahlberg (2007) estimated that in Australia 38% of lifetime benefits received by individuals were financed through taxes they paid at another stage of their life-cycle, and the remaining 62% involved redistribution between the rich and the poor. In Sweden, 18% of lifetime benefits involved redistribution between individuals and 82% involved redistribution over different phases of the life-cycle of an individual. Sweden, as the other Nordic countries, relies heavily on universal benefits while Australia relies more on targeted and means-tested transfers. The choice between targeted and means-tested transfers is often reflected in tax rates: means-tested benefits can generate high marginal effective tax rates during the withdrawal phase, whereas universal benefits generally lead to high average tax rates because they are costly. Unfortunately, the data available often do not allow disentangling redistribution across individuals from the redistribution over the life-cycle. Nor they allow an analysis of income mobility – i.e. individuals moving between different quantiles of the income distribution over time.

Cross-country differences in the public/private nature of insurance mechanisms and in the taxation of social benefits are also important. Some countries rely mostly on private pension funds to ensure income redistribution across the life-cycle and, often to a lesser extent, on private insurance companies to provide insurance against health risks. Because contributions to, and benefits received from, private funds are not considered as part of the redistributive system, the size of the welfare system is smaller than in the countries which rely mostly on public coverage. At the same time, the countries that rely more on private schemes may display more progressive public schemes since these do not include pensions and other benefits governed by insurance mechanisms, which often benefit lower income households less. The taxation of social benefits also affects cross-country comparisons. In some OECD countries, transfers are subject to broadly the same tax treatment as wage income (e.g. Nordic countries) while in others (e.g. Japan) they are largely untaxed. Adema and Ladaïque (2009) provide estimates for net public social expenditure, i.e. adjusting for the impact of the taxation of social benefits and tax breaks with a social purpose as well as for indirect taxes. This leads to a reassessment of the magnitude of welfare states and to a greater similarity in social expenditure-to-GDP ratios across countries.

Figure 3. **Public cash transfers to households: level and composition**¹
2007



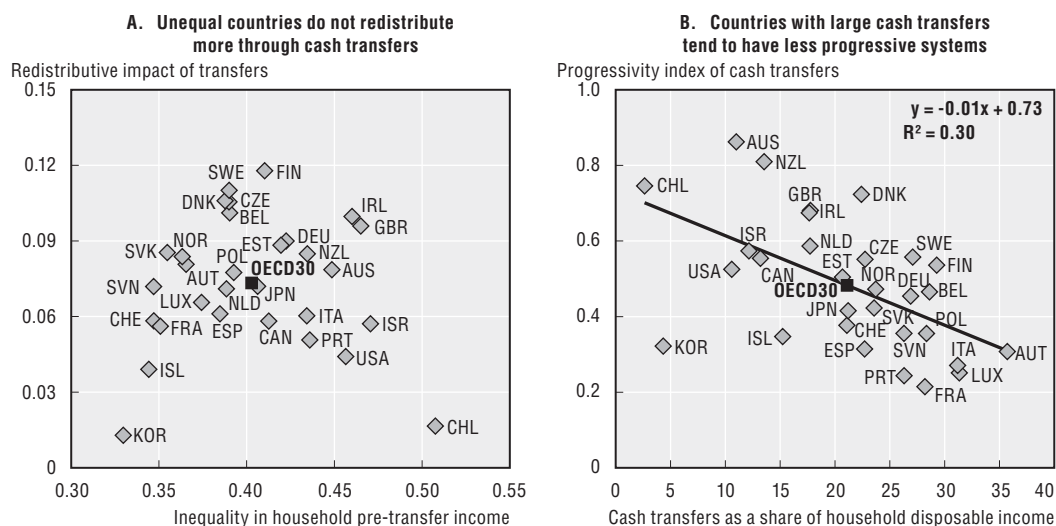
1. The data shown here exclude private mandatory spending which accounts for an important share of total social spending in some countries (in particular Chile, Germany and Switzerland). In addition, public cash transfers shown here may not fully account for those programmes and services provided, or co-financed, by local governments. Measurement gaps may be high, notably in federal countries such as Canada.
2. Incapacity-related spending covers expenditure on disability pensions and sick leave schemes (occupational injury and other sickness daily allowances).

Source: OECD Social Expenditure Database.

- There is no clear link between the degree of market income inequality and the redistributive impact of transfers – the most unequal countries do not redistribute more (Figure 4, Panel A). The redistributive impact is highest in the Czech Republic, Finland, Sweden and Denmark, all characterised by a dispersion of market income close to the OECD average. The redistributive impact of cash transfers is especially low in Korea and Chile, followed by Iceland, the United States and Portugal. Moreover, countries with a similar dispersion in household market income (e.g. Finland and Canada) can opt for distinct redistributive strategies – the redistributive impact of cash transfers in Finland is about twice as large as in Canada.
- The cross-country variation in the redistributive impact of cash transfers reflects differences in the size and progressivity of these transfers (the annex provides information and analysis on the various measures used in this paper to assess the redistributive impact of taxes and transfers). Countries obtain a similar redistributive impact through drastically different size and progressivity combinations (Figure 4, Panel B). For instance, in Portugal and the United States transfers attain about the same reduction in inequality but for different reasons. In the United States, the limited reduction in inequality is due to the smaller size of transfers compared with the OECD average whereas in Portugal it is mainly due to their lower progressivity.
- From the mid-1990s to the late 2000s, the redistributive impact of cash transfers slightly weakened on average for the 19 countries for which data are available. This decline is due to a lower size, partly owing to a reduction in unemployment, whereas progressivity increased. The lack of, or incomplete, indexation of cash transfers has impinged

Figure 4. **The redistributive impact of cash transfers**

In the late 2000s



Note: Inequality in household pre-transfer income is measured by the concentration coefficient for household market income. The redistributive impact of cash transfers is measured as the difference between the concentration coefficient of market income and that of market income after transfers but before taxes. The progressivity index of cash transfers is the Kakwani index, defined as the concentration coefficient for market income less the concentration coefficient for transfers (see the annex). Data for France and Ireland refer to the mid-2000s.

Source: OECD Income Distribution and Poverty Database.

negatively on their generosity. The examination of 10 countries suggests that incomplete indexation of benefits resulted in recipients losing ground in a majority of these countries (OECD, 2011a). The choice of indexation – to prices *versus* wages – affects the income loss, which is often more pronounced at lower income levels.⁷

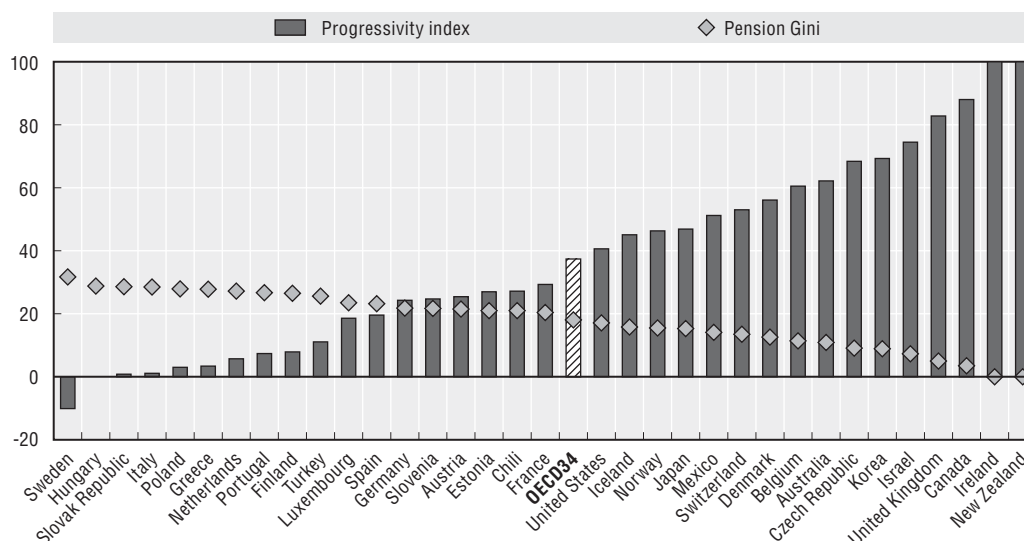
- The progressivity of transfers varies significantly across benefit schemes. It tends to be lower for old-age and disability pensions as well as unemployment benefits than for family and housing benefits. The transfer mix thus plays a role in explaining cross-country differences.

2.2. The redistributive impact of pension systems depends on their design

Old-age pensions account for the largest share of total cash transfers – 55% in the mid-2000s for the OECD on average. Unsurprisingly, for people above 65, they accounted for the bulk (more than 90%) of total transfers received, but for working-age people, their share was also large: 37% for the OECD average but around 80% in Italy and 60% in Poland.⁸ Old-age pensions can be sub-divided into three tiers (OECD, 2011c). The first two tiers are mandatory whereas the third is voluntary. The first tier has a redistributive function and is publicly provided. The second tier plays mostly an insurance or income-replacement role, ensuring a living standard comparable to that prior to retirement. The third tier reflects voluntary pension arrangements, and is thus likely to have little or no redistributive impact.

The OECD has produced a progressivity index for mandatory old-age pensions. For flat basic pensions, the index reaches 100 (OECD, 2011a; Whitehouse, 2006). New Zealand and Ireland are the only OECD countries where public pensions have flat and universal payments, without second-tier schemes. As a result, they have the most progressive pension system (Figure 5). Other countries with highly progressive pension systems are Canada, the United Kingdom, Israel, Korea and the Czech Republic. On the other hand,

Figure 5. **Progressivity index of the pension system**¹
2008, pensions before tax



1. The progressivity index is calculated considering only the mandatory part of the pension system plus the quasi-mandatory parts with broad coverage. For instance, in Denmark and Sweden there are quasi-mandatory, occupational defined contribution schemes with broad coverage that are included in the index. The index shown here is not a Kakwani index. It is based on pension systems' parameters and is computed as 100 minus 100 times the ratio of the Gini of pension payments to the Gini of personal gross earnings in 2008. The Gini indices are calculated using the OECD average earnings distribution. Pension entitlements are computed using the OECD pension model and refer to workers entering the labour market in 2008. The calculations are based on the rules applying in 2008. They include the effects of pension reforms legislated by 2008 but to be phased in later. The pension Gini is the Gini index for pension payments multiplied by 100.

Source: OECD pension models and OECD (2011c), *Pensions at a Glance* 2011.

Sweden has a regressive mandatory pension scheme, due to the U-shaped profile of the replacement rate.⁹ Some of the southern and eastern European countries, as well as Finland and the Netherlands, also show little progressivity. Among these countries, Italy and Poland now have defined-contribution second-tier pensions, which have been specifically designed to forge a strong link between contributions and benefits – i.e. redistribution over the life-cycle instead of across individuals.¹⁰

Differences in mortality rates across individuals and the design of tax systems – two issues not covered by the progressivity index above – often reduce the progressivity of pensions. Low-income earners tend to die at a younger age than high-income earners (e.g. Waldrom, 2007; Christia, 2007; Marmot and Shipley, 1996). The shorter average life span of low-income individuals reduces particularly the progressivity of contributive insurance-type pension systems, as part of low-income earners' contributions ultimately finance pension payments of high-income earners.¹¹

Taxes and social security contributions can affect the progressivity of pensions, and therefore the degree of redistribution they achieve, substantially (Keenay and Whitehouse, 2003). Pension income is in general taxed at lower rates than work-related income because: i) the personal income tax is progressive and gross replacement rates are generally below 100%; ii) pensioners are often exempt from certain types of social security contributions or pay them at a reduced rate. The effect of taxes on pension progressivity can be gauged by comparing the gap between gross (before taxes) and net (after taxes) replacement rates for low and high-income earners.¹² Figure 5 shows that taxes and social

security contributions slightly reduce the progressivity of retirement-income schemes on average across the OECD. Still, in 15 out of the 34 countries, taxes and social security contributions enhance the progressivity of pensions.

Over the past two decades, pension reforms have slightly reduced pension progressivity on average for the 20 countries for which data are available (OECD, 2009; Whitehouse, 2009), though there was again wide cross-country heterogeneity. The drop in the progressivity of pensions in countries such as the Slovak Republic, Poland and Hungary is partly due to the introduction of defined-contribution schemes, which provide a stronger link between pensions and earnings. On the other hand, pension reforms which increased the number of years required to calculate the earnings basis for pension payments (in addition to raising the effective retirement age) have tended to make pension systems more progressive, because higher income individuals typically have a steeper wage profile over their working life.

2.3. Disability benefits are redistributive but risk creating poverty traps

Cash transfers associated with disability and sickness benefits are also large. They amounted to 2% of GDP on average in the OECD in 2007 and reached more than 3% in the Nordic countries and the Netherlands. In 2007, around 6% of the working-age population received such benefits on average across the OECD, and in some countries this share was well above the unemployment rate (OECD, 2010d). During the past 10-15 years, the number of recipients increased in around half of the OECD countries partly reflecting the use of disability programmes to soften the impact of downturns (Benítez-Silva *et al.*, 2010) and, to a lesser extent, population ageing. The increase also reflects a shift away from early retirement schemes and unemployment benefits as governments have tightened the eligibility criteria of these programmes.

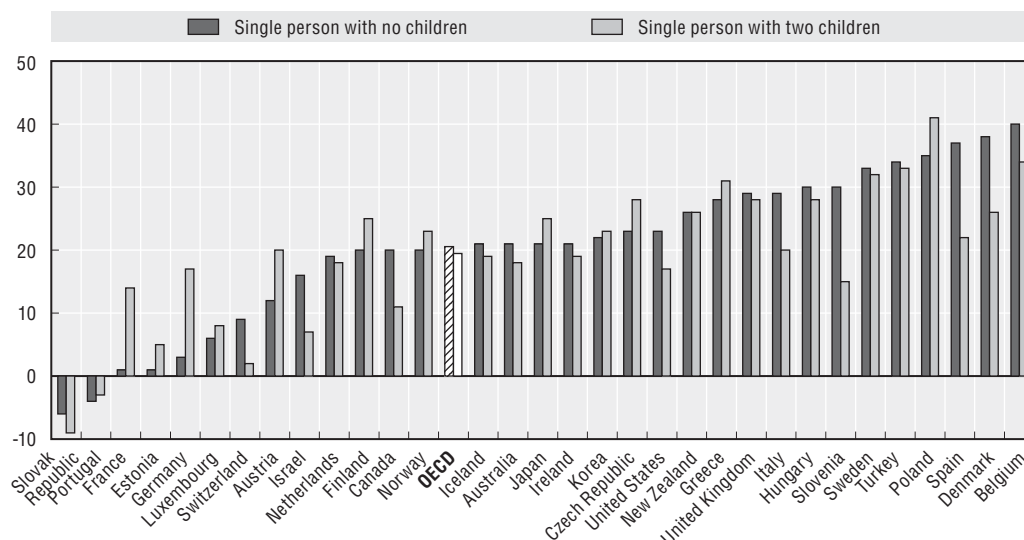
Disability benefits reduce income inequality at a given point in time, as net replacements rates for low-wage earners are higher than for high-wage earners (OECD, 2010d). However, they may increase lifetime income inequality by reducing income mobility and creating poverty traps. Across the OECD, disability benefits are often the only means of sustenance for people with a disability, but often do not suffice to escape poverty.¹³ People receiving disability benefits indeed have lower employment and higher unemployment rates than people with no disability. Many countries have thus started to reform disability benefits to reach a better, and more sustainable, balance between income security and labour market (re-)integration of disabled people.

2.4. Unemployment benefits are mostly insurance-based and thus not very progressive

The redistributive effect of unemployment benefits depends on the system's parameters including eligibility criteria, replacement rates for low and high-income earners and benefit duration. These benefits are conditional on past contributions, and are earnings-related in most countries. Greece, Iceland, Ireland, Poland and the United Kingdom are exceptions since they provide flat though relatively low benefits, enhancing their redistributive impact. Many countries impose a ceiling on unemployment benefits, thus also introducing an element of progressivity. However, the ceiling is sometimes fairly high, and for a few countries, there is no upper limit.

The progressivity of unemployment benefits can be gauged by comparing the net replacement rates of low and high-income earners. Figure 6 shows that unemployment benefits for the initial phase of unemployment tend to be progressive, with a wide

Figure 6. **Progressivity of unemployment benefits net of taxes**
Measured by the difference in net replacement rates between low and high income earners¹
2009, initial phase of unemployment



1. Progressivity is defined as the difference in the net replacement rate for low and high earners defined as having earnings equal to 67 and 150% of the average wage. The larger the difference, the more progressive are unemployment benefits. Countries are ordered from the smallest to the largest values in progressivity for a single person with no children. These replacement rates refer to all unemployment benefits and not only to those insurance-based, but no social assistance “top-ups” are included in either the in-work or out-of-work situation. One limitation of this indicator is that it does not take into account the duration of the unemployment spell. In addition, it is based on net replacement rates and thus also reflects the progressivity of personal income taxes (any income taxes payable on unemployment benefits are determined in relation to monthly values, multiplied by 12, even if the maximum benefit duration is shorter than 12 months). Children are aged 4 and 6 and neither childcare benefits nor childcare costs are considered.

Source: OECD, *Tax-Benefit Models*, www.oecd.org/els/social/workincentives.

cross-country variation.¹⁴ Unemployment benefits have become slightly more progressive over the past decade, in particular in those countries where they were initially less progressive. In contrast, progressivity has declined in countries where the systems were the most progressive.

Most OECD countries also operate minimum-income programmes as a last-resort safety net (Immervoll, 2010). The benefit level is unrelated to previous income and has thus a considerable redistributive effect. The overall redistributive impact is however difficult to gauge as it depends on how minimum income benefits are combined with other social assistance schemes. For instance, in continental Europe, minimum income programmes often complement other benefits delivering important first-tier safety nets whereas in Australia and New Zealand it represents the main benefit for individuals without income.

2.5. Family cash benefits are targeted towards low-income groups

Family cash benefits have a rather strong redistributive impact. Although they account for a rather small share of total cash transfers in most countries, they tend to be more progressive than other transfers.¹⁵ In the mid-2000s, the redistributive impact of family cash benefits was the largest in Ireland, followed by the Netherlands, Australia and Austria, but well below the OECD average in the United States, Switzerland, Portugal, Denmark and Norway. As with other cash benefits, cross-country variations in the redistributive impact reflect differences in the size and progressivity of such benefits. While the majority of

OECD countries implement universal family cash benefits, some rely on income-tested schemes. In addition, child benefits based on the number of children in the household can benefit low-income groups more as these households often have more children, at least in some countries including the United Kingdom (ONS, 2010).

2.6. The redistributive impact of taxes: cross-country differences and driving forces

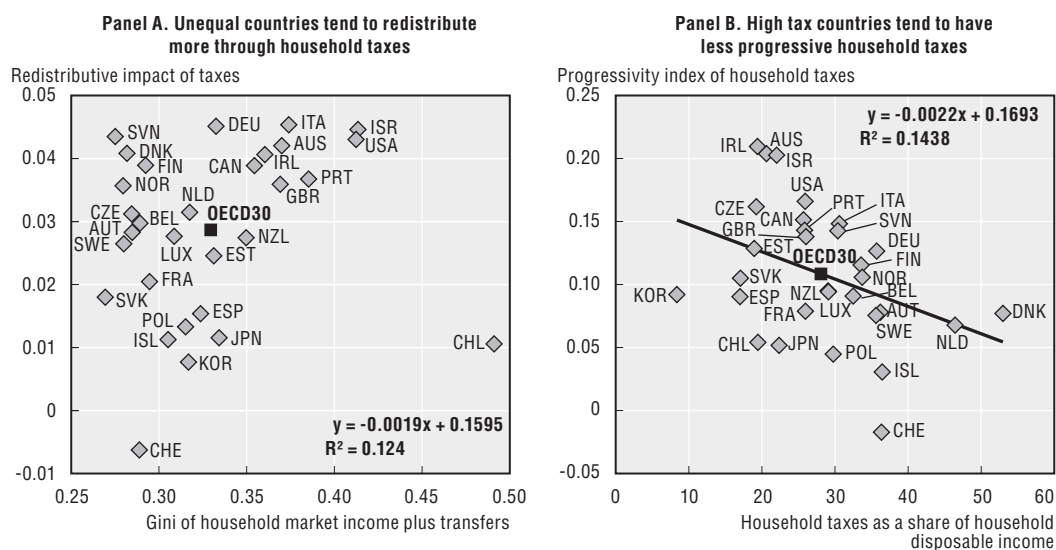
The overall redistributive impact of taxes depends on the amount of taxes collected (size), the tax mix and the progressivity of each tax. Household surveys are useful as they provide actual tax payments including tax relief. But they exclude social security contributions paid by employers and consumption taxes. In addition, household taxes covered by household surveys vary across countries. This section thus includes additional information to assess the redistributive impact of taxes.

2.7. Redistribution via household taxes as gauged by household surveys

The redistributive impact of taxes can be gauged by the difference in the concentration coefficients for income before and after taxes, as derived from household surveys (see the annex). In the late 2000s, the redistributive impact was the highest in Australia, Denmark, Germany, Israel, Italy and the United States (Figure 7, Panel A). It was by far the lowest in Switzerland, followed by Iceland, Korea and Japan. Some of the countries with the highest inequality in market income tend to redistribute more through household taxes than less unequal countries. Australia, Israel, Italy, the United Kingdom and the United States are examples. Chile, however, clearly stands out, having a wide market income dispersion combined with little redistribution via the tax system.

Figure 7. The redistributive impact, size and progressivity of household taxes

In the late 2000s



Note: The redistributive impact of household taxes is measured as the difference between the concentration coefficient of income after transfers but before taxes and that of disposable income (i.e. after taxes and transfers). The progressivity index of household taxes is the Kakwani index computed as the concentration coefficient for taxes less the concentration coefficient for income after transfers and before taxes (see the annex). Data for France and Ireland refer to the mid-2000s. In Panel A, the trend line excludes Chile. Data for Greece, Hungary, Mexico and Turkey are not available.

Source: OECD Income Distribution and Poverty Database.

The redistributive impact of household taxes depends on both their share in disposable income (i.e. their size) and their progressivity. The redistributive impact varies little across countries despite large cross-country differences in the size of taxes. As an illustration, household taxes absorbed more than 35% of household disposable income in Austria, Denmark and Sweden in the late 2000s, but their redistributive impact was lower than in Australia, Israel and the United States, all characterised by a much lower tax-to-income ratio. In many high-tax countries, taxes have a relatively low redistributive impact because they embody little progressivity (Figure 7, Panel B) – this is particularly the case in Belgium, Denmark, Iceland and Sweden. And household taxes are more progressive in the United States than in most EU countries.¹⁶ However, some countries (including Chile, Korea and Japan) combine a relatively low tax burden with very little progressivity.

2.7.1. Going beyond household surveys when assessing the redistributive impact of taxes

Assessing the redistributive impact of tax systems based on household surveys has serious limitations. Respondents may not be able and willing to give the correct information.¹⁷ In addition, the data are available for only a few years, which makes it difficult to assess the impact of tax reforms. Furthermore, most household surveys focus on the personal income tax, social security contributions paid by employees and, sometimes, property taxes.¹⁸ They do not therefore take into account consumption taxes, employers' social security contributions and corporate income taxes, thus leaving aside more than 50% of total tax revenues on average across the OECD. This omission creates serious biases since the tax mix varies widely both across countries and over time. In particular, consumption taxes – which are often seen as being regressive (see below) – have declined as a share of total tax revenue in most OECD countries.¹⁹ In 2008 this share ranged from about 15% in Japan and the United States to over 30% in Chile, Denmark, Greece and Poland. The rest of this section will go beyond household surveys to assess the redistributive impact of taxes, by relying on statutory tax schedules and actual tax revenues as well as a literature review.

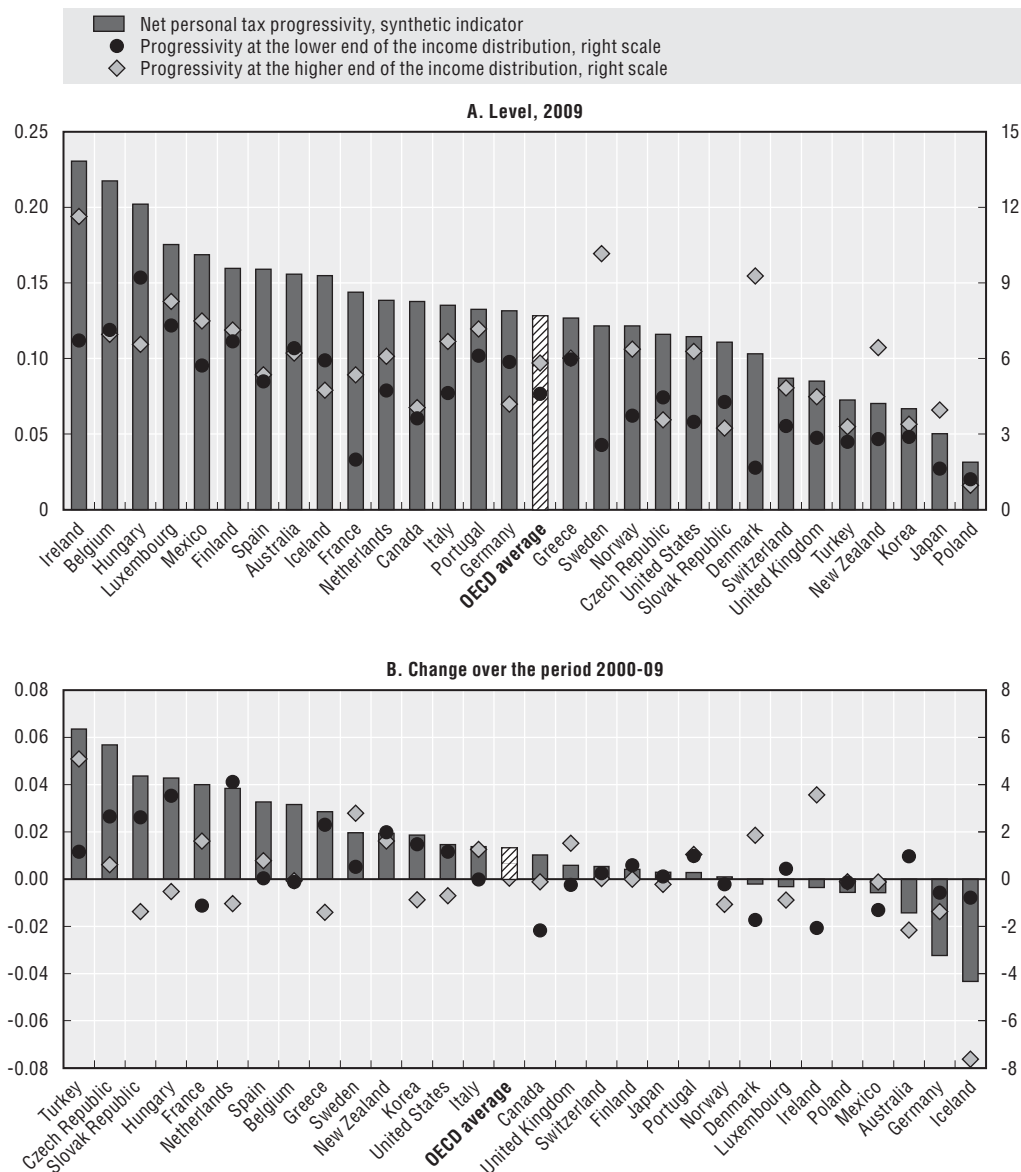
2.8. Labour income taxes: progressivity indicators based on statutory tax schedules

The progressivity of tax systems can also be measured by statutory tax schedules. Compared with those derived from household surveys, such measures have the main advantage of being unaffected by cross-country differences in the definition of household taxes and by differences in responding to household surveys. The OECD has built synthetic indicators of labour income tax progressivity, based on statutory tax schedules, over a wide income range.²⁰ Focusing on a single wage earner (Figure 8, Panel A) shows that there is wide cross-country variation in the degree of progressivity of statutory schedules for personal income taxes and employees' social security contributions.

Also interesting are the differences in the progressivity structure along the income ladder. Progressivity at the higher end of the income distribution – i.e. income equal to 167% of the average wage – is strongest in Ireland, Sweden and Denmark. At the lower end of the income distribution – i.e. income equal to 67% of the average wage – tax schedule progressivity is highest in Hungary, Luxembourg and Belgium. The US tax schedule has slightly more progressivity at the upper end but its overall progressivity is below the OECD average – at least for single wage earners – while Japan and Korea have very little progressivity embedded in their tax schedule for labour income.²¹

Figure 8. Progressivity of statutory personal income tax and employee social security contribution schedules

Based on statutory tax schedules for single tax payers without children



Note: Net personal income tax is defined as the sum of personal income tax and employee social security contributions net of standard cash transfers. Standard tax relief measures – including those linked to marital and family status and income level – are accounted for. Non-standard tax relief measures, i.e. those determined by reference to actual expenses incurred (such as the amount of interest paid on loans), are not included. The synthetic indicator for net personal tax progressivity presented here is not a Kakwani index. It is calculated as the difference between the average net personal tax rate at two income levels based on the assumption of a similar income dispersion across OECD countries. This difference is then divided by the change in income level. Progressivity at the lower end (respectively higher end) of the income distribution is computed as the difference in personal income tax rates (personal income tax and employee social security contributions expressed as a per cent of gross wage earnings) between the average wage and 67% of the average wage (respectively between 167% of the average wage and the average wage).

Source: OECD (2008b), *Taxing Wages 2008-2009* and OECD estimates.

2.8.1. Despite cuts in top marginal rates, labour taxes have often become more progressive

Statutory tax schedules can also be used to assess changes in progressivity over time. Personal income tax schedules have generally become flatter over the past decades (Piketty and Saez, 2007; Sabirianova Peter et al., 2008). Top marginal rates have declined in the vast majority of the OECD countries since 2000, by more than 10 percentage points in Belgium, the Czech Republic, France, Mexico and the Slovak Republic (Table 1). In addition, the income thresholds from which these top marginal rates apply have been raised in some countries including Australia, Canada, Germany and the United States. Finally, cross-country variation in top rate thresholds is wide: the top rate applies to those earning the average wage in Denmark while in the United States it applies only to those earning about 10 times the average wage.

Despite cuts in top rates, tax schedule progressivity has increased in a majority of OECD countries since 2000, largely driven by changes at the lower end of the income distribution (Figure 8, Panel B). To make work more attractive for spouses and low-paid workers, many countries (including Belgium, Canada, Finland, France, the Netherlands, the Slovak Republic, Sweden, the United Kingdom and the United States) have introduced or strengthened in-work benefits targeted at low-income groups, thereby incidentally increasing the progressivity of the personal income tax. Several countries (including Austria, Finland, Germany, Italy and the Slovak Republic) have also raised the tax-free allowance²² or made social security contributions less regressive by removing or raising social security contribution caps or floors (for instance, France and the United States).²³ In parallel, partial or total exemptions for social security contributions below a given income threshold have been introduced or made more generous in some European countries (including Austria, Belgium, France, Spain and the United Kingdom) to reduce the cost of labour for low-paid workers.

2.9. The progressivity of the personal income tax is often hollowed out by tax expenditures

The use of tax expenditures has been growing in many OECD countries (OECD, 2010e) and their value tends to increase with income. With the main exception of earned-income tax credits targeted at low income groups, the value of tax reliefs often increases for higher tax brackets, because the income or transaction targeted is most commonly used by higher-income individuals.²⁴ Tax breaks for health and child care, education, owner-occupied housing and retirement savings often fall into this category. Regarding the latter, Antolin et al. (2004) confirm that in Canada, the United Kingdom and the United States voluntary tax-favoured retirement schemes benefit disproportionately upper income individuals. Overall, tax expenditure can thus reduce the progressivity of the personal income tax significantly. Landais et al. (2011) further show that, in France, tax expenditures result in a decline of the effective personal income tax rate beyond an income threshold.

Only the United States provides much information on who benefits from tax expenditures. There, tax expenditures pertaining to the personal income tax clearly raise after-tax incomes more for higher-income than lower-income taxpayers (Burman et al., 2008). More than 90% of the savings from preferential tax rates on long-term capital gains and qualified dividends go to taxpayers in the top quintile of the income distribution, and nearly half of the benefits go to people in the top 0.1% (Williams, 2011). Concerning health care related tax expenditure (1.3% of GDP), Toder et al. (2009) estimated that more than 40%

of the implicit subsidy accrues to the 20% richest households. Likewise, almost 70% of the implicit subsidy associated with the deductibility of mortgage interest on owner-occupied homes benefits the top income quintile.²⁵

Table 1. **Top personal income tax rates and thresholds**

	Top statutory income tax rate (%) ¹			Threshold (multiple of the average wage) ²		
	2000	2009	Change 2000 to 2009	2000	2009	Change 2000 to 2009
Australia	48.5	46.5	-2.0	1.2	2.8	1.6
Austria	50.0	50.0	0.0	2.3	2.1	-0.2
Belgium	63.9	53.7	-10.2	1.2	1.1	-0.1
Canada	46.4	46.4	0.0	1.7	2.9	1.2
Czech Republic	32.0	15.0	-17.0	2.4	0.4	-2.0
Denmark	59.7	51.6	-8.1	1.0	1.0	0.0
Finland	55.2	49.1	-6.1	2.1	1.8	-0.3
France	58.3	47.8	-10.5	2.9	2.8	-0.1
Germany	53.8	47.5	-6.3	1.7	6.2	4.5
Greece	45.0	40.0	-5.0	3.8	3.6	-0.2
Hungary	40.0	36.0	-4.0	0.9	0.8	-0.1
Iceland	45.4	37.2	-8.2	1.5	0.3	-1.2
Ireland	44.0	41.0	-3.0	1.0	0.9	-0.1
Italy	46.4	44.9	-1.5	3.9	3.2	-0.7
Japan	50.0	50.0	0.0	4.5	4.6	0.1
Korea	44.0	38.5	-5.5	5.5	3.2	-2.3
Luxembourg	47.2	38.9	-8.3	2.1	1.0	-1.1
Mexico ³	40.0	28.0	-12.0	49.3	4.7	-44.6
Netherlands	60.0	52.0	-8.0	1.6	1.2	-0.4
New Zealand	39.0	38.0	-1.0	1.7	1.5	-0.2
Norway	47.5	40.0	-7.5	2.6	1.6	-1.0
Poland	40.0	32.0	-8.0	3.3	2.8	-0.5
Portugal	40.0	42.0	2.0	3.4	4.3	0.9
Slovak Republic	35.0	19.0	-16.0	3.2	0.5	-2.7
Spain	48.0	43.0	-5.0	4.4	2.4	-2.0
Sweden	55.4	56.5	1.1	1.5	1.5	0.0
Switzerland	43.2	41.7	-1.6	4.0	3.6	-0.4
Turkey	35.6	35.6	0.0	8.1	3.0	-5.1
United Kingdom	40.0	40.0	0.0	1.4	1.3	-0.1
United States	46.7	41.9	-4.8	8.9	9.6	0.7
OECD average	46.7	41.5	-5.2	2.9	2.5	-0.4
Standard deviation	7.9	9.3	1.5	2.0	2.0	0.0

1. These are the top statutory tax rates (combined central and sub-central) that apply from the threshold levels reported in the fourth and fifth columns.

2. These columns report the level of gross wage earnings (expressed as a multiple of the average wage) at which the top personal income tax rate starts to apply. The average and dispersion exclude Mexico.

3. The threshold figure for Mexico in 2000 reflects a tax schedule with two supplementary brackets designed to tax very high earners more heavily. These supplementary brackets were removed in 2002, resulting in the threshold of the upper bracket coming down sharply as a proportion of average earnings.

Source: OECD (2009), OECD Tax Database.

2.10. Taxes on capital income have been reduced and are often lower than taxes on labour income

Various savings schemes have long been granted a preferential tax treatment in most OECD countries. Since capital income tends to be concentrated in upper income brackets, such tax relief implies less progressivity of the income tax. Governments promote private

pensions by means of tax incentives in the majority of OECD countries. In the most common regime, private pension savings can be deducted from the income tax base and accrued return on investment is exempt from taxation, but pension benefits arising from these savings are taxed (Yoo and de Serres, 2004). Housing investment also often benefits from a favourable tax treatment with imputed income from owner-occupied dwellings and capital gains on the sale of a principal residence taxed less than other capital income, or not taxed at all, while interest payments on debt-financed investment in owner-occupied housing are sometimes deductible from taxable personal income. These tax-favoured schemes, however, tend to affect the mix, rather than the volume, of private savings. They may thus divert saving and investment away from other activities that may be more conducive to growth.

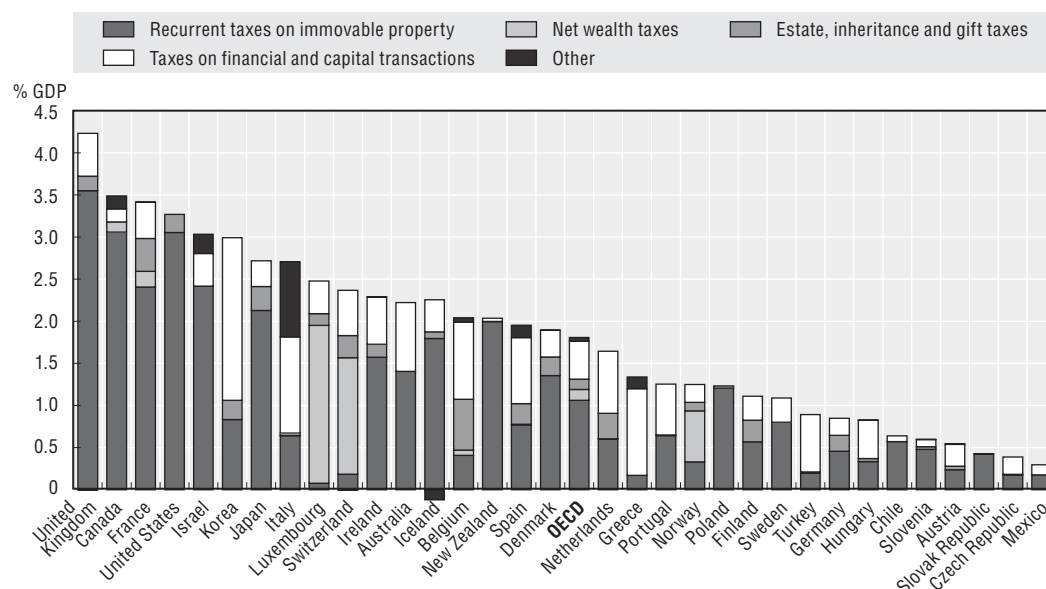
The low taxation, if any, of capital gains on shares also has important distributional consequences, though its impact on growth is subject to debate. It is often argued that a lower tax rate on capital gains encourages risk-taking and entrepreneurship, thus promoting growth, while high capital gains taxes create an inefficient “lock-in” effect. Burman and Moynihan (2011) show that 94% of the value of capital gains tax breaks in the United States benefit the top quintile. They consider that, since losses are often supported by the government (in the form of reduced taxes), capital gains should be taxed. They also argue that the lock-in effect is small. Because it is often difficult to distinguish between labour and capital income, in particular for the self-employed, low taxation of capital income further creates opportunities for income-shifting and tax planning (Diamond and Saez, 2011). And it may ultimately favour top income groups most (top executives, finance professionals and entrepreneurs), who can benefit from carried interest arrangements and the low taxation of stock options (OECD, 2011a).²⁶

Some countries have moved further towards a non-progressive and reduced taxation of most capital income, in particular in Europe. The main objective of such reform is to reduce tax distortions across savings instruments and incentives for capital exports. Precursors were the Nordic countries which adopted a dual income tax system in the late 1980s or early 1990s. Under such a system, a unique flat tax rate applies to net capital income (interest income, dividends and capital gains) while labour income is subject to a progressive tax schedule. Many countries have not adopted a “pure” dual income tax system but they increasingly tax interest income at flat rates, usually lower than the marginal rates which apply on labour income (Joumard, 2001). In contrast, several countries have continued to tax most types of capital income as labour income, i.e. at progressive rates, including Canada, Ireland, Korea, Luxembourg, Switzerland, Turkey, the United Kingdom and the United States (OECD, 2006).

2.11. Property taxes play a minor role in many OECD countries

Raising property taxes is often presented as one option to increase the redistributive impact of tax systems. Property taxes amount to more than 10% of total tax receipts in several OECD countries and about 2% of GDP on average across the OECD. As a share of GDP, they are highest in the United Kingdom, Canada, France and the United States and lowest in several continental European countries and Mexico (Figure 9). Recurrent taxes on immovable property account for the bulk in most countries though taxes on financial and capital transactions play a dominant role in Belgium, Greece, Korea, Italy and Turkey.

Figure 9. **The property tax take varies significantly across OECD countries**
2009, per cent of GDP



Source: OECD (2010c), *Revenue Statistics* 2010.

2.11.1. Real-estate taxes are regressive in some countries

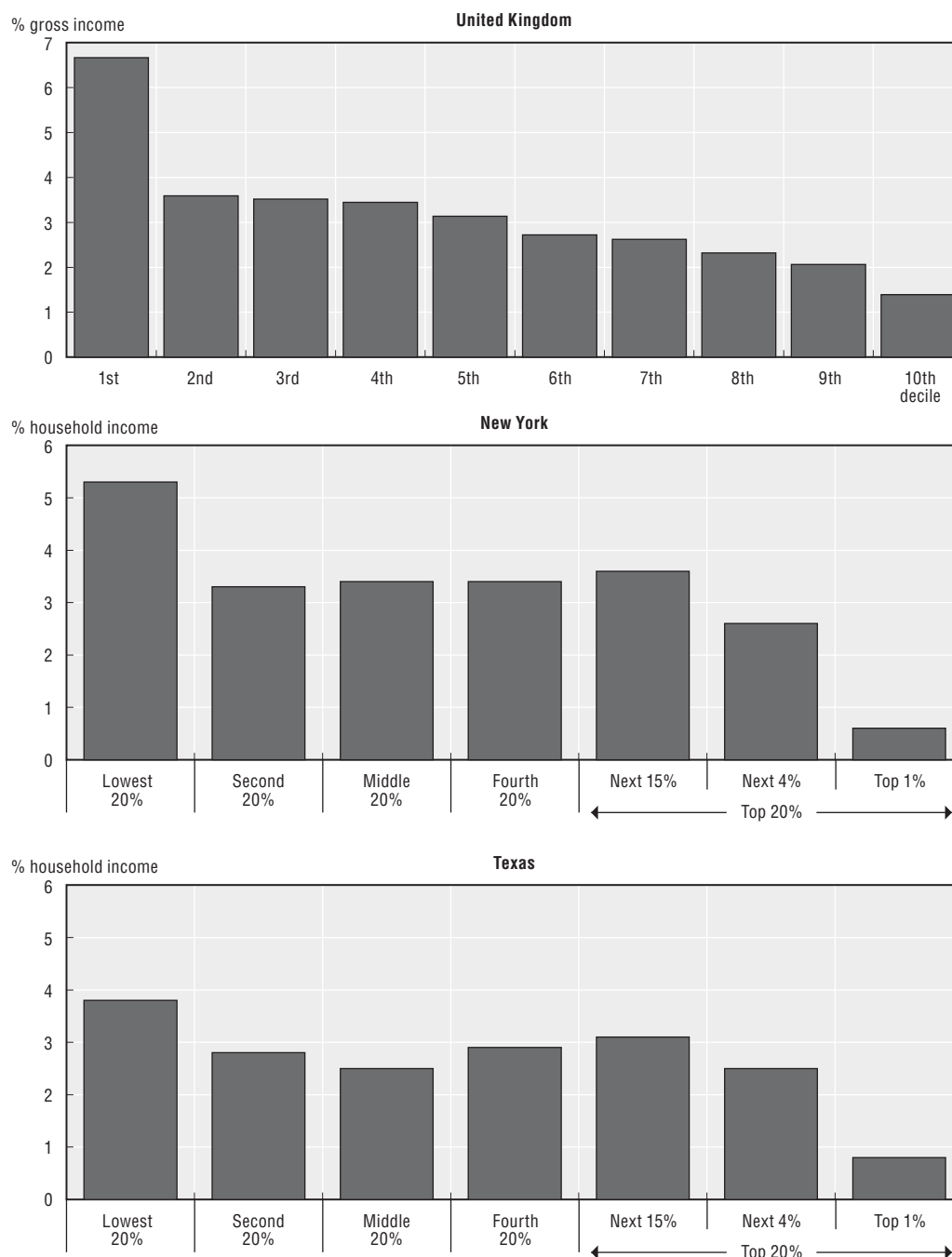
While high-income households pay more recurrent taxes on immovable property in absolute terms, real estate taxes often absorb a larger share of the income of the poorer households. In the United Kingdom, for instance, the Council Tax amounts to over 6% of income for non-retired households in the bottom decile, but less than 2% for those in the top decile (Figure 10). A similar pattern is found in Canada (Chawla and Wannel, 2003) and in the United States (Davis *et al.*, 2009). One explanation is that recurrent taxes on immovable property are often a sub-national government tax whose amount should reflect the benefit of local public services (waste collection, etc.) which does not increase much with income. In some countries, real estate taxes are also paid by renters, who often have low income. Part of the regressive nature of real estate taxes may also reflect the fact that many pensioners own expensive houses but receive relatively little income. Still, Palameta and Macredie (2005) found that this is only part of the story in Canada, since non-seniors make up the majority of lower-income homeowners.

Some countries have introduced tax allowances, income-conditional exemptions or progressive tax rates to reduce real estate tax payments on low-income groups. For instance, regressivity is mitigated in some US states by a flat dollar amount exemption – *e.g.* homestead exemptions – or a tax credit designed to assist low-income taxpayers. Similar tax relief is provided by some Canadian provinces and municipalities. And in France, generous income- and family-related tax relief has succeeded in making the largest recurrent tax on immovable property (*Taxe d'habitation*) slightly progressive since 2000, at least for the first part of the income distribution (Conseil des Prélèvements Obligatoires, 2011; Marical, 2009).²⁷

2.11.2. Wealth, inheritance and gift taxes have been reduced in many countries

Taxing household wealth, either annually or at the time of transfer (gift and inheritance), is attractive for various reasons. First, the tax base is large and had grown

Figure 10. **Real estate taxes tend to be regressive in the United Kingdom and selected US states**



Note: Data for the United Kingdom refer to the Council tax and Northern Ireland rates, less discounts, Council tax benefits and rate rebates, for non-retired households for the fiscal year 2009/10. They are expressed as a percentage of gross income (market income plus transfers). The data for New York and Texas cover property taxes – property primarily includes homes, but may include property other than real estate such as cars – paid by non-elderly households in 2007. The states of New York and Texas were chosen as examples for the United States to represent states with above average (New York) and below average (Texas) property values. In New York State, there is no general homestead exemption for all home-owners, but homeowners with income below \$500 000 are entitled to a partial school tax exemption. In Texas, there is a basic homestead exemption available to all homeowners.

Source: ONS (2011), *The Effects of Taxes and Benefits on Household Income, 2009/10*, www.ons.gov.uk/ons/rel/household-income/the-effects-of-taxes-and-benefits-on-household-income/2009-2010/the-effects-of-taxes-and-benefits-on-household-income-2009-10.pdf; ITEP (2009), *Who Pays? A Distributional Analysis of the Tax Systems in All 50 States*, www.itepnet.org/whopays3.pdf.

briskly prior to the crisis. As an illustration, households' net worth in France is five times higher than GDP and it has grown over 7% on average per year and in real terms between 1997 and 2007, compared with a 1.7% average annual increase for GDP (Conseil des Prélèvements Obligatoires, 2011). Taxing wealth at a rather low rate should thus generate large and rising tax revenues. *Second*, real estate accounts for a large share of household net worth (Fredriksen, 2011) and the tax can thus hardly be avoided. *Third*, inheritance and gift taxes, not only on immovable property but on all net assets, could offer an alternative to the taxation of lifelong saving. It could be considered as a way of taxing, for example, income or capital gains that were tax-exempt during a person's lifetime. Inheritance taxes have the advantage of generating less distortion than annual wealth taxes because it is more difficult to find ways of avoiding the tax.²⁸ Several countries, including the United States, have made inheritance and gift taxes highly progressive by providing tax-free allowances and by applying progressive rates.²⁹ Finally, wealth is more concentrated than income and is becoming more unequally distributed. In the seven OECD countries covered by the Luxembourg Wealth Study, the 10% richest households hold between 40% (Italy) and 70% (United States) of total wealth. And the value of inheritances and gifts as a share of GDP has grown rapidly in some countries – it has risen three-fold since 1950 to reach almost 15% in 2008 in France (Piketty, 2010) – perpetuating income inequality.

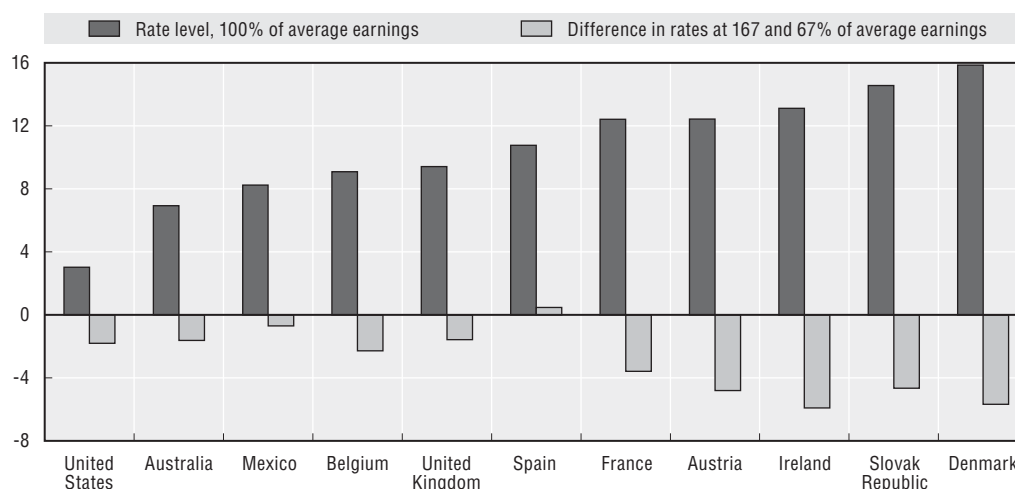
In practice, however, the use of wealth and inheritance taxes has declined. Wealth taxes have been abolished in about a third of the OECD countries since the mid-1990s and several countries (including the United Kingdom) never had this type of tax.³⁰ In 2010, only four OECD countries (Canada, France, Norway and Switzerland) still imposed wealth taxes (Price and Dang, 2011) and wealth taxes often apply only to a very small fraction of the population. Inheritance and gift taxes are applied rather widely but several countries have reduced or abolished them since the mid-1990s (including Austria, France, New Zealand, Portugal, Slovak Republic and Sweden). The risk of wealth/capital flight to low-tax countries, as well as administrative and collection costs, have often been cited as the main reasons for the limited use of wealth taxes.³¹ It could also be argued that wealth and inheritance taxes entail a double taxation of immovable property, since real estate taxes may already be high, while financial wealth is too mobile to be taxed. However, real estate taxes often finance local services that benefit local populations and businesses. The double-taxation argument has thus a weak basis.

2.12. Consumption taxes tend to be regressive

Consumption taxes account for a significant revenue share in all OECD countries (about 27% on average) and tend to decline as a share of household disposable income since lower-income households tend to consume a larger share of their income (Prasad and Deng, 2009; Roach, 2003; Warren, 2008). As an illustration, in the United Kingdom, indirect taxes amounted to 13% of household gross income in 2008 (defined as market income plus cash benefits) but to over 25% for the lowest quintile and less than 10% for the top quintile (ONS, 2010).³² Likewise, in the United States, sales and excise taxes levied by states are found to be highly regressive. Poor families pay almost eight times more as a share of their income than the best-off families (Davis *et al.*, 2009). It should be noted, however, that calculations based on annual income data may overstate the regressive nature of consumption taxes since consumption largely depends on lifetime income which is less variable than annual household income (Poterba, 1989). In particular, pensioners with low annual income may consume out of their previous (accumulated) earnings.³³

A lack of data makes it difficult to investigate the redistributive impact of consumption taxes in a cross-country setting. Implicit consumption tax rates can, however, be used to derive estimates (OECD, 2008b). They suggest that the regressive impact of consumption taxes – as measured by the difference in the implicit consumption tax rate for those at 167% of average earnings and those at 67% – is higher in the European countries than in the other OECD countries, due to higher consumption tax rates (Figure 11).³⁴ Warren (2008) also found a higher regressivity of consumption taxes – measured as the contribution to the Gini coefficient – in Denmark, Finland, Hungary, Norway and Sweden and the lowest regressivity in Japan and the United States. Thus, omitting consumption taxes affects estimates of redistribution achieved through the tax and transfer system, as well as how they differ across countries and evolve over time.

Figure 11. **Average consumption tax rate at different income levels**



Note: Average consumption tax rates are estimated by using microdata on consumption patterns available from household budget surveys and the corresponding tax rates (VAT, sales taxes and excise duties) in order to calculate the tax payments for each individual/family by income level. Estimated tax payments are then divided by net income (i.e. gross earnings minus personal income tax and employees' social security contributions plus family benefits).

1. OECD (2008b), *Taxing Wages*, 2007-2008.

To mitigate the regressive impact of consumption taxes, many OECD countries apply reduced rates and exemptions for goods and services deemed to account for a large share of poorer households' consumption basket. For instance, food, water supply, medical care and public transport are often granted reduced rates or exemptions.³⁵ This approach typically implies a considerable dead-weight loss, and people at higher income levels often benefit more in absolute terms since they consume more. In the case of Mexico, the total implicit subsidy due to the zero-rating of food was estimated at some 1.8% of GDP in the mid-1990s (Dalsgaard, 2000). The distribution by income decile showed that the highest decile captured nearly 30% of this amount, while the lowest three deciles together received only 12% of the value of the subsidy. Likewise in the Czech Republic, the lower VAT rate covers about 41% of the consumption of goods and services subject to VAT, and there is only very little variation in the share of such goods in the consumption baskets of households across the income deciles. Reduced VAT rates benefit the average individual in the top income decile about 2.5 times as much as the average consumer in the bottom

decile (OECD, 2010b). Moving towards better targeted aid through in-kind benefits, cash transfers and vouchers appears thus as a more effective redistribution tool (EC, 2007; Van den Noord and Heady, 2001).

2.13. A limitation of the analysis: the incidence of taxes and transfers

When assessing the impact of the tax and transfer system on income distribution, most analyses (including this article), assume that taxes and transfers do not affect economic behaviour. The assumption of “no behavioural response” is likely to overstate the amount of redistribution as taxes and transfers typically affect incentives to work and save (Moffit, 2011). It also entails that the efficiency costs of redistributive policies – e.g. output foregone and lower real wages – are not accounted for. The ultimate incidence of taxes and transfers crucially depends on how individuals and firms respond to a change in relative prices. The greater the responsiveness, that is, the higher the price elasticities of supply and demand, the more likely it is that someone else will bear the tax burden or somebody else will benefit from a transfer. The ultimate effect will depend on the relative size of the elasticities. For instance, if labour demand is more sensitive to wages than labour supply, then payroll taxes end up being mainly borne by the employee in the form of a lower wage. Conversely, if labour supply is relatively inelastic and labour demand is relatively elastic, then the enterprise will bear more of the tax burden.

Changes in tax progressivity may have a different impact on the labour supply of low- versus high-income earners. For low-income groups, more progressivity through earned income tax credit (EITC) schemes increases work incentives but the resulting increase in labour supply may reduce wages – the EITC may increase the dispersion of before-tax income.³⁶ However, for high-income groups, more progressive taxes may dampen work incentives and lower working hours. This could narrow the earnings dispersion. Taxes may also affect labour demand, with potential job losses more likely to affect low-skilled workers.³⁷

The incidence and ultimate income inequality effect of property taxes, housing transfers and consumption taxes may also differ from the first-round effect. While most property taxes are paid by owners, they may largely be passed onto renters in the form of higher rents as the supply of housing is relatively inelastic, at least in the short term. Similarly, housing cash transfers targeted on low-income groups may be reflected in higher rents, in which case they benefit the (higher-income) owners.³⁸ Consumption taxes will be paid by consumers in the case of strong competition. However, the degree of competition could differ for different goods and services. As an example, recent cuts in French consumption taxes on restaurants have not been fully passed on to consumers. They have partly financed higher wages and employment as well as raised profit margins. These examples suggest that the overall distributional impact of taxes may partly depend on behavioural responses.

3. Tax and cash transfer policy indicators help identify types of welfare systems

Countries rely on various tax and transfers instruments which differ in their design and impact on the income distribution. As discussed above, there are wide variations in the size, mix and progressivity of both taxes levied on and cash transfers paid to households. Indicators on tax and transfer policies have been assembled, which were brought together in country profiles. The country profiles put the tax and transfer policy framework into an

international perspective and allow the identification of reform options to address income inequality. Indicators on tax and transfers policies have also been used to identify groups of countries sharing broadly comparable welfare systems.

3.1. A set of policy indicators on taxes and cash transfers for each OECD country

The redistributive impact of taxes depends on: i) a size effect (the overall tax level); ii) the tax mix (some taxes are more progressive than others) and iii) the progressivity of each tax. The same logic applies to cash transfers. For both taxes and transfers, policy indicators have been assembled for each of these three dimensions using the *OECD Income Distribution and Poverty Database* and various other OECD databases. To identify the tax and transfer policy framework, the country profiles show for each country the value of each indicator compared with the OECD average. As an illustration, the main features that can be gleaned from the set of policy indicators for Australia and Germany are presented below (Figure 12), with a similar presentation for all OECD countries available in Joumard *et al.* (2012). The redistributive impact of taxes and transfers is higher than the OECD average in the two countries but the size, mix and progressive nature of both taxes and transfers differ significantly.

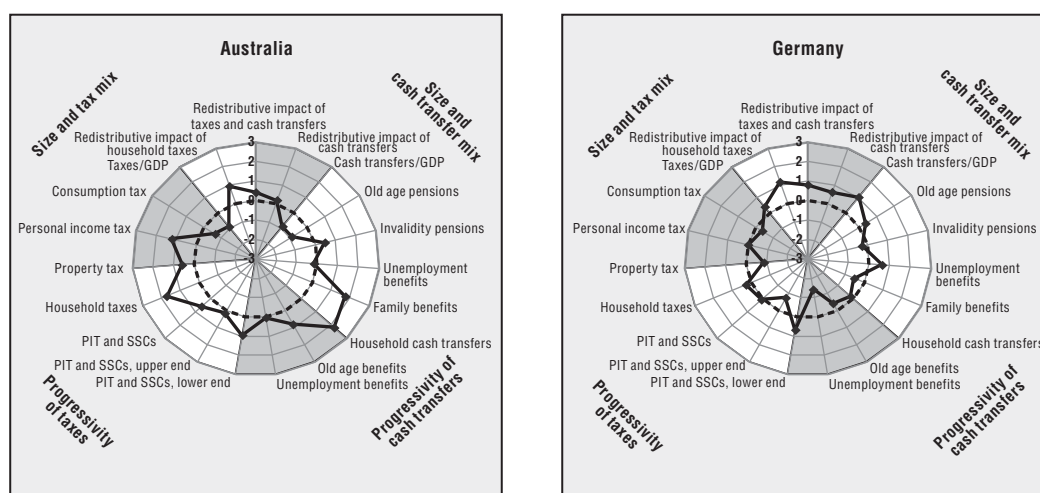
3.1.1. In Australia, taxes and transfers are smaller but more progressive than the OECD average

The redistributive impact of taxes and cash transfers is above the OECD average in Australia. This mainly reflects the higher redistributive impact of taxes, even though the size of the Australian tax system, as measured by the tax to GDP ratio, is considerably below the OECD average (27% and 35%, respectively in 2008). Both the tax mix and the progressive nature of taxes raise the redistributive impact of taxes. Personal income taxes account for a larger share of total taxes, while consumption taxes – which, as discussed above, tend to be regressive – play a less important role than in many other OECD countries. The data contained in the *OECD Income Distribution and Poverty Database* further reveal that household taxes are more progressive – as measured by a Kakwani index – than in the OECD on average. So are the personal income tax and social security contributions paid by employees (based on statutory tax schedules from the *OECD Tax Database*), in particular at the lower end of the income distribution. On the spending side, household cash transfers as a share of GDP are below the OECD average – 8% versus 11.5% in 2007 according to the *OECD Social Expenditure Database*. However, the transfer mix favours redistribution across individuals, with family benefits accounting for a relatively high share of total transfers. The progressivity of total cash transfers to households (as measured by the Kakwani index derived from the *OECD Income Distribution and Poverty Database*) is also above the OECD average. This also applies to old-age pensions (based on the OECD progressivity indicator), while the progressivity indicator for the unemployment benefit system is close to the OECD average.

3.1.2. In Germany, taxes and transfers are larger but less progressive than the OECD average

The redistributive impact of taxes and cash transfers in Germany is above the OECD average. On the tax side, the total tax-to-GDP ratio stands above the OECD average (37% and 35%, respectively, in 2008) while the progressivity of household taxes is close to the OECD average. However, the progressivity of the personal income tax and social security contributions is steeper at the lower end than at the upper end of the income distribution.

Figure 12. Tax and cash transfer policy indicators for Australia and Germany



Note: The dotted line represents the OECD average, the solid line represents the country shown. Where the solid line falls inside the OECD average, the variable considered stands below the OECD average. For instance, the tax/GDP ratio in Australia is lower than in the OECD area. Inversely, where the solid line is outside the OECD average, the variable is above the OECD average (the cash transfer/GDP ratio in Germany is higher than the OECD average, for example). The indicators are presented in units of standard deviation.

Legend:

Size and mix of taxes:

Taxes/GDP = Total tax revenue, % of GDP.

Consumption tax = Taxes on goods and services, % of total tax revenue.

Personal income tax = Income taxes on individuals or households, % of total tax revenue.

Property tax = Taxes on property, % of total tax revenue.

Progressivity of taxes:

Household taxes = Progressivity of total household taxes (Kakwani index, based on household surveys).

PIT and SSCs = Net personal income tax progressivity, synthetic indicator, based on income tax plus employee contribution schedules net of standard cash transfers as a % of gross wage earnings, single person without children.

PIT and SSCs, upper end = As above, gap in tax rate between those earning 167% of the average wage and those at the average wage.

PIT and SSCs, lower end = As above, gap in tax rate between those earning the average wage and those at 67% of the average wage.

Size and mix of cash transfers:

Cash transfers/GDP = Total cash transfers, public and mandatory private sources, % of GDP.

Old age pensions = Old age and survivors' pensions, % of total cash transfers.

Invalidity pensions = Incapacity related cash transfers, % of total cash transfers.

Unemployment benefits = Unemployment cash benefits, % of total cash transfers.

Family benefits = Family cash benefits, % of total cash transfers.

Progressivity of cash transfers:

Household cash transfers = Progressivity of total household cash transfers (Kakwani index, based on household surveys).

Old age benefits = Progressivity of pensions.

Unemployment benefits = Progressivity of unemployment benefits, net of taxes for a single person.

Total cash transfers to households, at almost 16% of GDP in 2007, are higher than in most OECD countries. Old-age pensions and unemployment benefits account for a larger share in total transfers, while family benefits are less important. The redistributive impact of household transfers is small, because of the low progressivity of the two main transfer components – old-age pensions and unemployment – reflecting their largely insurance-based nature.

3.2. Four tax and transfer systems can be identified

A cluster analysis of 19 policy indicators of the size, mix and progressivity of both taxes and transfers has been performed.³⁹ It allows identifying four groups of countries with most similar tax and transfer systems:⁴⁰

- A group of four Nordic countries (Denmark, Finland, Norway and Sweden) plus Belgium, Hungary, the Netherlands and Spain is characterised by large cash transfers to households, which are not dominated by old-age pensions and tend to be more progressive than the OECD average. The tax-to-GDP ratio is high (Spain being an exception in this regard), with a tax mix which promotes redistribution – a rather large role for personal income taxes, while consumption taxes account for a small share of total taxes. Labour income taxes are rather progressive. Overall, the redistributive impact of taxes and transfers – as measured by the decline in the concentration coefficient before and after taxes and transfers – is above the OECD average in all of these countries except Spain.
- A group of 10 continental European countries (Austria, Czech Republic, France, Germany, Greece, Italy, Luxembourg, Portugal, Slovak Republic and Slovenia) features large cash transfers to households and a high tax-to-GDP ratio. However, old-age pensions dominate cash transfers whose overall progressivity tends to be below the OECD average – the welfare system is dominated by transfers that redistribute over the lifecycle rather than across individuals. On the tax side, the personal income tax often plays a marginal role in total taxes (Germany and Italy are exceptions) and the progressivity of labour tax schedules is relatively limited.
- A group of 11 countries have in common relatively small cash transfers and taxes, combined with a large role of property and personal income taxes. A sub-group, Australia, Iceland, Ireland, Israel, New Zealand and the United Kingdom, is further characterised by a relatively small share of old-age pensions in total cash transfers which are, in addition, often means-tested and thus highly progressive. Another sub-group consists of Canada, Japan, Korea, Switzerland and the United States. In these countries, cash transfers are dominated by old-age pensions and are less progressive than in the first sub-group.
- A group of four countries – Chile, Mexico, Poland and Turkey – is characterised by relatively small cash transfers to households (Poland is an exception), which are dominated by old-age pensions and often not highly progressive. Two additional features further limit the redistributive impact of the welfare system: public spending on in-kind services (mostly education and health) as a share of GDP is low and consumption taxes play a dominant role in total taxes.
- It is interesting to note that there is a close, but not perfect, correspondence between country clusters based on tax and transfer policy indicators and country clusters based on inequality outcomes (Hoeller et al., 2011). As an illustration, the Nordic countries and Switzerland are all characterised by relatively low inequality emerging from the labour market and they appear in the same inequality outcome group. Looking at the tax and transfer side, the Nordic countries again fit within the same group because their tax and transfer policies are broadly similar. However, Switzerland is in a different policy group because it implements much less redistribution via the tax and transfer system than do the Nordic countries.

Notes

1. The household income data used in this article are “equivalised”, taking into account the size of each household type in the population and assigning a value in proportion to its needs. This equivalence adjustment uses a scale which divides household income by the square root of the household size.
2. It should be noted that two populations may have the same Gini but still be characterised by different income distributions, e.g. when the share of different quantile groups are examined. These considerations also apply to concentration coefficients and to indicators used to measure the redistributive impact of taxes and transfers, especially as these tend to operate more strongly at the top and bottom of the income distribution, respectively.
3. The *OECD Income Distribution and Poverty Database* relies on household income surveys carried out by national experts who apply common conventions and definitions, thus enhancing cross-country comparability. In the OECD database, however, income data for Greece, Hungary, Mexico and Turkey are presented net of taxes, and data on household taxes are not available. Data from household surveys face other limitations, discussed in Jourmard et al. (2012).
4. When assessing the redistributive impact of taxes and transfers, most analyses (including this paper) assume that taxes and transfers do not affect economic behaviour. Incidence issues are discussed at the end of this section.
5. Looking at the working age population yields broadly the same message.
6. In the *OECD Income Distribution and Poverty Database*, the Earned Income Tax Credit is booked as a transfer.
7. As an example, social transfers targeted at low-income groups in France – the minimum income (RMI/RSA) and minimum pensions – are only adjusted for price inflation. As the average wage has grown more rapidly than prices over the past decade, the relative income of social transfer recipients has declined substantially, undoing the discretionary measures to improve their generosity (Conseil des Prélèvements Obligatoires, 2011).
8. The high share of pensions received by working age individuals in some countries is attributable to the low effective retirement age. There is a negative correlation between this share and the standard or effective retirement age. The correlation coefficient between them is -0.61 (based on data for the mid-2000s) and is statistically significant at the 1% level.
9. In Sweden, the replacement rates of mandatory pensions are progressive for a large part of the income distribution. The replacement rate declines with income up to a certain income level beyond which it starts to increase. Also, it is worth emphasizing that pension systems with high payments can be characterised by low overall progressivity and *vice versa* as progressivity basically depends on the difference in replacement rates between low- and high-income earners and not on the level of replacement rates.
10. It is worth noting that the pension progressivity index differs from the progressivity indicators used elsewhere in this paper since it focuses on redistribution across individuals.
11. Empirical evidence corroborates this (Garrett, 1995, Goda et al., 2009 for the United States and Hachon, 2009 for France). Hachon (2009) shows that, for sufficiently large differences in mortality rates, insurance-based pension systems can become regressive.
12. In pure flat pension schemes, the replacement rate of benefits decreases monotonically whereas in pure insurance schemes the replacement rate is constant across the earnings distribution. In general, a pension scheme will be more redistributive the larger the difference between the replacement rate of low and high pensions. Although this is a rough progressivity measure, as it does not take into account the inequality in personal earnings, the correlation coefficient between this progressivity measure and the progressivity index used for Figure 6 is 0.85.
13. On average in the OECD, 22% of households with a disabled person receiving benefits live in poverty, compared with around 14% for other households. This gap is especially high in Australia, Ireland, Korea, the United Kingdom and the United States (OECD, 2010d).
14. Progressivity of unemployment benefits also depends on the type of family. For instance, unemployment benefits for a family with children are slightly less progressive than for those without. Long-term unemployment benefits and social assistance for people who have been unemployed for five years or more are, on average, as progressive as those granted during the initial phase of unemployment spells.

15. Family cash benefits do not include public spending on services for families with children (e.g. direct financing and subsidising of childcare providers and early education facilities), nor financial support for families provided through the tax system.
16. Various studies have compared the progressivity of tax systems of European countries with that of the United States (see for instance Prasad and Deng, 2009; Piketty and Saez, 2007; Joumard, 2001). Though they use different definitions, methods and databases, they reach the same conclusion: the US tax system is more progressive than those of the continental European countries.
17. After comparing the implied aggregate receipts and other data sources, it has been decided to rely on data for the mid-2000s, instead of those for the late 2000s, for France and Ireland.
18. In OECD (2008a), the data are drawn from household surveys, and household taxes should in principle cover personal income tax, social security contributions paid by employees (but not by employers) and property taxes. In practice, however, the coverage varies from one country to another. Furthermore, the database does not allow a breakdown of these taxes. Coverage also varies significantly across studies. Piketty and Saez (2007) rely on actual tax returns, and include the federal corporate income tax for the United States. Assuming that the incidence of the US federal corporate income tax falls entirely on capital income, they find that the corporate income tax is progressive. With a similar assumption, Roach (2003) reaches the same conclusion but notes that if 25% of corporate taxes are allocated to consumers and another 25% to workers, then the progressivity of corporate taxes virtually disappears. Duncan and Sabirianova Peter (2008) focus on the personal income tax only. Fuest *et al.* (2010) assess the redistributive impact of personal income taxes and social security contributions paid by both employees and employers.
19. Between 1975 and 2008, the share of consumption taxes in total tax revenues dropped from 26 to 22% in Canada, from 32 to 24% in France and from 17 to 14% in the United States.
20. Taxes on labour income consist of personal income taxes, social security contributions paid by employees as well as payroll taxes when relevant. The calculation and coverage of progressivity indices based on tax schedules differ from the Kakwani index presented above. In particular, they include standard cash (mostly family-related) transfers and do not account for non-standard tax reliefs, such as those associated with mortgage interest payments. Drawing international comparisons for single taxpayers without children allows leaving aside most cash transfers to focus mostly on taxes. The correlation between the progressivity index based on tax schedules (for single taxpayers and under the assumption of a similar distribution of income across countries) and the Kakwani progressivity index based on household surveys is 0.58, significant at 5%.
21. Due to the various tax reliefs for low-income earners with children, the US personal income tax is much more progressive for families with children than for single tax payers.
22. The Slovak Republic replaced the progressive personal income tax system by a flat rate system in 2004. However, the basic tax allowance, which declines as income grows, and the refundable tax credit targeted at low-income earners introduced in 2009 reinforce tax progressivity significantly at the lower end of the income distribution.
23. In Denmark, Hungary, Spain and Switzerland, minimum amounts of social security contributions – floors – still have to be paid by employees and/or employers. Caps are in place in many OECD countries.
24. Tax reliefs take different forms, including: i) tax allowances and exemptions (amounts are deducted/excluded from the tax base); ii) rate relief (a reduced rate of tax applied to a group of taxpayers or transactions); iii) tax deferral (a delay in paying the tax); and iv) tax credits (amounts deducted from tax liabilities). Standard tax reliefs – including those linked to marital and family status and income – are accounted for in the data on progressivity of personal income taxes and employee social security contributions from *Taxing Wages*. Thus, EITC type tax reliefs are included. Non-standard tax reliefs, i.e. reliefs determined by actual expenses incurred (such as the amount of interest paid on loans), are not included.
25. Matsaganis and Flevotomou (2007) used the tax-benefit model EUROMOD to quantify the distributional impact of mortgage interest tax relief in the Netherlands, Sweden, Finland, Italy and Greece. They show that higher-income groups capture a disproportionate share of mortgage interest tax relief in all these countries. The effect is most regressive in the Netherlands and least regressive in Sweden.
26. Individuals may benefit from “carried interest” arrangements when they have a relatively small equity stake in a business. If successful, rewards are taxed as capital gains, hence at a rate that is generally below their marginal personal income tax rate.

27. The Conseil des Prélèvements Obligatoires (2011) also notes that existing taxes on real estate transactions – *Droits de mutation à titre onéreux* – are regressive as they are calculated as the sum of a fixed amount and a percentage of the value of the transaction. The effective tax rate on small transactions is *de facto* much higher and often paid by low-income families.
28. Avoidance is easier when *intervivos* gifts are exempt or pay a lower rate and when business and agricultural assets get favourable treatment (e.g. to avoid breaking up family undertakings).
29. Roach (2003) shows that US estate and gift taxes were the most progressive elements of federal taxation because they applied only to large estates/gifts and because rates were progressive.
30. Among the countries that reduced or abolished wealth taxes since the mid-1990s, some have increased the taxation of top incomes (Germany) or capital income (Luxembourg and the Netherlands). Spain introduced a wealth tax in September 2011.
31. In France, about 5 000 individuals paying the wealth tax (ISF) left the country between 1996 and 2005 (Conseil des Prélèvements Obligatoires, 2011).
32. In cash terms, the top fifth of households pay three times as much indirect tax as the bottom fifth. This simply reflects higher expenditure by higher income households. The only indirect taxes where average payments in absolute terms do not vary much across the income distribution are those on tobacco, television licences and the tax element of the National Lottery.
33. It is worth noting that applying the Kakwani index to define progressivity, in certain countries, depending on the distribution of primary income, the reduced VAT rates would be progressive.
34. Reflecting differences in the level of consumption taxes (standard rates at 5% in Japan and about 7% in the United States, but up to 25% for the standard VAT rate in the Nordic countries), Garfinkel *et al.* (2006) noted that the same hypothetical USD 1 000 cash transfer to low-income households buys more goods in the United States and Japan than in the Nordic countries – more than USD 930 compared with USD 750. Adema and Ladaïque (2009) also recognise that consumption taxes reduce the real value of consumption which can be financed out of a given level of benefits. Furthermore, they note that, in some countries, policy explicitly took into account the impact of indirect taxation on the financial position of low-income households. For example, when the Goods and Services Tax was introduced in Australia in July 2000 at a rate of 10% (with food being exempt), a compensation package for social protection benefit recipients was introduced at the same time.
35. For details, see OECD (2011b). Reduced VAT rates and exemptions are taken into account in the OECD estimates of the consumption tax rate at different income levels.
36. Rothstein (2008) found for the United States that the EITC increases labour supply and studied the effect on wages. Low-skilled single mothers keep only \$0.70 of every dollar they receive. Employers of low-skilled labour capture \$0.72 (of which about 40% from single mothers and the rest from ineligible workers whose after-tax incomes fall). The net transfer to low-skilled workers is about \$0.28 per dollar spent.
37. In a perfectly competitive labour market, higher labour taxes should not affect equilibrium unemployment since workers bear the entire tax burden through lower net wages. However, if firms cannot shift the entire tax burden onto workers (for example, because of minimum wages or strong trade unions), higher taxes will reduce labour demand. Several empirical studies support this view (e.g. Belot and van Ours, 2004 and Bassanini and Duval, 2006). Also, behavioural responses to changes in capital taxation are particularly problematic in small open economies. If capital is highly mobile across borders, higher capital-income taxes may result in lower capital stock and lower real wages.
38. On the final incidence of property taxes, see Fullerton and Metcalf (2011). On the impact of housing cash benefits on rents paid by low-income groups, see Conseil des Prélèvements Obligatoires (2011) and Facks (2005).
39. The following indicators have been used for the cluster analysis: i) for the size – the tax, transfer and in-kind service to GDP ratio; ii) for the mix: the shares of old-age pensions, disability, family and unemployment in total transfers; the shares of consumption, personal income and property taxes in total taxes; and the share of education and health in total in-kind transfers iii) for the progressivity: *à la Kakwani* progressivity indicator for both total household taxes and total cash transfers and specific progressivity indicators for old-age pensions, unemployment, personal income tax and social security contributions. Estonia has not been included in the cluster analysis because most tax data were missing.
40. Esping-Andersen (1990) proposed a typology of welfare systems consisting of three main regimes: i) a “liberal regime” characterised by little public intervention, means-tested benefits and

subsidised private welfare, mainly implemented in the English-speaking countries; ii) a “socio-democratic regime” with broad social entitlements and universal coverage, largely implemented in the Nordic countries; iii) a “conservative welfare regime” built around social insurance where entitlements depend primarily on life-long employment.

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ANNEX

Assessing the redistributive impact of cash transfers and taxes

Various measures can be used to assess the redistributive impact of cash transfers and tax systems. Three are used extensively in this article: the concentration coefficient, the difference in income dispersion before and after redistribution, and a progressivity measure.

The **concentration coefficient for cash transfers** provides an indication of who receives the transfers. It is zero when everyone receives the same transfer. The concentration coefficient is negative when the poor receive more in absolute terms than the rich – *e.g.* when benefits are means-tested – and becomes positive when the rich receive more in absolute terms (*e.g.* old-age pensions). Even in the latter case, there may be redistribution if market income is distributed more unevenly than benefits. Likewise, the **concentration coefficient for taxes** provides an indication of who pays the taxes across the income distribution. If the richest pay most of the taxes, the concentration coefficient will be high. Still, the concentration coefficient for taxes reflects not only the progressivity of the tax system but also the dispersion of pre-tax income. A more unequal country will raise more tax revenues from the wealthy and less from the poor. It will therefore show a higher concentration coefficient even if it features the same tax system as the less unequal country.

The **redistributive impact of cash transfers and taxes** is best measured by the difference in the concentration coefficients for income before and after cash transfers and taxes (Musgrave and Thin, 1948; Norregaard, 1990). It depends on both the size of cash transfers and taxes and their progressivity (Kakwani, 1977 and 1979).

The redistributive impact of cash transfers can be expressed as:

Concentration coefficient of market income *plus* transfers – Concentration coefficient of market income.

It is also equal to:

Size of cash transfers * Progressivity of cash transfers (Kakwani index).

where the size of cash transfers is measured as their share in market income *plus* transfers and the Kakwani index is defined as (Concentration coefficient of cash transfers – Concentration coefficient of market income, *i.e.* before taxes and transfers).

The redistributive impact of taxes can be expressed in the same way:

Concentration coefficient of disposable income – Concentration coefficient of market income *plus* transfers.

And it is also equal to:

Size of taxes * Progressivity of taxes (Kakwani index)

where the size of taxes is measured as their share in household disposable income and the Kakwani index is defined as (Concentration coefficient of taxes – Concentration coefficient of market income plus transfers).

A tax is considered to be progressive when high-income groups face a higher average tax rate than low-income groups (relative progressivity). In some cases, *e.g.* as regards consumption taxes, high-income groups pay a higher amount of taxes than low-income groups (absolute progressivity) but still face a lower average tax rate. Taxes are then considered as regressive and the Kakwani index becomes negative. Similarly, **cash transfers are considered to be progressive** when they account for a larger share of the low income groups' income. This definition implies that flat cash transfers (*e.g.* a minimum pension for all) are considered to be progressive. And cash transfer programmes which benefit the rich most in absolute terms (*e.g.* subsidies for tertiary studies) are still considered as progressive as long as the share of these transfers in household income is lower for high-income than for low income groups. Joumard *et al.* (2012) provide numerical examples.

In measuring the redistributive impact of taxes and cash transfers, it is assumed in this article that cash transfers are received first and taxes paid afterwards, an approach consistent with OECD (2008a). Indeed, benefits are taxable in many countries. Thus, assessing the redistributive impact of taxes by comparing the concentration coefficient of market income and the concentration coefficient of market income *minus* taxes would distort the picture – the tax system would appear more regressive than it is. However, in some countries benefits are largely set on the basis of after-tax market income. In this case, comparing the concentration coefficients for market income and for market income plus transfers results in a biased measure of the redistributive impact of benefits. In a study of 14 OECD countries (Immervoll and Richardson, 2011), the measurement approach is chosen to reflect, as far as possible, the actual legal sequence implicit in each country's tax and benefit system. In particular, the redistributive impact of taxes is determined by comparing Gini indices of market income and net-of-tax income for Australia, the Czech Republic, Germany, Israel and the United States. This option only partly solves the problem since some of the benefits are taxable in these countries (*e.g.* pensions and unemployment benefits in the United States). Overall, however, a simulation carried out on two countries (France and the United States) suggests that a different sequencing does not alter significantly the estimated redistributive impact of taxes (or transfers).

Fiscal multipliers and prospects for consolidation

by

Ray Barrell, Dawn Holland and Ian Hurst*

This article looks at various aspects of fiscal consolidation in 18 OECD economies. The prospects for fiscal consolidation depend upon the problems a country may face with its debt stock, the political will to deal with these problems and on the costs of consolidation. These costs are a function of the impacts of fiscal policy on the economy, which is the focus of this study. The analysis is based on a series of simulations using the National Institute Global Econometric Model, NiGEM. Fiscal multipliers differ across countries because the structure and behaviour of economies differ. They also differ within countries, depending on factors such as the fiscal instrument implemented, the policy response to fiscal innovations, and expectation formation by economic agents. The purpose of this study is to allow an assessment of the likely impact on the economy and on the fiscal position of consolidation programmes. We decompose the key factors that determine the size of the multiplier by changing them one at a time. Even under a specified set of assumptions, the outturn for the budget balance retains a high degree of uncertainty. We illustrate this uncertainty by calibrating probability bounds around projected debt profiles. This can allow an assessment of the probability of achieving specified fiscal targets, such as those set out in the European Union's new Fiscal Compact.

JEL classification codes: E17; E37; E62

Key words: Large scale structural macro models; fiscal multipliers; rational expectations; budget consolidation in the OECD

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The severe recessions as a result of the financial crisis in 2008-09 resulted in a sharp rise in government budget deficits in almost all major industrialised countries. The cyclical impact was compounded by fiscal stimulus packages and emergency financial sector support. This in turn has led to a sharp rise in global government debt, giving rise to concerns about long-term fiscal sustainability. Pressures have been particularly high in some euro area countries, which have pushed government bond yields to exceptionally high levels in some countries such as Spain, Italy, Portugal and Greece. As a result, fiscal consolidation packages have been introduced by many of the major economies to stem the rise in sovereign debt.

This paper considers the impacts of fiscal consolidation on GDP growth in 18 OECD economies. The analysis is based on a series of simulations using the National Institute Global Econometric Model, NiGEM.¹ The key features of the model are that it is estimated and has a common structure across the 18 countries. If the results differ across countries it will be because they are different. Some of these differences, such as the openness of the economy, are important. They change over time and they are not related to estimation. Others, such as the speed of response to changes in income, do depend upon how the model was estimated. Details underlying key equations and the core structure of NiGEM are given in the Appendix.

Fiscal multipliers differ across countries because the structure and behaviour of economies differ. They also differ within countries, depending on factors such as the fiscal instrument implemented, the policy response to fiscal innovations, and expectation formation by economic agents. Much of the recent literature on fiscal multipliers also suggests that the size of the multiplier may also depend on the state of the economy (see, for example, Delong and Summers, 2012; Auerbach and Gorodnichenko, 2012). Others have focused on identifying links between the fiscal position and the risk premium on government borrowing, which is of particular importance in the euro area (see *e.g.* Arghyrou and Kontonikas, 2011; Bernoth *et al.*, 2012; De Grauwe and Ji, 2012; Schuknecht *et al.*, 2010, Corsetti *et al.*, 2012).

The purpose of this study is to allow an assessment of the likely impact on the economy and on the fiscal position of the consolidation programmes that are being introduced. The impact will depend on the factors discussed above – structure and behaviour of the economy, fiscal instruments, expectation formation, policy response, state of the economy – and we decompose these factors by changing them one at a time. Even under a specified set of assumptions, the outturn for the budget balance retains a high degree of uncertainty. We illustrate this uncertainty in selected countries by calibrating probability bounds around the projected debt profiles. This can allow an assessment of the probability of achieving specified fiscal targets, such as those set out in the European Union's new Fiscal Compact.

1. Short-term impact multipliers

Barrell, Fic and Liadze (2009) demonstrate that multipliers are time and state dependent. Fiscal multipliers differ across countries because the structure and behaviour of economies

differ. They also differ within countries, depending on factors such as the fiscal instrument implemented, the policy response to fiscal innovations, and expectation formation by economic agents. Thus there is no single “multiplier” that can be attributed to a given economy, as the impact of a fiscal innovation on GDP depends on a wide range of factors. In this section we decompose the impact of several of these factors by changing them one at a time.

1.1. Fiscal instruments

In a model such as NiGEM multipliers are small. They average around 0.3 or less, as can be seen from Tables 1 and 4 below. Even then these estimates probably exceed the multipliers that one would see with any actual consolidation programme, because for some actions implementation speed is faster in the model than in the world. If one allows for more gradual implementation, this would reduce average multipliers to below 0.2. This matters in particular when comparing multipliers for taxes and benefits to those for spending. Taxes or benefits can be cut by 1% of GDP relatively easily both in the model and in the world. Multipliers in response to income tax and benefit adjustments are small, as a part of the decline in personal sector income is offset by a temporary adjustment in the savings rate. As one can see from the tables, multipliers appear larger for cuts in real government spending. This is in part because of the assumption that such cuts can be implemented immediately, and this is certainly not the case. It is also in part because government consumption is part of the income identity and hence when it is cut (and the number of people employed or goods and services bought is reduced) measured real output falls. If one were to reduce government spending by as much, but do it through wage reductions, then the impact on real GDP would be much less, and the second round effects of the shock would effectively be the same as an increase in taxes.

Table 1. **First-year multipliers from 1% of GDP temporary fiscal contraction**

	Government spending		Taxes	
	Consumption	Benefits	Indirect	Direct
Australia	-0.82	-0.27	-0.25	-0.22
Austria	-0.53	-0.17	-0.09	-0.13
Belgium	-0.17	-0.04	-0.05	-0.03
Canada	-0.53	-0.16	-0.05	-0.12
Denmark	-0.53	-0.10	-0.06	-0.04
Finland	-0.64	-0.14	-0.09	-0.08
France	-0.65	-0.32	-0.09	-0.27
Germany	-0.48	-0.29	-0.09	-0.27
Greece	-1.07	-0.44	-0.22	-0.32
Ireland	-0.33	-0.09	-0.07	-0.08
Italy	-0.62	-0.17	-0.07	-0.12
Japan	-1.27	-0.65	-0.34	-0.57
Netherlands	-0.53	-0.19	-0.07	-0.16
Portugal	-0.68	-0.15	-0.08	-0.11
Sweden	-0.39	-0.14	-0.06	-0.16
Spain	-0.71	-0.15	-0.17	-0.09
United Kingdom	-0.74	-0.22	-0.16	-0.15
United States	-1.12	-0.35	-0.35	-0.25

Note: No shift in the budget target. Experiments conducted in one country at a time.

In order to determine the effects of an *ex ante* change in fiscal policy one has to avoid offsetting or reinforcing policy effects, but the model must otherwise be allowed to run. In each of our simulations in this section we make the following assumptions:

- Policy reactions are turned off for the first year:
 - ❖ The central bank does not change the short-term interest rate for a year, whatever the shock. It then follows a targeting regime that stabilises either the inflation rate or the price level.
 - ❖ The government does not target the deficit for the first year. The model has a feedback rule which adjusts the direct tax rate in relation to the gap between actual and target deficits. This is switched off for a year.
 - ❖ Government investment is fixed at the baseline for a year and does not respond to long-term factors in the first year. The same, where this is appropriate, is true for government consumption.
 - ❖ Other tax rates and all benefit replacement rates are held constant throughout the simulation period.
- Markets work and all quantities and prices can react and there are no exogenous variables in the model, with the exceptions of policy targets, labour supply and risk premia:
 - ❖ Financial markets look forward and are assumed to follow arbitrage paths, and expectations for those paths are outturn consistent.
 - Long-term government bond rates are the forward convolution of future short-term policy rates plus an exogenous premium.
 - Long-term real interest rates are the forward convolution of future short-term real policy rates plus an exogenous risk premium made up of the bond premium plus private sector risks.
 - Equity prices are the discounted value of future profits, where the discount factor is the market interest rate plus the exogenous equity premium.
 - Exchange rates “jump” when future interest rates change and they follow the arbitrage path given by nominal interest rates.
 - ❖ Labour markets are described by an exogenous labour supply, a labour demand equation and by a wage equation based on search theory, where the bargain depends on backward and forward looking inflation expectations.
 - ❖ Capital stocks adjust slowly towards that associated with expected capacity output four years ahead, which in turn depends upon a forward looking user cost of capital. Expectations are rational and factor demands and capacity output are based on a CES production function.
 - ❖ Consumers respond to their forward looking financial wealth, but are not fully forward looking.

In the next sections, the implications of several of these default assumptions will be tested.

Table 1 reports the estimates of the first year multipliers for 18 OECD countries, under the default assumptions described above, for a 1% (*ex ante*) GDP fiscal contraction – a rise in taxes or cut in spending that is reversed after one year. The multipliers for cuts in government consumption spending and spending on benefits are reported, as well as for rises in indirect taxes and direct (personal) taxes. Simulations are run one country at a time,

so there are no spillovers across countries in the reported multipliers. Generally multipliers peak in the first year and then decline, and the *ex post* improvement in government revenues will normally be less than 1% of GDP as tax bases change. Some of the effects of the impulse will be offset by declines in interest rates. Both short and long rates should fall, but the former may be trapped at the lower bound at present. Even when short rates are trapped at the lower bound, forward-looking long rates can fall as long as they retain some downward flexibility. In NiGEM, investment behaviour is mainly influenced by long real rates through the user cost of capital, and as long as these are free to fall in response to a temporary fiscal tightening, the impact of hitting the zero bound in short rates will be limited.

The multipliers reported in Table 1 illustrate some of the key differences across fiscal instruments, and also highlight important differences across countries. Government consumption spending multipliers tend to be larger than tax or benefit multipliers, as a fraction of any disposable income change is absorbed through a temporary adjustment to savings. However we should bear in mind the caveat mentioned above that it is not necessarily feasible to cut the provision of government goods and services at short notice. The effects of government investment and corporate taxes will not be investigated in this study.²

1.2. Structure of the economy

Country size is an important distinguishing factor across country multipliers, as the long term fall in real interest rates that is produced by consolidations is an international phenomenon. When capital moves freely between countries, real interest rates are determined largely by the balance between global saving and global investment, and large countries such as the United States have much more impact than small ones such as Greece. In addition, the initial interest rate response will be smaller in countries in EMU because the ECB responds to euro area inflation.

Multipliers tend to be smaller in more open economies, because the more open an economy is the more of a shock will spread into other countries through imports, and small open economies such as Belgium have small multipliers. Another structuring factor is the degree of dependence of consumption on current income. This is often related to liquidity constraints, with a higher current-income elasticity more common in financially unliberalised economies such as Greece than in Belgium or the United States. Finally, the speed of response of the economy depends in part on the flexibility of the labour market and the speed at which policies, such as a rise in VAT feed into prices.

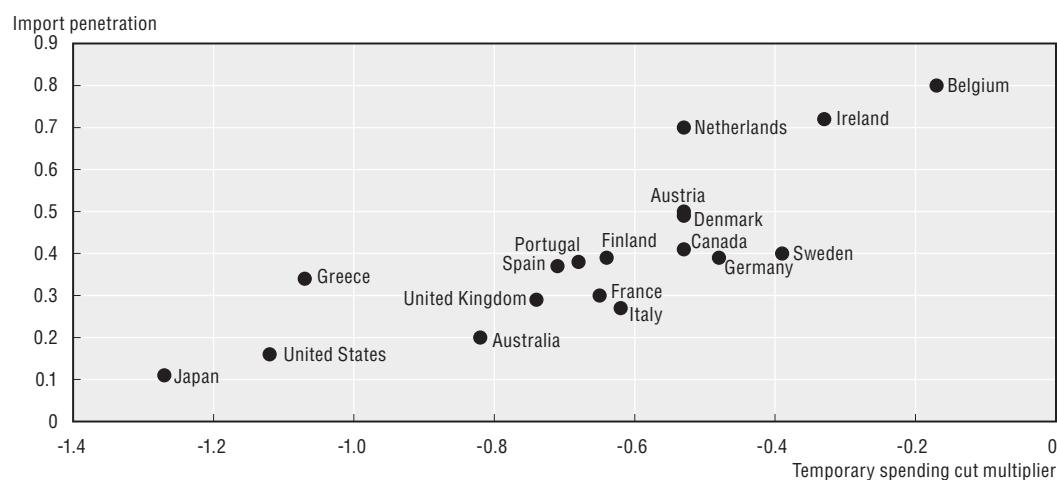
Table 2 compares the temporary government consumption spending and direct tax multipliers from Table 1 with some of the key factors determining the differences in the magnitude of multipliers across countries: country size (measured at 2005 PPPs), import penetration (measured as the volume of imports of goods and services in 2005 as a share of GDP) and the estimated short-term income elasticity of consumption. At the bottom of the table, the correlations between each factor and the two multipliers are reported. The largest estimated multipliers are found in Japan, the United States and Greece. For Japan and the United States this is largely a reflection of the low level of import leakages, with imports amounting to just 10-15% of GDP. Import penetration is also relatively low in Greece, given the size of the economy, while the estimated short-term income elasticity of consumption is higher than in most of the other economies in the sample, and both factors increase the estimated multiplier.

Table 2. **Key factors determining cross-country differences in multipliers**

	Temporary spending cut multiplier	Temporary income tax rise multiplier	2005 GDP (PPPs)	Import penetration	Short run income elasticity
Australia	-0.82	-0.22	696	0.20	0.23
Austria	-0.53	-0.13	279	0.50	0.23
Belgium	-0.17	-0.03	337	0.80	0.17
Canada	-0.53	-0.12	1 132	0.41	0.17
Denmark	-0.53	-0.04	181	0.49	0.00
Finland	-0.64	-0.08	160	0.39	0.00
France	-0.65	-0.27	1 869	0.30	0.51
Germany	-0.48	-0.27	2 512	0.39	0.68
Greece	-1.07	-0.32	278	0.34	0.48
Ireland	-0.33	-0.08	159	0.72	0.17
Italy	-0.62	-0.12	1 634	0.27	0.14
Japan	-1.27	-0.57	3 873	0.11	0.24
Netherlands	-0.53	-0.16	572	0.70	0.23
Portugal	-0.68	-0.11	217	0.38	0.08
Sweden	-0.39	-0.16	300	0.40	0.22
Spain	-0.71	-0.09	1 184	0.37	0.00
United Kingdom	-0.74	-0.15	1 933	0.29	0.17
United States	-1.12	-0.25	12 638	0.16	0.15
Spending correlation			-0.55	0.81	-0.08
Tax correlation			-0.39	0.63	-0.54

Note: Consumption and direct tax multipliers from Table 1. Import penetration is measured as the volume of goods and services imports as a share of GDP in 2005. Income elasticity is the estimated response of consumption to current changes in income, from the consumption equations in NiGEM (see Appendix for details).

Across all the countries in the sample, the correlations indicate a 40-55% correlation between country size and the tax and spending multipliers, suggesting that the larger the economy the bigger the multiplier. The large economy impact on world interest rates must be more than offset by other features of large economies, such as the tendency to be less open to imports than the smaller economies, as the interest rate change in response to a temporary shock is very small. Import penetration has a very strong correlation with the impact multipliers, suggesting that more open economies tend to have smaller multipliers, both in response to spending cuts and tax rises. Figure 1 illustrates the strength of this correlation with the temporary spending on goods and services multiplier.

Figure 1. **Temporary spending cut multiplier and import penetration**

The short-term income elasticity of consumption has little relationship with the first year government consumption multipliers, as government consumption is a direct component of GDP, and the impacts on GDP via the household consumption channel are secondary. However, this elasticity shows a 50% correlation with income tax multipliers, which feed directly into personal income, and affect GDP through the household consumption channel. The indirect tax and benefit multipliers will also depend upon the short-term relationship between income and consumption. An indirect tax increase reduces real income, and the extent to which this feeds into GDP is directly related to the short-term income elasticity of consumption. Similarly, benefit payments are a component of income, and affect GDP through the consumption channel, so first-year multipliers for these instruments will also be sensitive to the short-term income elasticity of consumption.

Fiscal multipliers are clearly sensitive to the short-term income elasticity of consumption, which is commonly associated with the severity of borrowing constraints within the economy. However, access to credit is dependent both on credit history and on current income, and so is necessarily sensitive to the state of the economy. As unemployment rises, a greater share of the population will be unable to access credit at reasonable rates of interest – at precisely the moment when they are in need of borrowing to smooth their consumption path. This means that consumption is likely to be cyclical, and that the income elasticity is likely to be time varying and dependent on the position in the cycle. Following a banking crisis the effects can be expected to be particularly acute, as banks tighten lending criteria, as discussed by Barrell, Fic and Liadze (2009). This also suggests that fiscal multipliers are dependent on the state of the economy – especially tax innovation multipliers – and this is consistent with recent studies such as Delong and Summers (2012) and Auerbach and Gorodnichenko (2012).

The consumption equations³ underlying the multiplier estimates reported in Table 1 are modelled as:

$$\Delta \ln(C_t) = \lambda \{ \ln(C_{t-1}) - [a + b_0 \ln(TAW_{t-1}) + (1 - b_0) \ln(RPDI_{t-1})] \} + b_1 \Delta \ln(RPDI_t) + b_2 \Delta \ln(NW_t) + b_3 \Delta \ln(HW_t) \quad (1)$$

where C is consumption, TAW is total asset wealth, which is the sum of net financial wealth (NW) and tangible wealth (HW), $RPDI$ is real personal disposable income, Δ is the difference operator, and the remaining symbols are parameters. The share of the population that is liquidity constrained will affect the short-term income elasticity of consumption, given by parameter b_1 . Al Eyd and Barrell (2005) discuss this further.

In order to assess the sensitivity of fiscal multipliers to this parameter, we calibrate the income tax multiplier under a series of eleven different models, allowing the parameter b_1 to rise incrementally. We illustrate the sensitivity using the United States as an example. When b_1 is equal to 0, this implies perfect capital markets with no liquidity constraints and consumer spending will be largely invariant to short-term fluctuations in income. When it is equal to 1 this implies that consumption is fully reliant on current income, with no scope for saving and smoothing consumption. In our standard model, the estimated parameter for b_1 in the United States is given by 0.15, suggesting a relatively low level of liquidity constraints historically, although as Table 2 illustrates this is not out of line with other advanced economies in an internationally comparative context. The estimated fiscal multipliers of income tax innovations under different assumptions on the short-run income elasticity of consumption are reported in Table 3. With no liquidity constraints, we would expect a fiscal multiplier of just 0.1% in the first year, while with no options for borrowing to smooth

Table 3. First year income tax rise multiplier in the United States, under different short-term income elasticities of consumption

Model	Short-run income elasticity of consumption (b_1)	Impact on GDP year 1
1	0.0	-0.11
2	0.1	-0.20
3	0.2	-0.29
4	0.3	-0.39
5	0.4	-0.50
6	0.5	-0.62
7	0.6	-0.75
8	0.7	-0.89
9	0.8	-1.04
10	0.9	-1.21
11	1.0	-1.38

consumption we would expect output to decline by 1.4%. These differences are confined to the short to medium term, and are expected to dissipate gradually over 5-7 years. This illustrative example for the United States can be used as a guide for other countries, as to the sensitivity of multiplier estimates to these key parameters.

Country size, openness and the income elasticity of consumption are some of the key factors that determine the size of the fiscal multiplier, but of course these are not the only factors. Model-based multiplier estimates will depend on the full set of equations and estimated elasticities underlying each country model. Equation dynamics are particularly important when looking at the longer term profiles, and we explore the sensitivity of multiplier profiles to key equations in the section on longer-term multiplier profiles below.

1.3. Permanent fiscal innovations

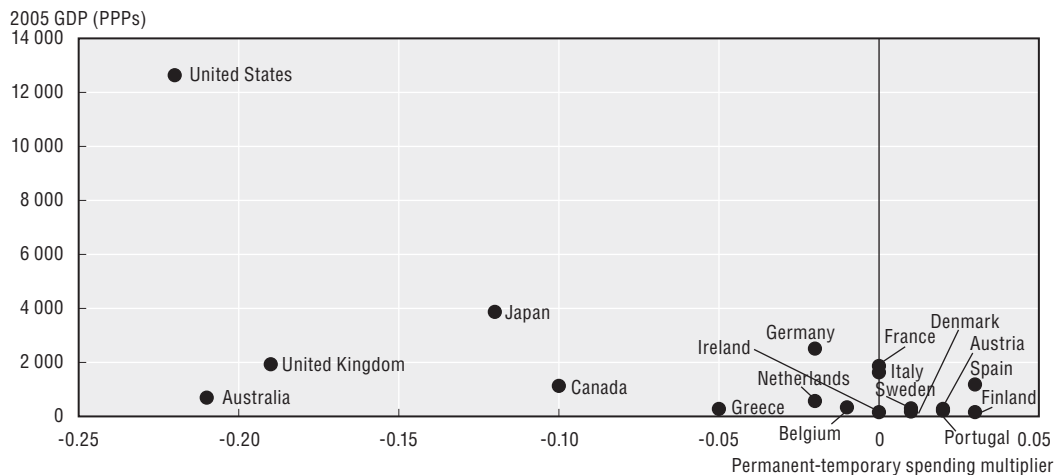
A permanent fiscal consolidation also involves changing the budget deficit target. The reported multipliers in Table 4 are based on the same set of shocks applied in Table 1, but with the cut in spending or increase in taxes being permanent and the deficit target is shifted by 1% of GDP. This changes the shape of the multiplier, as income taxes will rise in all scenarios from the second year of the simulation to cover any shortfall in the 1% of GDP consolidation, and long-term interest rates will fall by more than for a temporary consolidation. The impact of tax increases in the second year varies across shocks, depending on the degree of shortfall in the *ex post* budget improvement compared with the *ex ante* estimates.

In general, permanent multipliers should be smaller than temporary ones, as the impact of the fiscal contraction on long rates will be larger, and the fall in long rates will induce increases in asset prices and in investment.⁴ Country size plays a much more direct role in determining the offset on a permanent consolidation relative to a temporary one than in determining the size of the multiplier itself. Figure 2 plots the difference between the permanent government consumption multipliers reported in Table 4 and the temporary multipliers from Table 1, against our measure of economy size. There is a 60% correlation between the series, with large countries such as the United States, which has an important role in determining global interest rates, seeing a much bigger decline in the magnitude of the multiplier when the consolidation is permanent than do small EMU countries such as Finland where monetary policy is not independent. The five countries

Table 4. **First-year multipliers from 1% of GDP permanent consolidation**

	Government spending		Taxes	
	Consumption	Benefits	Indirect	Direct
Australia	-0.61	-0.17	-0.32	-0.12
Austria	-0.55	-0.18	-0.05	-0.13
Belgium	-0.16	-0.04	-0.02	-0.03
Canada	-0.43	-0.13	-0.10	-0.08
Denmark	-0.54	-0.10	-0.02	-0.05
Finland	-0.67	-0.16	-0.05	-0.10
France	-0.65	-0.33	-0.11	-0.26
Germany	-0.46	-0.29	-0.12	-0.25
Greece	-1.02	-0.44	-0.29	-0.37
Ireland	-0.33	-0.11	-0.06	-0.08
Italy	-0.62	-0.17	-0.06	-0.12
Japan	-1.15	-0.58	-0.43	-0.48
Netherlands	-0.51	-0.19	-0.05	-0.15
Portugal	-0.70	-0.17	-0.06	-0.12
Sweden	-0.40	-0.17	-0.05	-0.13
Spain	-0.74	-0.17	-0.16	-0.12
United Kingdom	-0.55	-0.14	-0.14	-0.08
United States	-0.90	-0.25	-0.27	-0.16

Note: Budget target shifted by 1% of GDP. Simulations conducted in one country at a time.

Figure 2. **Permanent and temporary spending multipliers against economy size**

with the largest differences between temporary and permanent multipliers all have independent monetary policies and hence a fiscal contraction will induce a larger decline in long rates and in the exchange rate than is observable in the countries within EMU.

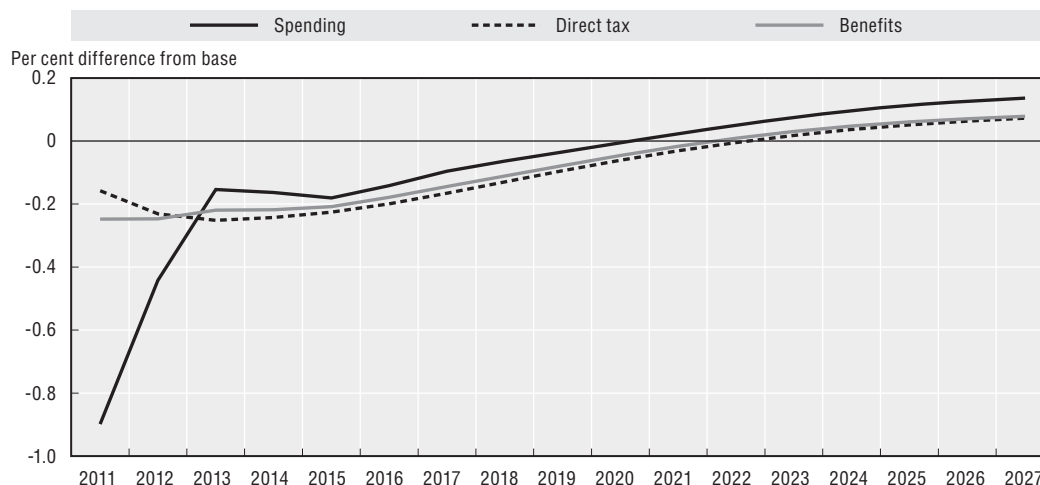
2. Longer-term multiplier profiles

This section goes beyond the short-run impact multipliers discussed above, and considers the longer-term impact of a permanent consolidation on output, and the dynamic path of adjustment. The use of the term multiplier is probably a misnomer in this context, but we will use it, rather than the more cumbersome “effect on the path to equilibrium”. The first-year impact multipliers discussed in the previous section illustrate the expected negative impact on output in the short-term in response to a fiscal tightening. Without a

simultaneous shock to the supply side of the economy, the demand shock will dissipate over time, bringing the level of output back towards its long-run equilibrium. The transmission mechanisms that allow output to recover are primarily through the financial markets and price adjustment. The contraction in demand leads to job losses and puts downward pressure on the price level. Higher unemployment leads to more moderate wage settlements, strengthening the disinflationary pressures. This allows interest rates to come down and a depreciation of the exchange rate, which in turn stimulate investment and net trade. While there will be a shift in the composition of demand (from the public to the private sector, or from consumption to investment and net trade) the level of output should return to base. In general, in large economies output should rise marginally in the long run in response to a fiscal consolidation in that country alone, as real interest rates will eventually be lower. This raises the desired level of the capital stock and thus potential output over the longer term. The profiles for a number of countries are reported, and each starts with the impact multipliers in Table 4.

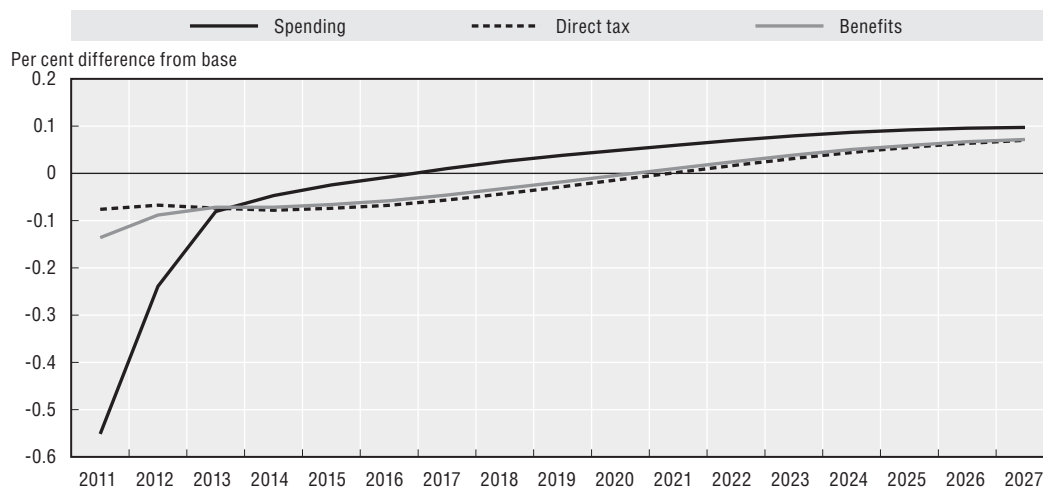
As one can see from Figure 3, output in the United States returns to the baseline relatively quickly after a cut in spending and a shift in the deficit target. In this simulation interest rates fall to zero only in the first quarter, and they are not trapped at that level, although this would be a common experience if the shock were larger. We omit the time paths for indirect taxes as they involve a rise in prices and the pattern depends upon the monetary policy response in a way the others do not. In general interest rates rise in response to inflation induced by tax rises in order to keep expectations in check, and the scale of the increase will affect the path of output, and it will depend upon the rule in place. Benefits multipliers are initially larger than tax multipliers because more benefit recipients are liquidity constrained than the average of the population.

Figure 3. **Permanent consolidation multipliers in the United States**

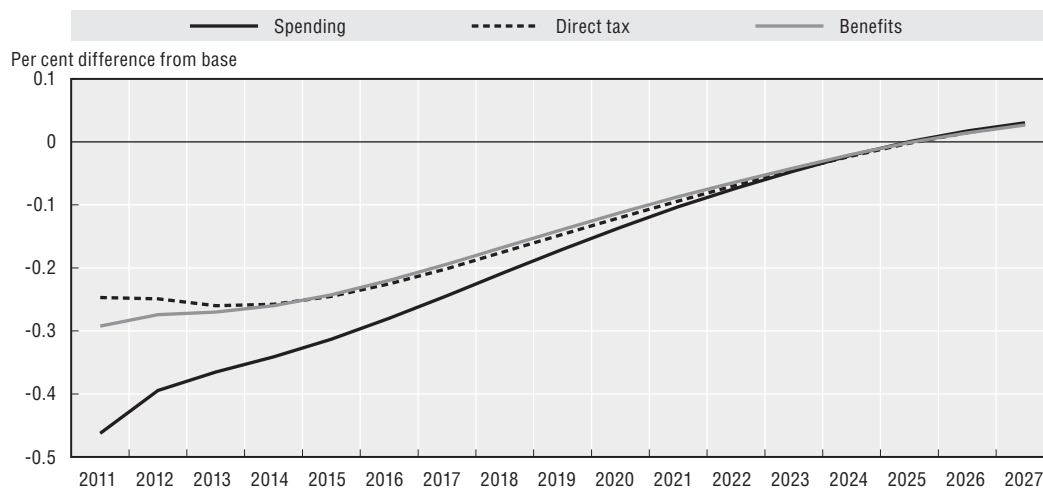


Note: The figure shows the deviations from baseline following a permanent fiscal shock.

Consolidation paths for the United Kingdom and the Netherlands (Figures 4 and 7) are similar to those for the United States, with markets working more rapidly than in France or Germany (Figures 5 and 6), where equilibrium is regained more slowly. This reflects both larger effects from current income in German consumption and slower reactions of real wages per person hour to unemployment. The former reflects the estimated consumption

Figure 4. **Permanent consolidation multipliers for the United Kingdom**

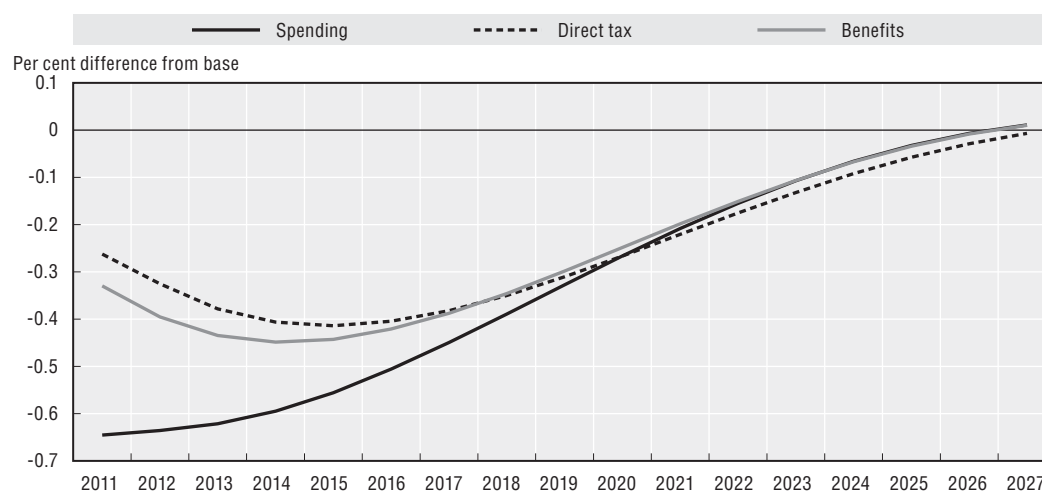
Note: The figure shows the deviations from baseline following a permanent fiscal shock.

Figure 5. **Permanent consolidation multipliers for Germany**

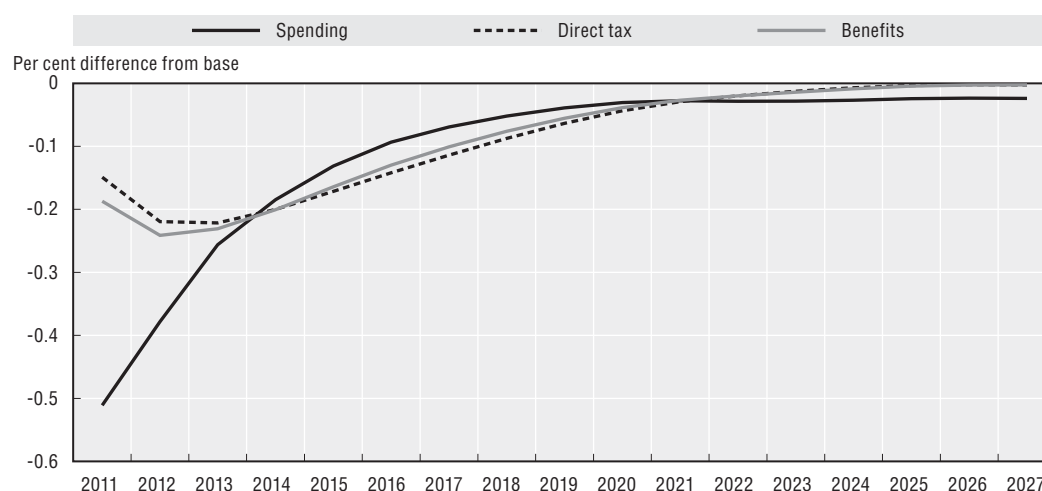
Note: The figure shows the deviations from baseline following a permanent fiscal shock.

function based on the approach used in Barrell and Davis (2007)⁵ whilst the latter reflects estimated labour demand and wage relationships. There is also less of an offsetting effect from declines in the exchange rate in the short term, and the inertia in the unemployment process in both countries, as in much of the rest of Europe, would mean total benefits would be higher in the medium term. In addition in Germany benefit recipients are more likely to be liquidity or borrowing constrained as compared with average taxpayers. The tax rule implies that this would be recouped by higher taxes on incomes and hence output growth would slow. This profile is only present in a permanent consolidation multiplier, as the effects are a combination of the shock to spending and the shock to the budget target.

Figure 8 disaggregates the differences between the longer-term multiplier profiles for Germany and the United States in response to a government consumption-based consolidation into the parts that can be attributed to differences in specific estimated equations for the two countries, and the part that is due to differences in key data ratios. The

Figure 6. **Permanent consolidation multipliers for France**

Note: The figure shows the deviations from baseline following a permanent fiscal shock.

Figure 7. **Permanent consolidation multipliers for the Netherlands**

Note: The figure shows the deviations from baseline following a permanent fiscal shock.

lines designated as German model/Germany data and US model/US data correspond to the spending multipliers for Germany and the United States in Figures 5 and 3 above. We start by replacing the import and export equations for Germany with those used in the US model, and rerun the German spending shock. This slightly increases the short-term multiplier, and speeds the adjustment back to base. We go on to replace the wage equation for Germany with that used in the US model, then the consumer price equation, then the producer price equation, and finally all the model equations (US model/German data). The differences between this final simulation (US model/German data) and the US model/US data can be attributed to key data ratios, such as the openness of the economy and the wealth to income ratio as well as the composition of wealth between interest sensitive equities (more in the United States) and bank accounts (more in Germany). Data ratios are clearly important for determining the magnitude of the short-run impact multiplier, while the speed of adjustment back to base is more closely connected to the parameter estimates of individual equations.

Figure 8. **Permanent spending cut multipliers for Germany under different equations**

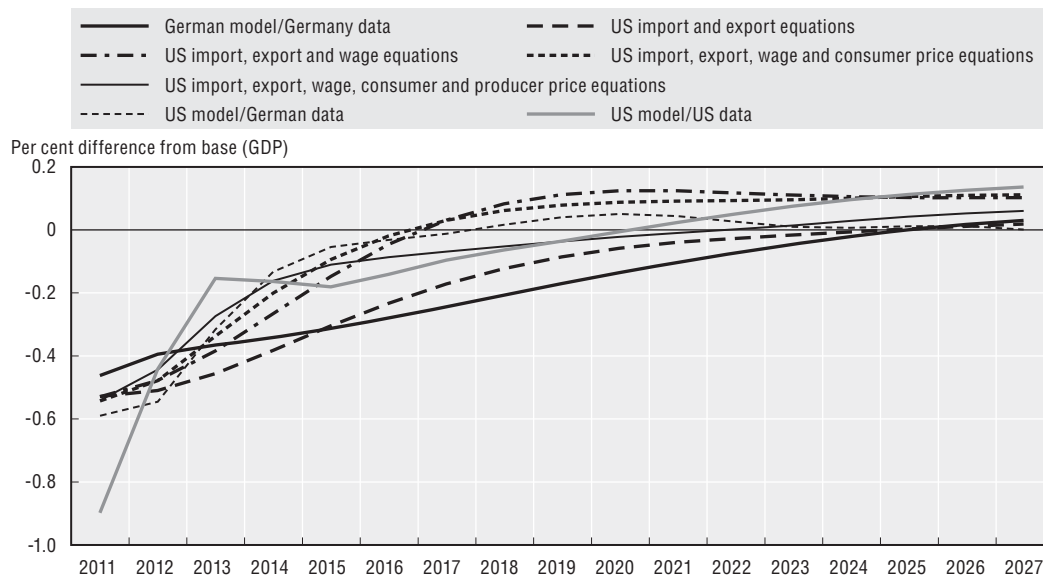
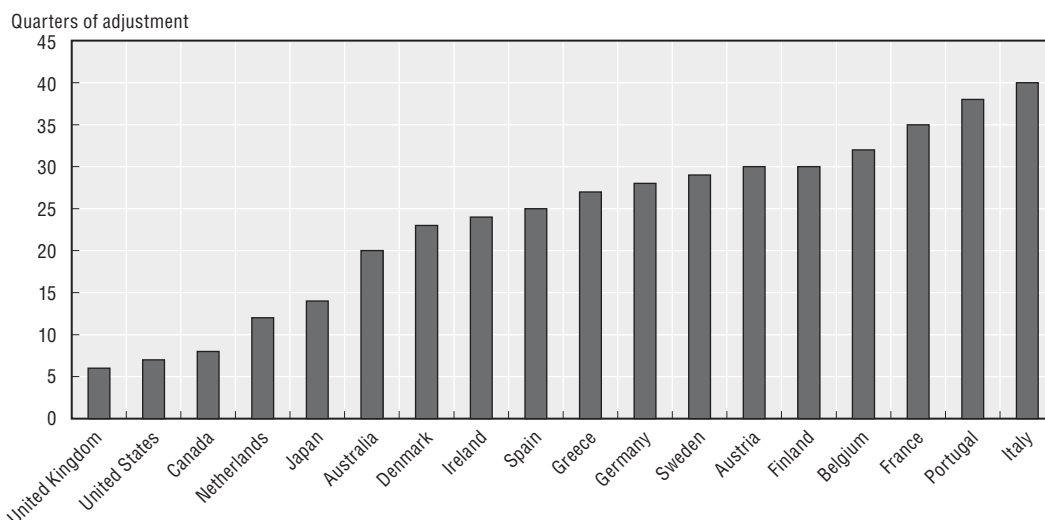


Figure 9 puts the other countries covered by this study into context with the dynamic adjustment paths illustrated above. This indicates the number of periods needed to allow half of a fiscal consolidation effected through a cut in government spending to dissipate. Canada and the Netherlands tend to behave more like the United States and the United Kingdom, and adjust relatively rapidly in response to a shock, whereas Italy, Portugal and Belgium are more sluggish, with a dynamic adjustment path more in line with that observed in France.

Figure 9. **Quarters of adjustment**



Note: The figure shows the “half-life” of a government spending shock, i.e. the number of quarters for half of the shock to GDP to dissipate.

The long-run multipliers are based on the assumption of an exogenous labour supply. If one were to allow an endogenous response of labour supply to either a rise in the income tax

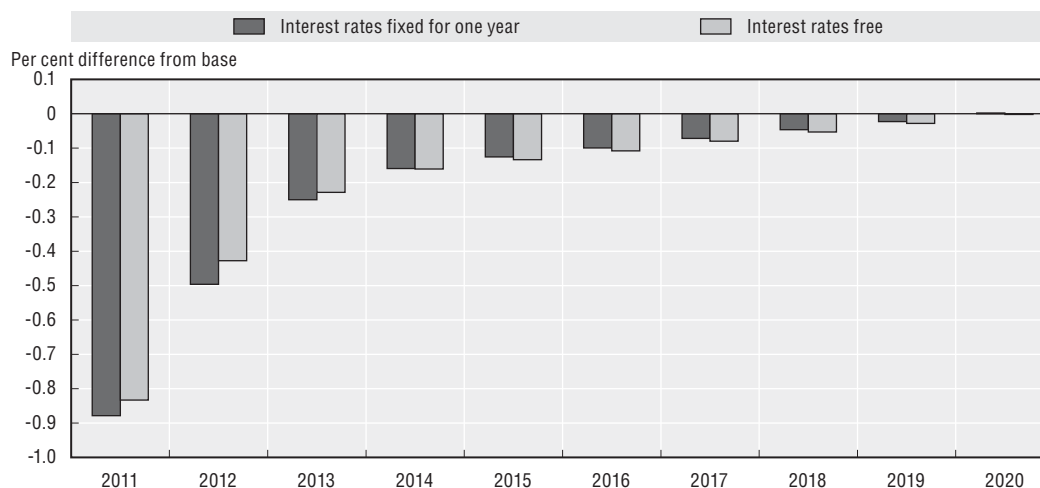
rate, which may reduce incentives to enter the labour force, or a decline in the benefit rate, which may increase incentives to enter the labour force, this would result in a permanent shift in potential output. The magnitude of the impact would depend on the assumed elasticity of labour supply to the tax and benefit rates.

3. Monetary policy response and the fiscal multiplier

The fiscal multipliers reported in Tables 1 and 3 and illustrated in Figures 3 to 7 above are based on the series of assumptions detailed above. However, multipliers are not immutable, and in the next two sections the implications of some of these assumptions will be assessed, and the impact on the estimated multipliers from adopting an alternative set of assumptions reported. In this section the focus is on the choice of the monetary policy response to a fiscal consolidation. We use the United States as an example, but similar results can be expected in other large advanced economies.

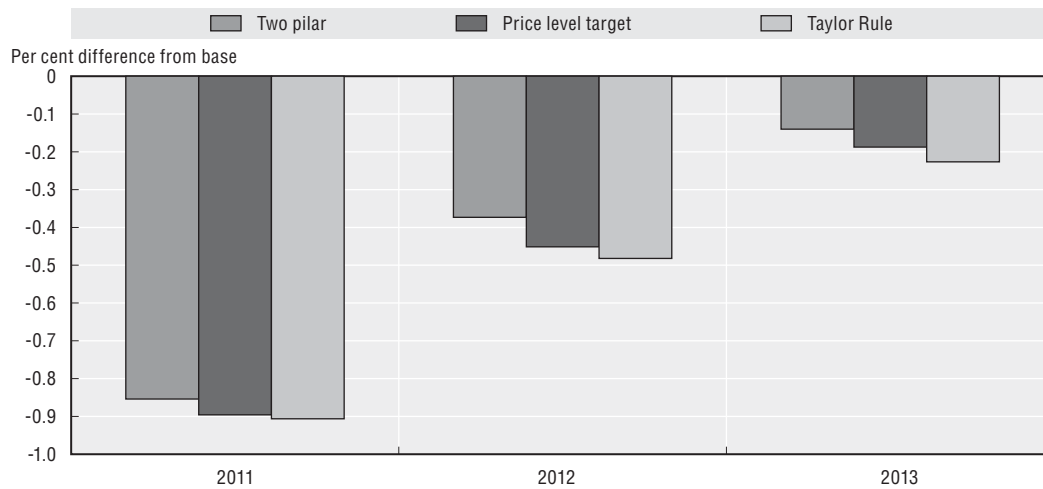
Under the default assumptions, nominal short-term interest rates are initially fixed for one year. Thereafter, the monetary authority is assumed to follow the standard feedback rule, which applies a combined target to both inflation and a nominal aggregate. If one allows interest rates to respond immediately, the monetary authority will cut interest rates in the first year to offset part of the contractionary impact of the fiscal consolidation. This reduces the fiscal multiplier slightly in the first three years, as illustrated in Figure 10, but raises it slightly in subsequent years, so that the net cumulative impact of this speed of interest rate response is negligible.

Figure 10. **US government consumption cut multipliers – different initial reactions**



Next the implications of the monetary authority having a different targeting regime in place are assessed. In Figure 11, the multiplier under the standard two-pillar rule applied in the previous simulations is illustrated, and compared with the estimated multipliers when a Taylor Rule is applied and when a price level target is applied. The impact on GDP is largely similar across the three feedback rules, suggesting that the chosen target itself is less important than the speed with which the response is implemented. The shock is deflationary and takes prices and output below their baseline initially, inducing a cut in interest rates under all three rules. The impact on long rates is least when a Taylor Rule is used, as this is a proportional feedback rule that is designed to take the inflation rate back

Figure 11. **US government consumption cut multipliers**
– under different monetary policy feedback rules



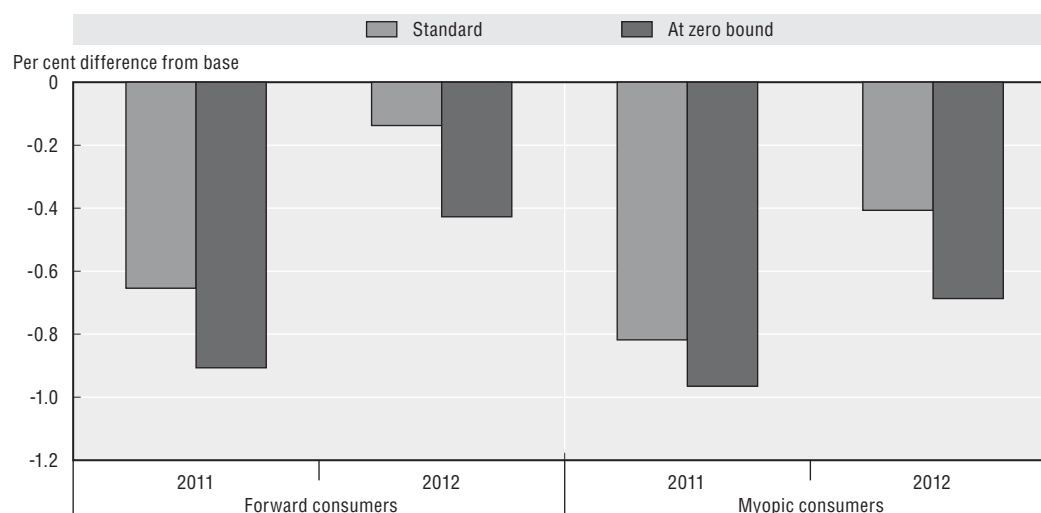
Note: The figure shows the deviations from baseline. Two pillar is when monetary policy targets both the inflation rate and a nominal aggregate.

to target after it has fallen below it. A price level rule, as implemented here, is a proportional, integral controller and targets the inflation rate as well as the price level. As the consolidation shock reduces the price level the rule induces a larger cut in interest rates than would a proportional controller in order to take prices back to target.⁶ A two pillar rule feeds back on nominal GDP and inflation, and hence with the same parameters reduces interest rates more as nominal GDP falls by the fall in prices relative to base plus the fall in output relative to base. Hence the offset to a fiscal contraction is greatest with an ECB style two pillar strategy and least with a Fed style Taylor Rule.

3.1. Impaired interest rate channel – the zero bound

It may of course be the case that monetary policy cannot react immediately because interest rates are at, or close to, zero. The Federal Reserve, and other major Central Banks, cut interest rates to near zero levels in 2009. More recently, the Federal Reserve has announced that these exceptionally low levels of interest rates are expected to remain warranted until mid-2015. This suggests that there is limited scope for monetary accommodation of the fiscal consolidation programme in the near term. We consider the impact on the first-year fiscal multiplier of a fiscal innovation introduced during a period like the present, where there is little scope for downward flexibility in interest rates for five years. This is compared with the estimated multiplier with full downward flexibility in interest rates. We compare the impacts under the assumptions of forward looking consumers and myopic consumers. Forward looking consumers (discussed further below and in the Appendix) take the net present value of their future incomes and spend in relation to this. With downwardly flexible interest rates, a fiscal consolidation reduces interest rates in the short term and hence consumption rises as a result. At the zero bound interest rates cannot fall (for at least five years in our experiment) and hence consumption does not absorb as much of the shock and output falls by $\frac{1}{4}$ percentage points more than in the normal case with forward looking consumers. In NiGEM myopic consumers are less influenced by short-term interest rates and investment decisions depend upon the user cost of capital. Hence the zero bound raises the multiplier by less if consumers are myopic, as can be seen from Figure 12. In this case, the binding zero bound on interest rates raises the impact on output in the first year by

Figure 12. **Impact of the zero lower bound on interest rates on the US government consumption cut multiplier**



Note: Forward consumers use forward-looking model-consistent expectation whereas myopic consumers are backward looking. The standard scenario allows for full downward flexibility in short-term interest rates, while the alternative scenario assumes short rates have no downward flexibility for five years.

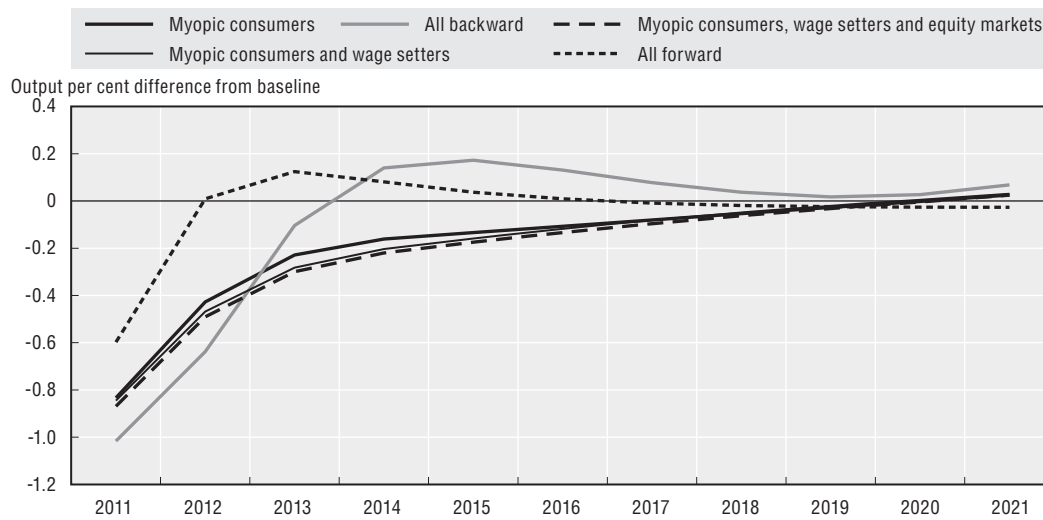
0.15 percentage points. Both scenarios allow for downward flexibility in long-term interest rates. If these were also constrained, the negative consequences for output would be much more severe in the short term.

4. Fiscal multipliers and expectations

Perhaps the most important set of assumptions affecting the size of the multiplier concern the role of expectations. In the standard set of simulations, the assumption is made that financial markets are forward looking. Long-term interest rates, equity price and exchange rates follow a forward-looking arbitrage path, which is consistent with the simulation outturns. Wage setting is also partly forward looking, with wage settlements driven by a weighted average of current and expected inflation. Consumers are assumed to be myopic, but respond to their forward-looking financial wealth, albeit rather slowly.

In this section, some of these assumptions are relaxed in order to assess their impact on the estimated fiscal multipliers. Figure 13 shows the US multiplier in response to a permanent spending consolidation under the default assumptions (labelled as myopic consumers in the figure) and compares this with a range of alternative sets of assumptions regarding expectations. If one turns labour markets and equities backward looking so that they do not depend upon expectations about the future then the multiplier path is little affected. This is illustrated by the lines labelled myopic consumers and wage setters, and myopic consumers, wage setters and equity markets in the figure. The size of the multiplier is marginally larger under these assumptions, but not significantly so. The shock still operates with a monetary feedback rule and slower growth will reduce inflation and hence interest rates in the future will be lower. This will cause the forward-looking exchange rate to jump down and forward-looking long rates to do the same. If one turns long rates backward looking and fixes the exchange rate in the first period (and thereafter in this experiment), the multiplier in response to the consolidation programme in the United States increases to over one in the first year. This is labelled “All backward” in the

Figure 13. **The impact of expectations on the US government consumption cut multiplier**



Note: The figure shows the deviations from baseline following a permanent fiscal shock.

figure. Short-term interest rates still fall and if one did not allow this to happen then the multiplier would be marginally larger still.

One can also move in the other direction and assume consumers are forward looking and react to the expected value of their future incomes. As taxes will be lower in the future and hence the net present value of incomes is higher, consumption is initially higher with forward-looking consumers than it is with myopic ones. There is estimated inertia in the adjustment to the long run even with our forward-looking consumption equations. Reducing the mark up would shrink the multiplier further from the -0.6 in the chart, but it would still be negative. However, as the myopia premium shrinks to zero the model comes close to being fully Ricardian in that future tax liabilities are more fully taken into account.

5. Fiscal projections and uncertainty

Model-based fiscal projections and multipliers reflect our estimate of the most likely outcome in response to a fiscal consolidation plan, under a restrictive set of assumptions. The sensitivity of the results to some of these key assumptions is discussed in the previous sections. However, even in a situation where all of the underlying modelling assumptions prove an adequate description of the real world, any fiscal programme can be blown off course, and there is a degree of uncertainty attached to any projections. This partly depends on the historical volatility of key economic data and partly depends on the explanatory power of individual country models. The two are generally strongly related, but will also depend on the sample periods used in estimation for key equations, which may differ across countries, and the sensitivity of the economies to factors not explicitly modelled within NiGEM. The degree of uncertainty surrounding projections will also depend on the persistence of shocks to the economy. The latter is determined by the dynamic adjustment path of the model equations, and all else being equal countries that exhibit a slow adjustment in response to shocks (France, Italy, Portugal, for example) would be expected to have a relatively wider margin of error than those that adjust quickly (the United States and the United Kingdom, for example).

One can calculate the risks involved by undertaking stochastic simulations with NiGEM. The bounds around a baseline set of debt stock projections are reported for the major seven economies and for the four European economies that currently face heavy financial market pressure. One can also investigate the use of debt and deficit feedback rules to reduce the uncertainty around any consolidation programme.

NiGEM is a 5 000+ variable model and bootstrapping is the only available way to undertake stochastic simulations. All historical shocks were repeatedly taken from a randomly chosen “time slice” between 1995 and 2010 and applied to the model. The error structures include unexplained components from the whole period, including the severe recession in 2009. The debt stock is a stochastic process, as it has a residual, and it was applied along with the other residuals. These residuals are generally small, but for some countries they were large in 2009 and 2010. Estimated serial correlation in the errors is maintained, and for these variables it is not strong. The model is run with a set of residuals and the outturn is used in the next period when another time slice is applied in the next stage of the future history.

Table 5. **Stochastic bounds around debt stock projections in 2007**

	95%	90%	80%	Base	20%	10%	5%
Canada	88.1	85.1	81.9	75.1	67.9	64.5	62.7
France	115.1	109.6	105.0	91.5	83.1	74.7	67.9
Germany	87.9	84.5	80.3	69.0	55.4	46.9	43.7
Greece	186.3	174.5	159.8	141.9	123.7	115.4	111.5
Ireland	138.4	135.1	131.9	121.5	116.6	112.9	109.4
Italy	136.6	132.9	123.0	111.9	95.5	88.0	84.4
Japan	237.9	235.0	231.5	224.3	213.6	209.3	206.3
Portugal	130.8	127.0	119.7	110.2	98.7	93.3	89.3
Spain	97.0	94.7	90.3	84.9	78.4	73.9	71.9
United Kingdom	104.0	102.1	100.1	95.8	93.5	91.6	90.1
United States	119.1	116.2	113.6	108.8	104.4	101.1	98.8

Note: Baseline projections from NIESR July 2012 forecast.

Table 6. **Data volatility and explanatory power**

	Data volatility				Explanatory power					
	GDP	Infl.	U	Total	Cons.	Emp.	Wage	Share prices	Exports	Total
Canada	0.63	0.54	1.12	2.29	0.38	0.19	0.43	4.88	1.23	7.11
France	0.53	1.03	1.14	2.70	0.43	0.17	0.31	5.00	1.07	6.98
Germany	0.83	0.59	1.05	2.47	0.29	0.44	0.62	6.05	1.03	8.43
Greece	1.32	2.23	1.25	4.80	0.58	0.36	1.39	9.28	2.07	13.69
Ireland	2.15	2.74	3.42	8.31	0.83	0.48	0.56	5.13	1.75	8.74
Italy	0.69	1.34	1.75	3.78	0.42	0.34	0.81	5.83	1.35	8.75
Japan	1.02	0.87	0.70	2.59	0.51	0.54	0.99	5.43	1.27	8.74
Portugal	0.94	1.31	1.91	4.16	0.82	0.61	0.82	5.37	1.59	9.20
Spain	0.61	1.22	3.86	5.69	0.35	0.25	0.53	6.40	1.13	8.65
United Kingdom	0.65	1.00	1.26	2.91	0.42	0.42	0.63	3.89	1.22	6.58
United States	0.66	0.90	1.60	3.16	0.29	0.21	0.47	3.31	1.08	5.35
Average	0.91	1.25	1.73	3.90	0.48	0.36	0.69	5.51	1.34	8.39

Note: Data volatility is measured as the standard deviations of quarterly growth rates of GDP and the level of inflation and unemployment over the sample period 1992q1-2009q4. Explanatory power measured as average value of shocks applied in stochastic simulations. Totals reflect the sum of values in the preceding columns. Average is a simple average across all countries.

Stochastic simulation bounds were applied around the baselines from 2012q1 to 2028q1. For the first five years tax rates are fixed so that shock effects show up in the deficit and not in the tax rate, and hence debt stocks can rise or fall without any reaction. After 2016, tax rates respond to bring the debt stock back towards the target imposing a no-Ponzi game condition. Uncertainty bounds are plotted in Figure 14. Each figure gives the 80, 90 and 95% probability bounds around the debt stock projections. The baseline projections are discussed in the July 2012 *National Institute Economic Review*.

Table 5 gives the values of the bounds for the debts stocks as a per cent of GDP for the major seven economies and for Spain, Portugal, Ireland and Greece. In each case these are the probability bounds for the debt stock if taxes do not increase in order to keep the stock within bounds. The Greek debt stock could, on these projections lie somewhere between 111 and 186% of GDP by 2017, whilst that in Japan (on a gross basis) could lie somewhere between 206 and 238% of GDP. These bounds can be brought under control by using feedback rules (see below).

As discussed above, the stochastic bounds around the central debt projections are a combined reflections of three sources of uncertainty and volatility: the volatility inherent in key historical data series themselves; the explanatory power of the equations; and the persistence of shocks to the economy, for which Figure 9 above can act as a guide. In order to distinguish between the uncertainty related to volatility in the data and uncertainty related to the explanatory power of the model, Table 6 reports the standard deviations of three core quarterly macro series (GDP growth, inflation and the unemployment rate) and the standard deviation of the error (detrended and demeaned) on a set of key behavioural equations underlying the model that reflect the shocks applied during the stochastic runs (consumption, employment, wages, share prices and exports). The historical data for Greece, Ireland and Spain are more volatile than for other countries, whereas it is relatively stable in Canada, Germany and Japan. Even with volatile data, if the direction of volatility is predictable, it may still be possible to build a model with a high degree of explanatory power. The model with the lowest degree of explanatory power is Greece, where share price, exports and wages are all relatively poorly explained by the NiGEM equation. The model with the highest degree of explanatory power is the United States. These factors can help explain some of the differences in the error bounds around the debt profiles illustrated in Figure 14.

5.1. Fiscal policy feedback rules

Fiscal policy feedback rules can either respond to the deviation of the deficit (gbr) from its target ($gbrt$) or the deviation of the debt stock (gdr) from its target ($gdrt$), or both. The first would be a proportional controller, the second an integral controller and the third a proportional and integral controller. The speed at which the debt stock returns to target depends on the choice of the rule and its parameters, as does the uncertainty around the target. The debt and deficit process is a two part one, with shocks occurring to deficits and to debts separately, as not all shocks to the debt stock (bank failures, privatisations, licence sales) affect the deficit. One can write the two equations as:

$$gbr_t = a + \lambda(gbr_{t-1} - gbrt_{t-1}) + \delta(gdr_t - gdrt_{t-1}) + \varepsilon_t \quad (2)$$

$$gdr_t = gdr_{t-1} - gbrt + \omega t \quad (3)$$

Feedbacks are included in the gbr equation (2), and either the deficit or debt targets or both may be used. In NiGEM the instrument used is the direct tax rate, although it is also possible to use other instruments. The default value for λ is set at 0.2 and that for δ is 0,

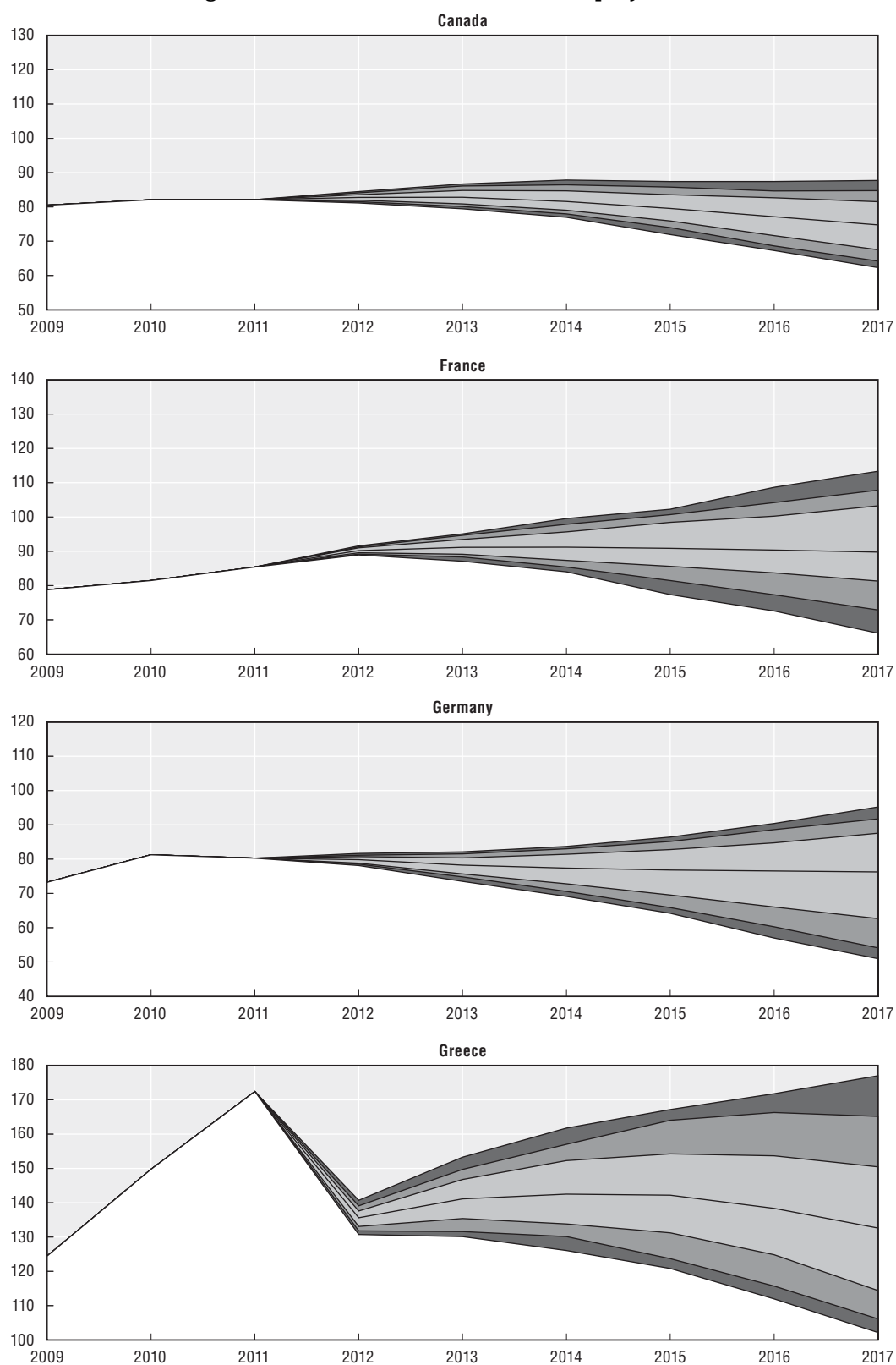
Figure 14. **Bounds around debt stock projections**

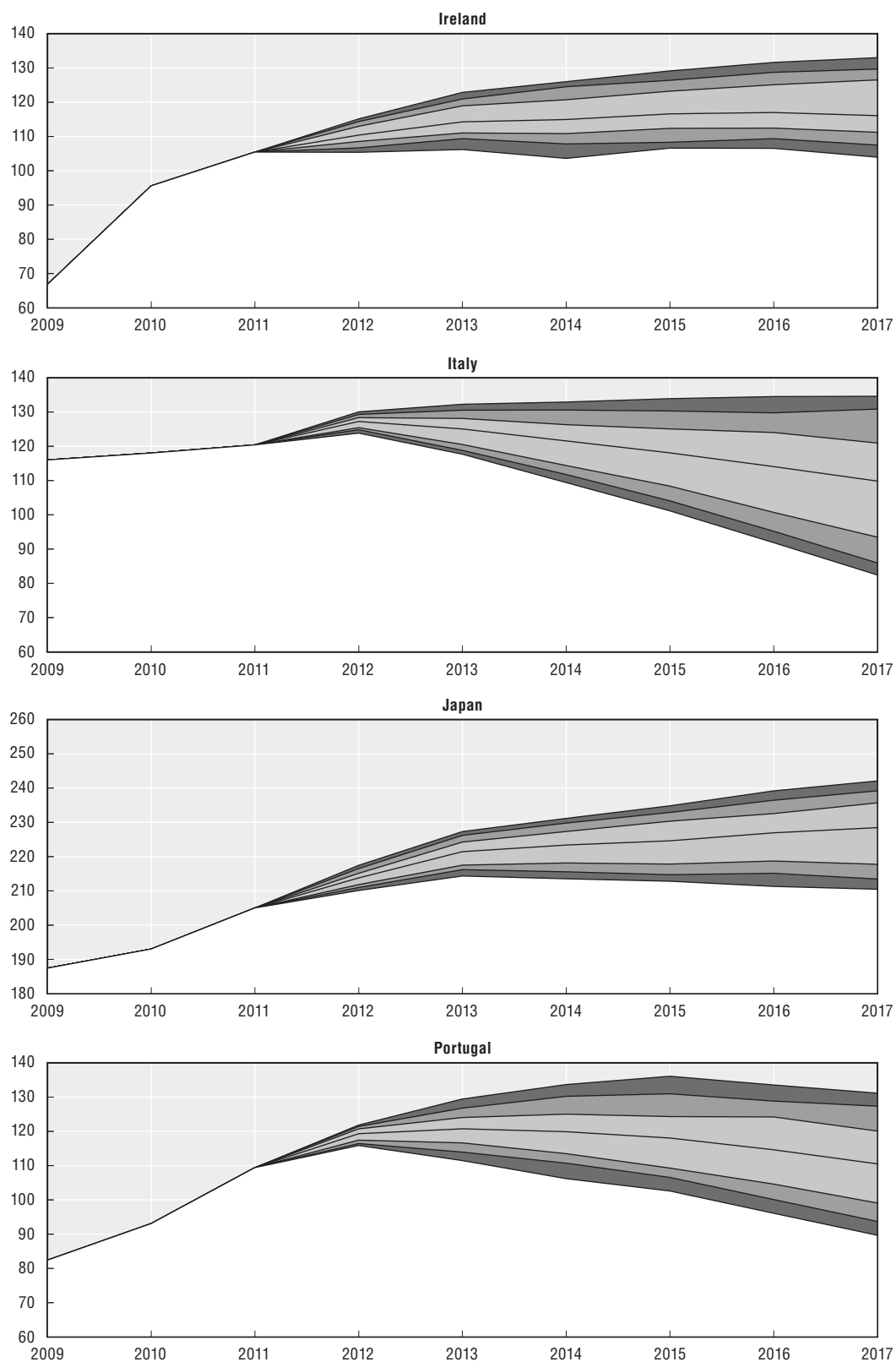
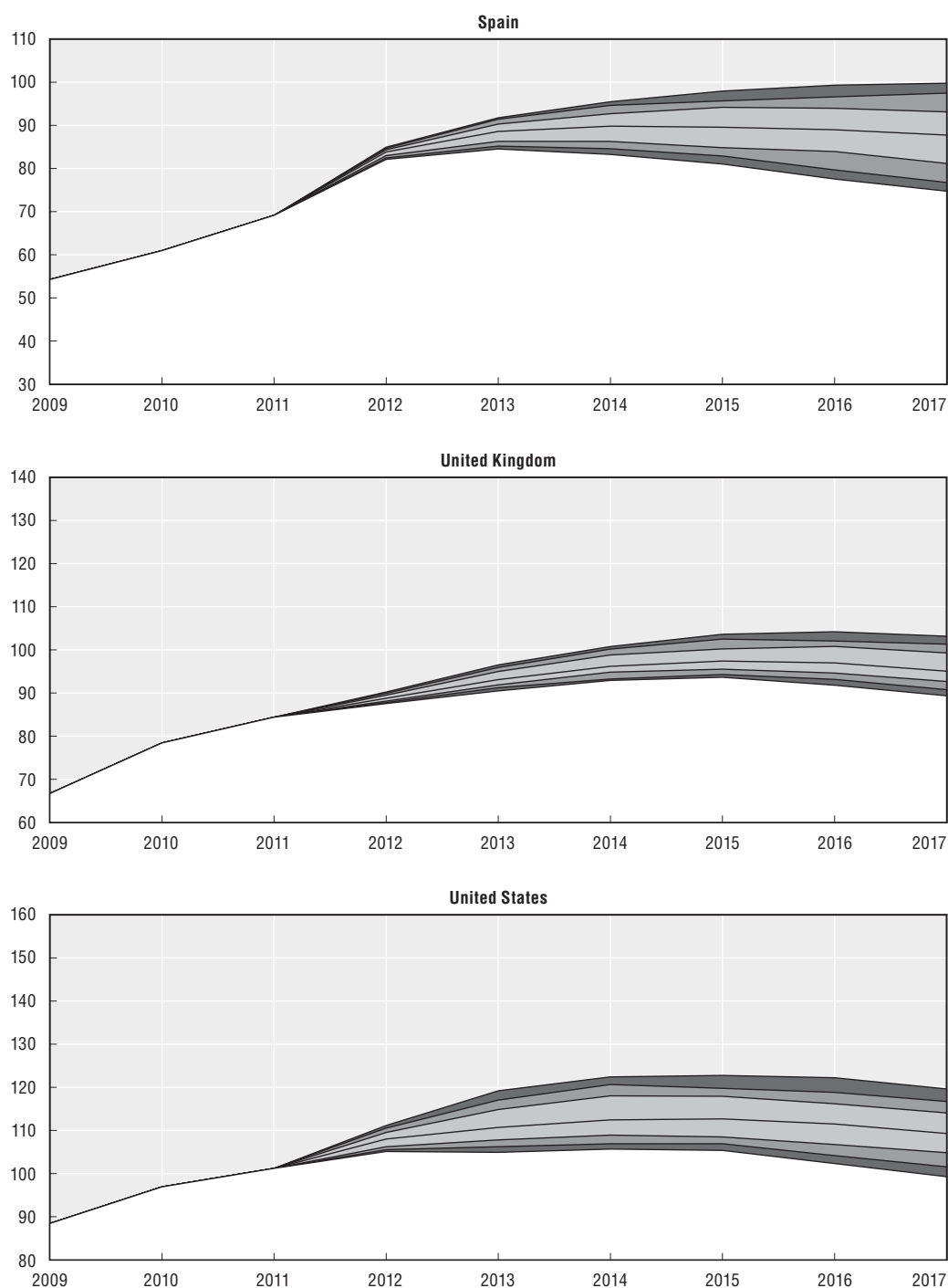
Figure 14. **Bounds around debt stock projections (cont.)**

Figure 14. **Bounds around debt stock projections** (cont.)

Note: The figure shows the evolution of gross debt and the 60%, 80% and 90% bounds from the stochastic simulations.
Source: NIESR simulations.

with an alternate setting of 0.0025 when the debt target is active. As the process is a two part one it is possible that shocks that improve the debt stock could lead to a loosening of fiscal policy through their effects on the feedback in the deficit equation.

A spending based fiscal consolidation of 1% of GDP in all euro area countries was simulated, and stochastic bounds around the outcome calibrated under the assumption that for the first five years taxes do not rise to pull the deficit back to target. These are the no solvency rule bounds around this initial consolidation scenario, and one can compare the bounds with those from a set of rules.

As governments are interested in keeping debt stocks within bounds one can investigate the effects of feedback rules on the distance between the baseline consolidation path and the upper 95% bound in the stochastic simulation. Table 7 shows the effects of the feedback case on the upper bound as compared with the initial scenario with no feedback. A feedback of 0.0025 on the debt stock difference from target reduces the distance of the upper bound from the baseline by 3.1% of GDP on average after five years. If one doubles the feedback on the debt stock then the average distance between the baseline and the upper 95% bound declines further. The results differ between countries in part because they have different estimated parameters, but also because they have faced different historical shocks both to the factors affecting the deficit and to the debt stock directly.

Table 7. **Impacts of rules on distance of 95% bound from baseline**

	Weak GDR	Strong GDR	GBR	GBR + weak GDR	Double GBR + weak GDR
	$\lambda = 0.00$	$\lambda = 0.00$	$\lambda = 0.20$	$\lambda = 0.20$	$\lambda = 0.40$
	$\delta = 0.0025$	$\delta = 0.005$	$\delta = 0.00$	$\delta = 0.0025$	$\delta = 0.0025$
Austria	-1.33	-1.60	-1.29	-2.12	-2.48
Belgium	-0.83	-1.69	-3.05	-3.35	-3.54
Finland	-1.44	-2.65	-0.75	-1.14	-1.64
France	-0.66	-1.30	-4.27	-3.05	-3.56
Germany	-4.19	-6.63	-7.87	-8.56	-10.50
Greece	-6.16	-8.92	-10.26	-13.26	-12.35
Ireland	-5.95	-4.78	-4.71	-11.05	-10.59
Italy	-4.37	-4.29	-4.41	-6.17	-3.67
Netherlands	-1.18	-1.34	-4.15	-2.71	-4.77
Portugal	-4.15	-4.89	-7.57	-6.67	-7.37
Spain	-3.42	-3.57	-4.25	-3.83	-5.57
Mean	-3.06	-3.79	-4.78	-5.63	-6.00

If instead of an integral controller a proportional controller with a value of 0.2 is used (which is the equivalent to the debt stock control in a quarterly model if nominal growth is 5%) then the debt stock is significantly better controlled. Further improvements can be made if one uses a proportional and integral control, and the stronger the proportional control is reacting to the deviation of the deficit from base the better the debt stock is managed. In the last column of Table 7 about a third of the variability of the debt stock is removed as compared with the no feedback rule used in Table 5. However, progress across rules is not uniform, as one can see from the table. As is common in control problems, a dual controller is more effective at stabilising both the deficit and the debt stock. Even then, uncertainty can only be reduced but not removed.

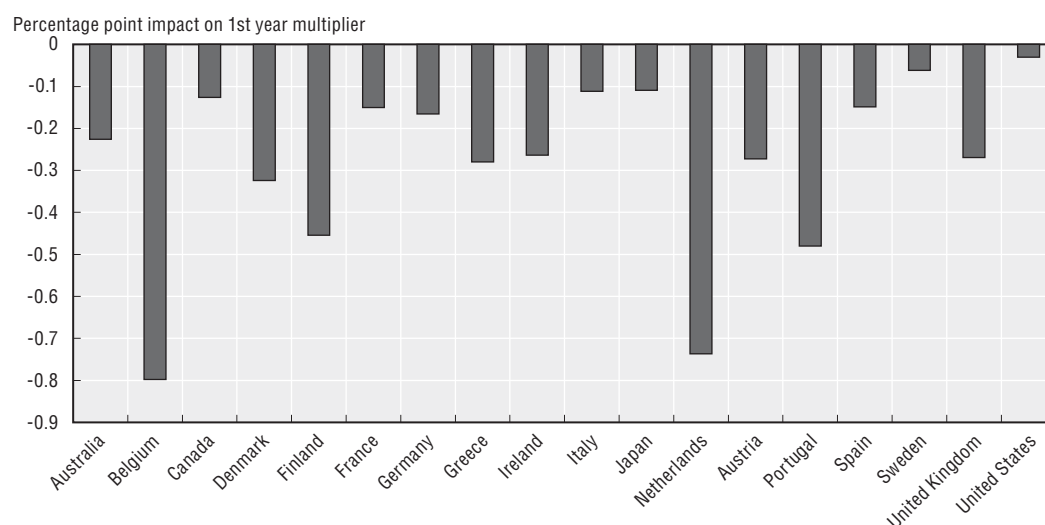
6. Unilateral versus synchronised fiscal innovations

When many countries are tightening policy simultaneously, the negative impact of domestic policy on output will be exacerbated by negative trade spillovers from policies

abroad. This is partially offset, especially in the smaller economies in the euro area, by the bigger impact of the joint action on ECB interest rate setting and more significant depreciation of the exchange rate. In order to assess the impact of synchronised policy innovations, we re-run the permanent spending shocks, which are reported in Table 4 above on a unilateral basis, applying a 1% of GDP spending-based consolidation in all 18 countries simultaneously.

Figure 15 illustrates the difference in the first year impact multiplier in each country in the joint consolidation scenario compared with the unilateral scenarios. Negative spillovers worsen the impact on output in all countries, with the biggest effects in the more open economies such as Belgium and the Netherlands. If the magnitude of policy innovations were to differ across countries, instead of the uniform 1% of GDP tightening illustrated in this scenario, joint consolidation could actually have a positive effect on output in some countries, reflecting the sensitivity of net trade to the exchange rate and relative price movements as well as the short-term sensitivity of demand to the real interest rate. The latter is particularly important in the United States and Japan, where spillovers from policy measures in the rest of the world are shown to be relatively limited.

Figure 15. **Impact of joint policy action relative to unilateral action**



Note: The figure shows the percentage point difference in the first-year multiplier in the simultaneous scenario and the unilateral scenarios from Table 4.

7. Fiscal consolidation and government borrowing premia

A number of studies have looked at the links between the risk premium on government borrowing (generally measured within the euro area as the spread of 10-year government bond yields over those in Germany) and fiscal sustainability, captured by current or expected values of the general government deficit or the stock of government debt. Table 8 reports key results from a sample of these studies. These studies suggest that rising government debt is likely eventually to put upward pressure on interest rates, so that fiscal tightening is likely to be necessary at some point. While the severe tightening of fiscal policy across the euro area has clearly made a significant contribution to the downturn, these studies generally suggest that improvements in the fiscal position are linked to a decline in government borrowing premia and therefore improve the medium-term sustainability of public finances and partly offset the contractionary effects of the consolidation.

Table 8. **Empirical relationship between government borrowing premia and fiscal variables**

	Spread (t – 1)	Debt to GDP ratio	Fiscal balance to GDP ratio	
			Implied long-run	
Arghyrou and Kontonikas (2011)	0.74		–2.0 (t + 1)	–7.7
Attinasi et al. (2009)	0.97		–1.6 (t + 1)	–54.9
Bernoth and Erdogan (2012)		2.2	–16 (t + 1)	
De Grauwe and Ji (2012)		$-6.12 (t) + 0.08 (t)^2$		
Schuknecht et al. (2010)		1.25	–12.64	

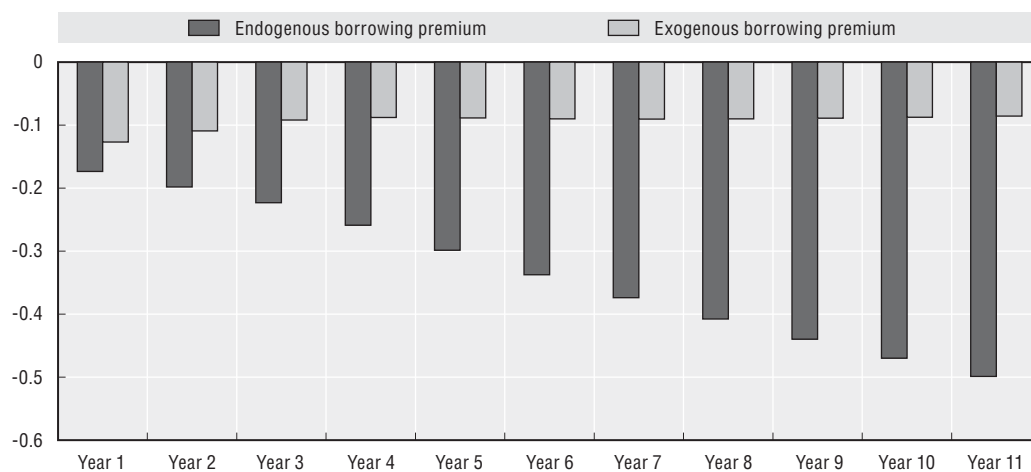
Note: Spread is defined as the 10-year government bond yield over that in Germany, expressed in basis points. (t + 1) indicates expectations 1 year ahead. (t)² indicates the current debt to GDP ratio squared.

The empirical estimates, on average, point to a 2-4 basis point rise in interest rates for a 1% of GDP rise in the government debt to GDP ratio. This may overstate the impacts for non-euro area countries. IMF (2012) points out that, “fiscal indicators such as deficit and debt levels appear to be only weakly related to government bond yields for advanced economies with monetary independence”.

In order to assess the impact of the potential feedback on borrowing premia, we model the government borrowing premium as:

$$GPREM = 0.04 * GDR$$

where *GPREM* is the government borrowing premium and *GDR* is the government debt to GDP ratio. Figure 16 illustrates the expected impact of a 1% of GDP fiscal consolidation programme on long-term interest rates, with and without allowing for the feedback from the decline in government debt on the borrowing premium in the United Kingdom. Similar results can be obtained for other countries. The impacts increase over time as the debt position improves. The impacts on GDP in the short term are negligible, although over time they become more significant. Where there is little scope for downward adjustment in interest rates, this channel can be expected to be impaired. However, where significant risk premia are present within the euro area (Greece, Ireland, Portugal, Spain, Italy) there is certainly scope for a decline in borrowing costs.

Figure 16. **Impact of 1% of GDP fiscal consolidation in the United Kingdom on long-term interest rates**

8. Conclusion

Fiscal multipliers differ across countries because the structure and behaviour of economies differ. They also differ within countries, depending on factors such as the fiscal instrument implemented, the policy response to fiscal innovations, and expectation formation by economic agents. In general in most countries fiscal policy multipliers are small, but are negative when fiscal policy is tightened. Spending multipliers tend to be larger in the short term than tax multipliers, although in the real world it may be difficult to implement real cuts in the provision of government services quickly. More open and financially liberalised economies tend to have smaller multipliers. Expectation formation also matters. The more forward-looking are economic agents, the smaller the estimated multiplier. Tighter fiscal policy reduces growth in the short run in almost all circumstances, but a lower debt stock reduces pressures on real interest rates and hence in the longer term can raise sustainable output. This effect is larger for larger countries. As suggested by Delong and Summers (2012), in the current economic environment, multipliers may be larger than usual, due to heightened liquidity constraints related to problems in the banking sector and a weak economy. Limited downward flexibility in short-term interest rates also raise the expected effects on output from fiscal consolidation programmes.

The need to reduce government debt stocks cannot be denied, but their evolution is very uncertain. The bounds around any consolidation programme can be reduced by setting up automatic feedbacks that raise taxes in response to overshoots on targets for debts and deficits, but the uncertainty bounds cannot be reduced to zero. In general targeting the debt stock and the deficit is more effective than targeting either alone, as both are subject to shocks that make them deviate from target.

Notes

1. For a full description of NiGEM, see <http://nimodel.niesr.ac.uk>. A brief overview is provided in the Appendix.
2. Government investment and corporate tax receipts are generally a small proportion of the economy, and a 1% of GDP change to either would be a large proportionate change. In a temporary shock, the impact of a shift in government investment would be the same as a government consumption shock of the same magnitude. A long-run shock to either government investment or the corporate tax rate would change the real equilibrium of the economy.
3. This model describes myopic consumers. The approach to modelling forward-looking consumers is discussed in the Appendix.
4. The impact of the consolidation on risk premia is not taken into account. These are largely absent currently for large countries such as the United States, the United Kingdom, France and Germany. For small countries such as Greece, Ireland and Portugal this is important.
5. The parameters of consumption functions underlying NiGEM differ somewhat from those reported by Barrell and Davis (2007), due to different vintages and sample periods of data used in estimation.
6. The parameters of the rules are nested, and hence the differences are due to their innate properties.

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APPENDIX

The NiGEM model

The National Institute's global econometric model (NiGEM) can be used in a number of ways, from a backward-looking structural model to a version that has similar long-run properties as the dynamic stochastic general equilibrium models used by institutions such as the Bank of England.¹ Although the model is estimated it has a strong role for expectations, and it is also flexible, as it can be run under different models of expectations formation, depending upon the thought experiment being undertaken. Financial markets normally follow arbitrage conditions and they are forward looking. The exchange rate, the long-term interest rate and the equity price will all jump in response to news about future events. Fiscal policy making involves gradually adjusting direct taxes to maintain the deficit on target, but it is assumed that taxes have no direct effect on labour supply decisions. Monetary policy making involves targeting inflation with an integral control from the price level, as discussed in Barrell, Hall and Hurst (2006) and inflation settles at its target in all simulations. Some of the key features of the model that determine the outturns of the simulation studies are detailed further below.

Production and investment

GDP (Y) is determined in the long run by supply factors, and the economy is open and has perfect capital mobility. The production function has a constant elasticity of substitution between factor inputs, where output depends on capital (K) and on labour services (L), which is a combination of the number of persons in work and the average hours of those persons. Technical progress ($tech$) is assumed to be labour augmenting and independent of the policy innovations considered here. Fiscal tightening measures have a negative impact on GDP in the short run, but unless they permanently shift the desired level of capital, labour supply or technical progress, these effects dissipate over time and will not affect the level of output over the longer term.

$$Y = \gamma(\delta(K)^{-\rho} + (1 - \delta)(Le^{\lambda_L tech})^{-\rho})^{-1/\rho} \quad (1)$$

Equation (1) constitutes the theoretical background for the specifications of the factor demand equations. Demand for capital is determined by profit maximisation of firms, implying that the long-run capital output ratio depends on the real user cost of capital. In general, forward-looking behaviour in production is assumed, and so investment depends on expected trend output four years ahead and the forward-looking user cost of capital. However, the capital stock does not adjust instantly, as there are costs involved in doing so that are represented by estimated speeds of adjustment. The user cost of capital is influenced by corporate taxes, depreciation and risk premia and is a weighted average of the cost of

equity finance and the margin adjusted long real rate. Fiscal innovations through the corporate tax rate or through government investment can permanently shift the level of the capital stock, and through this shift the long-run level of potential output.

Labour market and wage setting

Demand for labour is also determined by profit maximisation of firms, implying that the long-run labour-output ratio depends on real wage costs and technical progress. Labour supply is modelled as essentially exogenous, determined by demographics and an exogenous rate of participation.

The equilibrium level of unemployment is the outcome of a bargaining process in the labour market, as discussed in Barrell and Dury (2003). NiGEM assumes that employers have a right to manage, and hence the bargain in the labour market is over the real wage. Real wages, therefore, depend on the level of trend labour productivity as well as the rate of unemployment. The dynamics of the labour market depend on the estimated speed of adjustments in the wage and labour demand equations, and the extent to which short-term wage dynamics depend on (rational) expectations of future inflation and on current or past inflation. The degree of price inertia/real wage flexibility in the economy is an important factor underlying the different dynamic profiles observed in response to a fiscal innovation.

Consumer behaviour

As Barrell and Davis (2007) show, both the level of total asset based wealth [$\ln(TAW)$ or $\ln(NW + HW)$] and changes in financial wealth [$d\ln(NW)$] and especially housing wealth [$d\ln(HW)$] will affect consumption (C).² Their estimates suggest that the impact of changes in housing wealth have five times the impact of changes in financial wealth in the short run, although long-run effects are the same. Barrell and Davis (2007) also show that adjustment to the long-run equilibrium shows some inertia as well.³ Al Eyd and Barrell (2005) discuss borrowing constraints, and investigate the role of changes in the number of borrowing constrained households. It is common to associate the severity of borrowing constraints with the coefficient on changes in current real incomes [$d\ln(RPDI)$] in the equilibrium correction equation for consumption (parameter b_1). These coefficients are important in evaluating impact multipliers. They may also be time-varying and dependent on the state of the economy, as the number of liquidity constrained consumers will rise during an economic downturn. This may be a key channel through which fiscal multipliers become dependent on the state of the economy, as suggested by *e.g.* Delong and Summers (2012). One can write the equation for $d\ln(C)$ as:

$$d\ln(C_t) = \lambda \{ \ln(C_{t-1}) - [a + b_0 \ln(TAW_{t-1}) + (1 - b_0) \ln(RPDI_{t-1})] \} + b_1 d\ln(RPDI_t) + b_2 d\ln(NW_t) + b_3 d\ln(HW_t) \quad (2)$$

where the long-run relationship between $\ln(C)$ and $\ln(RPDI)$ and $\ln(TAW)$ determine the equilibrium savings rate, and this relationship forms the long-run attractor in an equilibrium correction relationship. The logarithmic approximation is explained in Barrell and Davis (2007).

Operating in forward-looking consumption mode, consumers react to the present discounted value of their expected future income streams, which is approximated by total wealth (TW), although borrowing constraints may limit their consumption to their personal disposable income in the short run. Total human wealth is defined as:

$$TW_t = Y_t - T_t + TW_{t+1} / [(1 + rr_t)(1 + my_t)] \quad (3)$$

Y is real income, T are real taxes, and the subscript $t + 1$ indicates an expected variable which is discounted by the real interest rate rr_t and by the myopia premium of consumers, my_t . The equation represents an infinite forward recursion, and permanent income is the sustainable flow from this stock. Fiscal multipliers are sensitive to the expectations formation of households. Fully forward-looking consumers anticipate that current consolidation measures may entail lower tax rates in the medium to longer term, offsetting some of the negative impact on consumption in the short term, as households aim to smooth their consumption path. Multipliers are higher with myopic consumers.

Government sector

In order to evaluate multipliers a reasonably disaggregated description of both spending and tax receipts is needed. Corporate (CTAX) and personal (TAX) direct taxes and indirect taxes (MTAX) on spending are modelled, along with government spending on investment (GI) and on current consumption (GC), and transfers (TRAN) and government interest payments (GIP) are separately identified. Each source of taxes has an equation applying a tax rate to a tax base (profits, personal incomes or consumption). As a default, government spending on investment and consumption are rising in line with trend output in the long run, with delayed adjustment to changes in the trend. They are re-valued in line with the consumers' expenditure deflator (CED). Government interest payments are driven by a perpetual inventory of accumulated debts. Transfers to individuals are composed of three elements, with those for the inactive of working age and the retired depending upon observed replacement rates. Spending less receipts gives the budget deficit (BUD), which adds to the debt stock.

$$BUD = CED \cdot (GC + GI) + TRAN + GIP - TAX - CTAX - MTAX \quad (4)$$

It has to be considered how the government deficit (BUD) is financed. Either money (M) or bond financing (DEBT) are allowed:

$$BUD = d(M) + d(DEBT) \quad (5)$$

and rearranging gives:

$$DEBT = DEBT_{t-1} + BUD - d(M) \quad (6)$$

In all policy analyses a tax rule is used to ensure that governments remain solvent in the long run. The default rule is applied to the personal direct tax rate, which is adjusted endogenously to bring the government deficit into line with a specified target. This ensures that the deficit and debt stock return to sustainable levels after a shock. A debt stock target can also be implemented and this is discussed below. The income tax rate (TAXR) equation is of the form:

$$TAXR = f(\text{target debt or deficit ratio} - \text{actual debt or deficit ratio}) \quad (7)$$

If the government budget deficit is above the target (e.g. 3% of GDP and the target is 1%), then the income tax rate is increased.

Monetary policy

A tighter fiscal policy will allow short-term interest rates to be lower now and in the future if there is no change to the monetary policy target, and hence long-term interest rates will be lower now. Barrell (2001) reviews evidence on expansionary fiscal contractions, and concludes they are exceptionally rare. Interest rates are set by the monetary authority in relation to a targeting regime, where policy interest rates are set in relation to a rule that is normally forward

looking. Fiscal multipliers depend on the assumed targeting regime, and the extent to which fiscal innovations are accommodated by monetary policy in the short term. We distinguish two types of rules, those that target only inflation and those that target the price level or a nominal variable such as GDP or the money stock. During the “Great Moderation” era, central bankers and many economists became convinced that they had changed the world they lived in by adopting simple feedback rules for monetary policy in combination with rules for fiscal policy that kept debt in bounds. The simple feedback rule was based on the Taylor Rule (TR) that suggests that when inflation increases, the central bank should increase the interest rate more than in proportion to the rise in inflation, and hence the real interest rate would rise and help choke off demand. In a forward-looking world it is possible to improve on this principal. If agents see the central bank as fully credible, then the announcement of a price level target (PLT), rather than just an inflation target, will stabilise fluctuations in output and in inflation. A price level targeting central bank will loosen policy more rapidly as it has to get the price level back to target. The converse will be true in a boom. These two feedback rules are shown in equation (8) below, with int being the intervention rate, ssr being the steady state (endogenous) real interest rate, og being the output gap, inf and inf_t being the inflation rate and the target, and P and PT being the price level and the price level target.

$$int_t = a_0 + a_1 ssr_t + a_2 og_t + a_3 (inf_{t+1} - inf_t) + a_4 (P_t - PT_t) \quad (8)$$

In a Taylor Rule, a_0 is zero, a_1 is 1.0, a_2 is 0.5, a_3 is 1.5 and a_4 is zero, whilst in a PLT regime a_1 is zero, a_2 is also zero, and a_3 is set to 0.7 and a_4 to 0.4. The PLT rule has the advantage of working only on observables. The same is true of a two pillar strategy as embraced by the ECB. The bank responds to deviations of inflation from target and also deviations of a nominal aggregate (NOM) – the money stock for instance – as described in the equation:

$$int_t = b_0 + b_1 (inf_{t+1} - inf_t) + b_2 (NOM_t - NOMT_t) \quad (9)$$

Forward looking financial markets

A deflationary shock such as a fiscal tightening will have a weaker interest rate response under a Taylor Rule than under price level targeting, and both may be weaker than a two pillar rule. If actors know the rule is in place then they will form expectations of the future path of short rates, and this will cause the current long rate to change, along with the exchange rate and the equity price. If fiscal policy is expected to be tightened in the future then long rates will fall now, increasing the offset, and perhaps even inducing a short-term expansion of output. Forward-looking long rates (LR) should be related to expected future short-term rates:

$$(1 + LR_t) = \prod_{j=1}^T (1 + int_{t+j})^{1/T} \quad (10)$$

Forward-looking equity prices (EQP) are related to future profits (PR) in a forward recursion where e_{prem} is the equity premium:

$$EQP_t = PR_t + \frac{EQP_{t+1}}{(1 + int_t)(1 + e_{prem_t})} \quad (11)$$

The exchange rate depends on the expected future path of interest rates and the exchange rate risk premia, solving an uncovered interest parity condition, so that the expected change in the exchange rate is given by the difference in the interest earned on assets held in local and foreign currencies:

$$e_t = e_{t+1} \left(\frac{1 + int_t^*}{1 + int_t} \right) (1 + r_{p_t}) \quad (12)$$

where e_t is the bilateral exchange rate at time t (defined as domestic currency per unit of foreign currency), int_t is the short-term nominal interest rate at home set in line with a policy rule, int_t^* is the interest rate abroad and rp_t is the exchange rate risk premium.

Notes

1. The Bank of England Quarterly model is discussed in Harrison *et al.* (2005). NiGEM is discussed in Barrell, Holland and Hurst (2007), Barrell, Hurst and Mitchell (2007) and in other papers at www.niesr.ac.uk. NiGEM does not impose maximising equilibrium conditions in the same way as Dynamic Stochastic General Equilibrium models, but has the same steady-state equilibrium properties.
2. Throughout d is the change operator and $\ln$ is the natural logarithm.
3. While the approach underlying NiGEM consumption equations is the same used in Barrell and Davis (2007), the estimated parameters differ, due to different vintages and sample periods of data used in estimation.

Interest-rate-growth differentials and government debt dynamics

by

David Turner and Francesca Spinelli*

The differential between the interest rate paid to service government debt and the growth rate of the economy is a key concept in assessing fiscal sustainability. Among OECD economies, this differential was unusually low for much of the last decade compared with the 1980s and the first half of the 1990s. This article investigates the reasons behind this profile using panel estimation on selected OECD economies as means of providing some guidance as to its future development. The results suggest that the fall is partly explained by lower inflation volatility associated with the adoption of monetary policy regimes credibly targeting low inflation, which might be expected to continue. However, the low differential is also partly explained by factors which are likely to be reversed in the future, including very low policy rates, the “global savings glut” and the effect which the European Monetary Union had in reducing long-term interest differentials in the pre-crisis period. The differential is also likely to rise in the future because the number of countries which have debt-to-GDP ratios above a threshold at which there appears to be an effect on sovereign risk premia has risen sharply. Moreover, debt is projected to increasingly rise above this threshold in most of these countries.

JEL classification: E43, E62, H63, H68

Keywords: fiscal sustainability, government debt, interest rates, interest-rate-growth differential.

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The financial crisis has led to severe fiscal imbalances in many OECD countries. Difficult decisions need to be addressed concerning the speed with which to close wide fiscal deficits given the underlying weakness of activity as well as concerns about long-run fiscal sustainability given ballooning government indebtedness. A key issue in assessing long-run fiscal sustainability is the future trend of the differential between the interest rate paid to service government debt and the growth rate of the economy. For highly indebted countries, a change in this differential of a couple of percentage points, if sustained, could mean the difference between an explosive and a declining path for the debt-to-GDP ratio. Indeed, the focus among policy-makers, the media and financial markets on both the level of long-term interest rates and the prospects for growth during the ongoing euro area crisis underlines the importance of this differential as a measure of fiscal sustainability.

In this context, it matters a lot whether OECD countries are likely to face the low interest-rate-growth differential environment which typically prevailed over much of the pre-crisis 2000s or the much higher and less favourable differential which was typical of the 1980s and the first half of the 1990s.¹ Among a group of selected OECD countries considered in this article the median interest-rate-growth differential fell from almost 2½ percentage points to about zero between these periods, with a much greater fall for those countries which initially had a larger differential. This article attempts to evaluate the relative importance of various explanations for the fall in the differential as a guide to understanding possible future trends, particularly given that there is little in the way of existing published analytical work which looks at this issue in a multi-country framework.²

The main findings of the article are as follows:

- The decline in uncertainty surrounding inflation, associated with the decline in the level and more particularly the volatility of inflation, has almost certainly contributed to a fall in the interest-rate-growth differential. The empirical work reported in this article suggests that it might have contributed between ¾ and 1 percentage point for the typical OECD country, and by more for those countries where inflation volatility has declined by more. This change is probably the consequence of a general move in the use of monetary policy towards a more credible targeting of inflation. To the extent that inflation expectations remain anchored in the future these gains might be expected to persist. This also suggests some caution in policy-makers attempting to reduce government indebtedness by deliberately engineering a period of high inflation. A period of unexpectedly high inflation will, *ceteris paribus*, tend to reduce the debt ratio, particularly the longer the maturity structure of debt (see Box 1.8 in *OECD Economic Outlook* No. 80). However, this effect could be easily offset if higher inflation led to greater uncertainty about future inflation and so a permanently higher interest-rate-growth differential.

- On the other hand, other factors behind the low differential over the last decade are unlikely to persist over the longer term and their reversal is likely to result in an increase in the differential:
 - ❖ Policy rates and short-term interest rates were unusually low for an unusually long time over the last decade, partially in response to fears about the severity of the downturn and the risks of deflation following the sharp fall in equity prices at the end of the 1990s. This, by creating expectations of future low interest rates, almost certainly dragged down long-term interest rates. In the wake of the financial crisis, policy rates in many countries have been further cut to extremely low levels. Although this situation may continue for a few (or even many) years, over the longer run as policy rates normalise this is likely to push up the interest-rate-growth differential. Estimates in this article suggest that for a typical OECD country this will imply a rise in the interest-rate-growth differential by around 1 to 1¼ percentage points.
 - ❖ This article provides some tentative empirical support for the effect of a “Global Savings Glut” originating from Asian emerging markets and oil exporters with an estimated effect of reducing the interest-rate-growth differential during the 2000s by around 1¼ to 1½ percentage points. Such a global savings-investment imbalance is unlikely to persist indefinitely. Indeed, there are arguments to suggest that future trends in global savings and investment are more likely to put upward pressure on global interest rates and hence raise the interest-rate-growth differential (Dobbs *et al.*, 2010).
 - ❖ Other research suggests that quantitative easing measures undertaken since the financial crisis may have reduced long-term interest rates by up to 100 basis points, implying that as the effect of such measures fades there will be a corresponding increase in long-term interest rates.
- One factor which is likely to exert a much larger positive influence on the interest-rate-growth differential over the future is higher fiscal sovereign risk premia associated with increased government indebtedness, which for many countries has increased substantially in the wake of the crisis. Some evidence is found in support of a threshold effect, whereby each percentage point increase in the gross government debt-to-GDP ratio above 75% of GDP leads to an increase in the differential of 4 basis points. According to recent OECD projections (OECD, 2011), there are likely to be 15 OECD countries with debt ratios exceeding this threshold compared with just six countries immediately prior to the crisis.
- Relative to the pre-crisis period, the change in the interest-rate-growth differential may be particularly large for some euro area countries, as it is clear that over the pre-crisis period the introduction of European Monetary Union led to a marked convergence of long-term interest rates among member countries so masking the effect of individual country characteristics such as indebtedness. Moreover, since the crisis there is evidence to suggest that, *ceteris paribus*, interest rates in euro countries are more sensitive to indebtedness than other OECD countries, a prediction consistent with the inability of members of a currency union to freely issue their own currency in response to increased government indebtedness. However the current euro area sovereign debt crisis is resolved, it seems likely that fundamentals will play a more important role in determining long-term interest rates of individual countries within EMU in the future.

The remainder of the article is organised as follows: Section 1 explains the importance of the interest-rate-growth differential in debt dynamics with a specific illustration with respect to the US fiscal position; Section 2 considers various measurement issues and examines past trends in the differential for OECD countries; Section 3 describes some of the possible explanations for past trends in the differential, namely changes in inflation volatility, policy rates, the “global savings glut”, European Monetary Union and government indebtedness; finally, Section 4 attempts to discriminate between these explanations using panel estimations on a large number of OECD countries.

1. The importance of the interest-rate-growth differential in debt dynamics

The interest-rate-growth differential is essential to understanding long-run fiscal sustainability; higher interest rates imply higher interest payments to service government debt so adversely influencing debt dynamics, whereas higher nominal GDP growth will tend to lower the debt-to-GDP ratio by increasing the denominator. More formally, the importance of the interest-rate-growth differential can be seen from the government budget identity,³ whereby the change in the net government debt-to-GDP ratio (d) is explained by the primary deficit ratio ($-pb$) plus net interest rates payments on the previous period's debt, where i_t is the effective interest rate paid on net government debt, so that approximately:

$$\Delta d_t = -pb_t + (i_t - g_t) d_{t-1}, \quad (1)$$

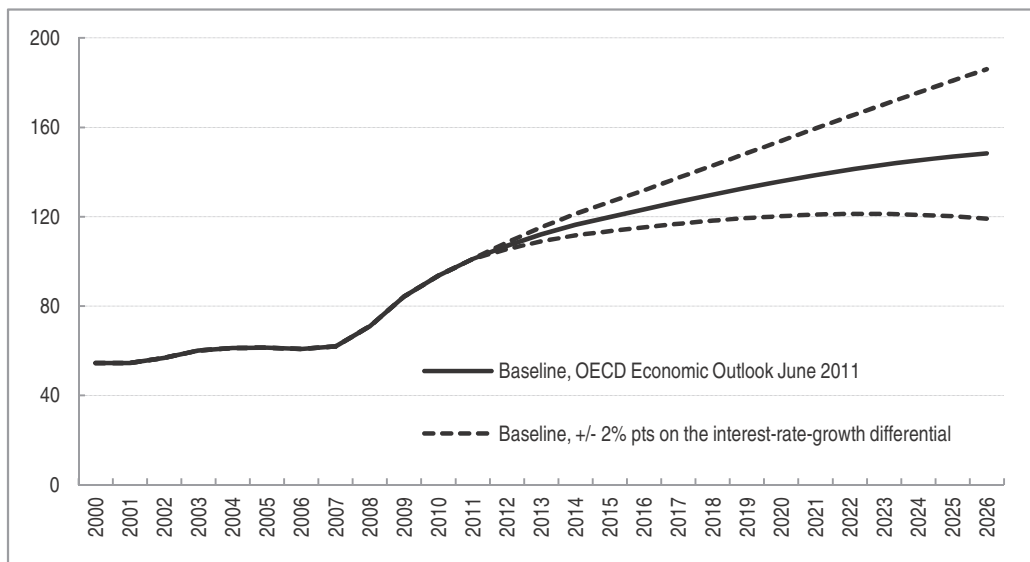
where g_t is the nominal GDP growth rate. Thus, for a given primary balance and initial net debt ratio, the rate of increase in the debt-to-GDP ratio is positively related to the interest-rate-growth differential.

In order to illustrate the importance of the interest-rate-growth differential in long-term fiscal projections, the sensitivity of recently published OECD fiscal projections to alternative assumptions regarding this differential are considered. The long-term projections published in June 2011 (OECD, 2011) are based on the stylised assumption that beyond 2012 gradual fiscal consolidation, equal to an improvement in the underlying primary balance of $\frac{1}{2}$ percentage point of GDP each year, is undertaken until the debt-to-GDP ratio is stabilised. The United States is one of only two OECD countries for which the stylised gradual fiscal consolidation would be insufficient to stabilise the government debt-to-GDP ratio by 2026, with gross general government debt reaching nearly 150% of GDP, although the rate of increase in the debt ratio is clearly diminishing (Figure 1). The importance of the interest-rate-growth differential in debt dynamics, particularly for a highly-indebted country, is illustrated by the substantial difference in two variant simulations in which the differential is alternatively increased and then decreased by 2 percentage points relative to this baseline, assuming that the primary balance remains the same as in the baseline.⁴

The calculations underlying this illustrative example ignore the likely interactions and feedback effects from the variables included in the government budget identity (1). For example, if the government boosts the primary surplus in response to a deterioration in the interest-rate-growth differential then a trend increase in the debt ratio could be avoided. On the other hand, other feedback effects may exacerbate the effect of the differential on debt projections:

- The shock to the differential is applied *ex post*, whereas if applied *ex ante* there might be reasons to expect further changes to the differential which re-enforce the effect of the

Figure 1. **Sensitivity of debt projections to the interest-rate-growth differential**
Gross government debt of United States as percentage of GDP



Source: OECD Economic Outlook, June 2011, and OECD calculations.

original shock; for example, if debt begins to rise as a consequence of a higher differential then fiscal risk premium on debt might be expected to rise; also at higher levels of debt there is some empirical evidence to suggest that there may be some adverse effect on real growth rates (Reinhart and Rogoff, 2010).

- These stylised fiscal projections are based on the assumption that primary public expenditure remains a stable share of GDP. However, if the differential falls as a result of faster growth it is likely that some components of public expenditure, such as infrastructure expenditure, would rise less than proportionately, which in turn would imply a more rapid reduction in debt.

2. Measurement issues

In analysing historical trends, the interest-rate-growth differential is here defined differently from how it appears in the budget identity described in equation (1) above. This is both to improve cross-country comparability, which is important when undertaking panel regressions, and to provide a better trend measure which abstracts from volatility, particularly that associated with the cycle, thus:

- Nominal potential GDP growth is used in place of actual GDP growth in order to reduce the volatility associated with the business cycle given that the focus here is on long-term fiscal sustainability. The estimates of potential output which are used are those described in OECD (2011) and are intended to measure the trend level of output which can be sustained without inflationary pressure.
- The interest rate that is used in the analysis here is that on 10-year government bonds which differs from the concept of the implicit interest rate on net government debt used in the budget identity (1) in a number of ways:
 - ❖ The interest rate in the budget identity is the implicit net interest rate paid on net debt and so takes into account the interest receipts earned on government asset holdings.

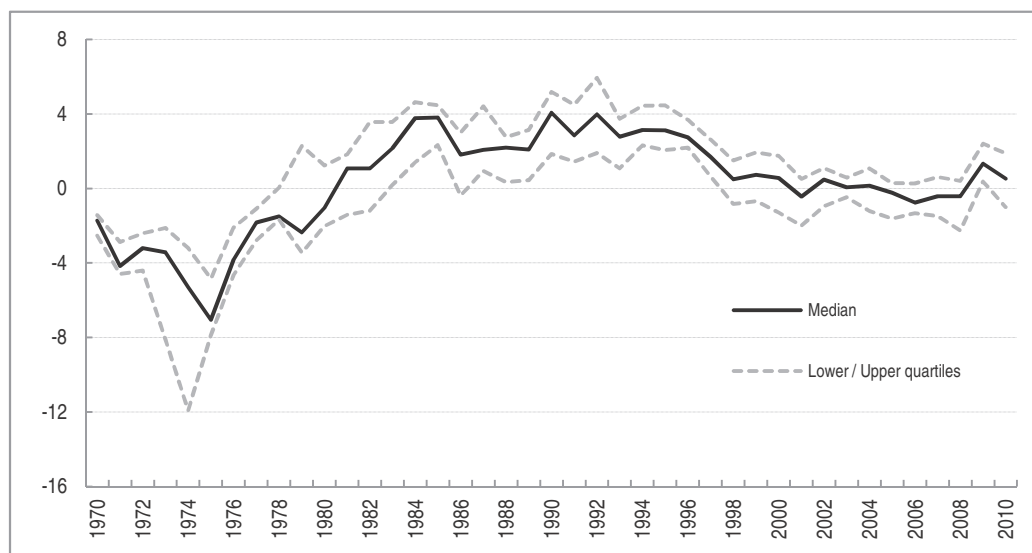
Nevertheless, the empirical analysis here focuses on the rates on 10-year government bonds because there is great heterogeneity in the size and composition of government assets holdings across countries.

- ❖ The interest rate in the budget identity is the *average* implicit interest rate paid on all debt which will differ from the interest rate on new issues of government debt. Thus, for example, after a prolonged period when long-term interest rates have been unusually low for a long period (perhaps, for example, because short-term policy rates have been low for cyclical reasons) but have recently begun to rise, then the average interest rate paid on gross government debt will be lower than the rate on new bond issues. However, the latter will provide a more timely indicator of the future trends in the cost of government financing.
- ❖ The interest rate which is used in the analysis is that on 10-year government bonds which will differ from even the rate of new bond issues if these are issued at different maturities. An argument for using the former in the analysis is that it is both simpler to implement and will abstract from differences across countries regarding the maturity structure of new bond issues which may well be temporary.
- ❖ Finally, using a measure of the implicit rate on net government debt in regression analysis is ruled out for many countries because when net government debt (the denominator in any calculation of the implicit rate) becomes very low the implicit rate can easily jump to absurd levels.

Based on the definitions described above (see Annex A1 for further details of the data), the interest-rate-growth differential for a group of OECD countries, for which consistent time series of data is available, shows a marked fall during the 1970s (Figure 2) as the inflation rate rose very substantially from levels experienced during the 1960s (Figure 3). As inflation surprises subsided, the level of the interest-rate-growth differential was much higher and for nearly all countries positive during the 1980s and the first half of the 1990s.

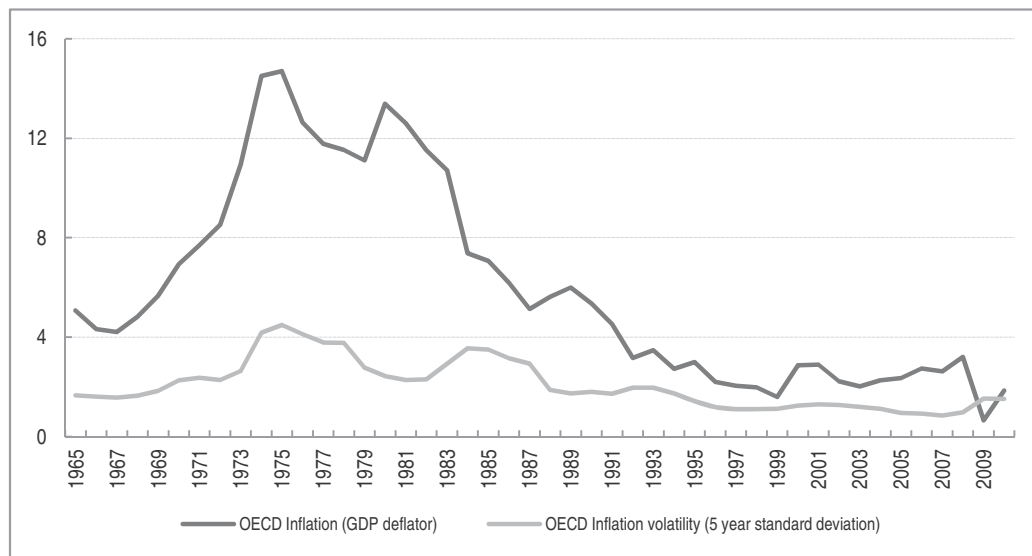
Figure 2. **The interest-rate-growth differential for selected OECD countries**

Percentage points



Source: OECD Economic Outlook, June 2011, and OECD calculations, country coverage varies over the sample period, see notes to Table 1 and Annex A1 for further details.

Figure 3. The level and volatility of OECD inflation
Change in the OECD-wide GDP deflator, percentage points



Source: OECD Economic Outlook, June 2011, and OECD calculations. For country coverage see notes to Table 1 and see Annex A1 for further details.

The differential then exhibits a marked fall from its median level in the 1980s and first half of the 1990s of typically about 2½ percentage points to close to zero during the pre-crisis 2000s (Figure 2 and Table 1). Moreover, there are many countries (*e.g.* Australia, Canada, Denmark, Spain, Ireland and Norway) where the interest rate-growth-differential fell by 4 percentage points or more between these two periods.

Table 1. The interest-rate-growth differential for selected OECD countries

	1970-79	1980-95	1996-99	2000-08	2010
G7 countries					
Upper quartile	-2.46	3.22	2.41	1.50	1.60
Median	-3.82	2.32	1.61	0.41	0.95
Lower quartile	-5.80	1.28	0.92	-0.19	0.12
Number of countries	6	7	7	7	7
Selected OECD countries¹					
Upper quartile	-1.80	3.80	2.41	0.68	1.76
Median	-3.36	2.41	1.42	-0.11	0.53
Lower quartile	-5.17	0.79	0.33	-1.40	-1.00
Number of countries	11	21	23	23	23
Selected EMU countries²					
Upper quartile	-2.29	3.70	2.40	0.74	3.80
Median	-3.66	2.64	0.98	-0.11	1.34
Lower quartile	-4.83	1.06	-0.13	-1.50	0.85
Number of countries	5	10	11	11	11

1. Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.

2. Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain.

Source: OECD Economic Outlook, June 2011, and OECD calculations. See Annex A1 for further details.

These data also suggest that in periods in which the interest-rate-growth differential is high government indebtedness tends to rise; over the period 1980 to 1995, when the differential was high, OECD gross government debt rose from 44% to 73% of GDP, whereas over the period 1995 to just prior to the crisis in 2007, when the differential was low, there was little change in the debt ratio.

3. Possible explanations for changes in the interest-rate-growth differential

This section discusses a range of potential explanations for the profile of the OECD interest-rate-growth differential, focusing in particular on the OECD-wide fall in the differential from the early 1980s, before attempting to distinguish between them empirically in the following section.

3.1. Financial repression

The empirical analysis in this paper focuses on OECD interest-rate-growth differentials since 1980 because the extent of financial repression measures among OECD countries prior to 1980 suggests that the determinants of interest rates on long-term government bonds is unlikely to be a useful guide to the experience since 1980 (Reinhart and Sbrancia, 2011). Financial repression includes direct lending to government by captive domestic audiences (such as pension funds), explicit or implicit caps on interest rates, regulation of cross border capital movements and was widespread among OECD countries until the end of the 1970s. Reinhart and Sbrancia (*op. cit.*) argue that this helps to explain why, among a sample of advanced economies, real interest rates were negative roughly half of the time during 1945-80. The combination of financial repression together with large inflation shocks also explains why measures of real interest rates were substantially negative for many OECD countries during much of the 1970s.

While the period since 1980 is subject to less distortion from financial repression measures, there is an argument that such measures-defining “financial repression” more broadly to include government policies to channel fund to themselves that in a deregulated financial market would go elsewhere-have returned as part of the response to the financial crisis (Reinhart *et al.*, 2011). The most obvious form which this has taken is direct large-scale purchases of government bonds by central banks through so-called quantitative easing measures. Research suggests that such measures carried out by the Federal Reserve and Bank of England may have reduced interest rates on US and UK long-term government bonds by up to 100 basis points (Joyce *et al.*, 2011 and Gagnan *et al.*, 2011) in the post-crisis period. These factors are not directly accounted for in the empirical analysis reported in the subsequent section. Nevertheless, to the extent that such measures are unlikely to be sustained over the longer-term, they serve to further emphasise the concern which emerges from the rest of the empirical analysis that the interest-rate-growth differential is likely to rise over the medium term from current levels.

3.2. Lower and less volatile inflation

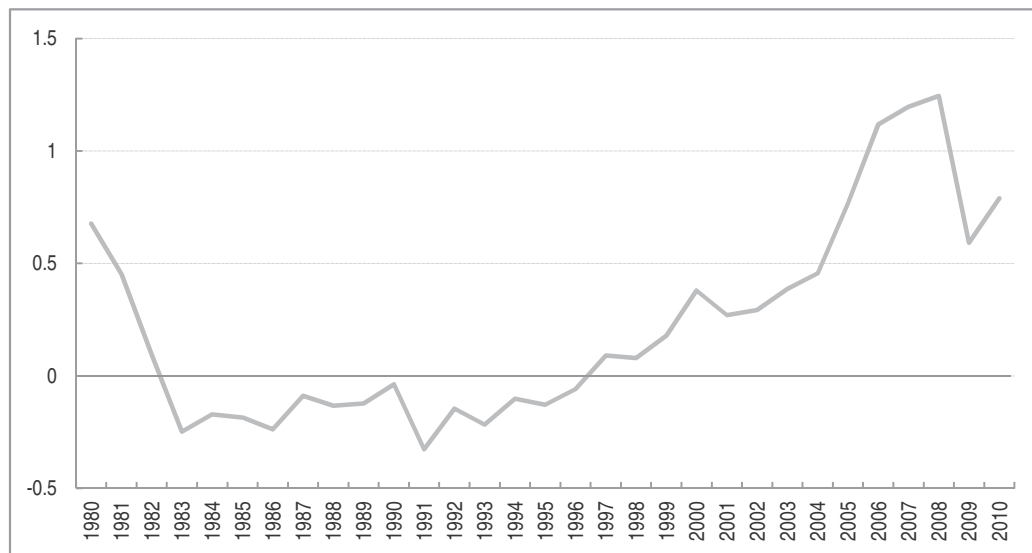
There is some evidence to suggest that inflation uncertainty is an important component of bond risk premia; certainly the decline in the interest-rate-growth differential broadly corresponds with the decline in both level and volatility of OECD inflation (Figure 3). In addition, there is evidence to suggest that the largest reductions in term premia occurred in countries that made radical changes in their monetary policy frameworks, such as introducing inflation targets and increasing the independence of their central banks (Wright, 2011).⁵

3.3. The global savings glut

According to the “global savings glut” hypothesis (Bernanke, 2005 and 2007), increased capital inflows to the United States from countries in which desired saving greatly exceeded desired investment – particularly Asian emerging markets and non-OECD oil exporters – were an important reason why long-term interest rates were lower than expected in the pre-crisis 2000s. Although the argument was originally applied to the United States, in principle it seems likely that it might also apply more generally to the advanced OECD economies.

A crude measure of the *ex ante* imbalance between global savings and investment is the *ex post* current account surplus of the Asian emerging markets and oil exporters expressed as percentage of world GDP (Figure 4) which is used here in the subsequent empirical analysis. There will, of course, always be some countries running a current account surplus so taking a subset of these and referring to it as a measure of a “global savings glut” is admittedly crude. Nevertheless, these countries are singled out here because they ran up large current account surpluses so rapidly – because of massive structural reform, fiscal adjustment or swings in commodity prices – that there was no possibility to easily absorb the additional savings in domestic investment opportunities.

Figure 4. **A measure of the “global savings glut”**
Combined current account surpluses of Asian emerging markets and oil exporters,
as a percentage of world GDP



Source: International Monetary Fund, *World Economic Outlook Database*, September 2011. For further details see Annex A1.

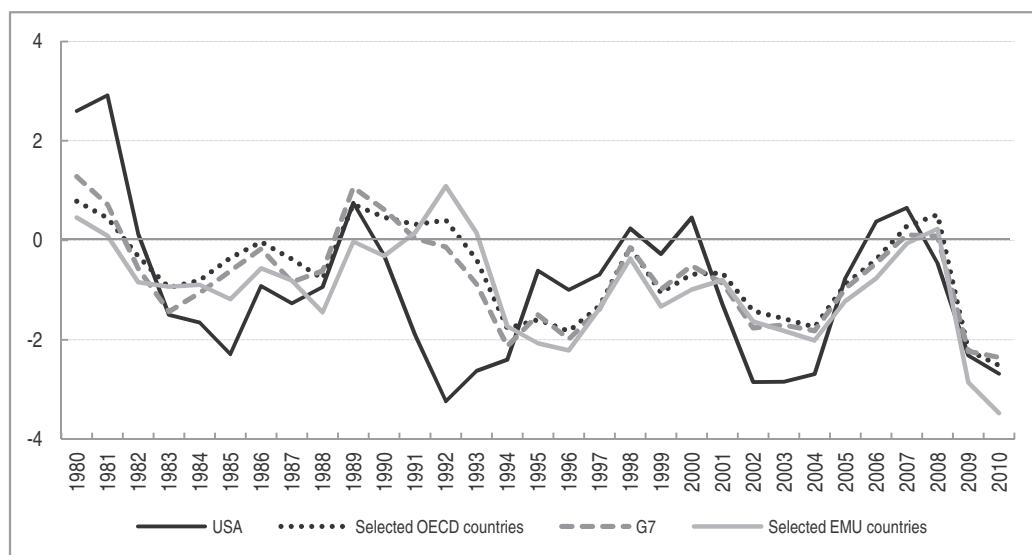
3.4. A prolonged period of low policy rates

If long-term interest rates are considered as a forward convolution of expected short-term interest rates plus term premia, it follows that large deviations of short-term rates which are expected to persist over a period of many years will also pull long-term interest rates away from their more fundamental levels. Monetary policy exerts a powerful influence on short-term market interest rates. In particular, policy rates have been unusually low for an unusually long time over much of the last decade, in response firstly to fears about the severity of the downturn and the risks of deflation following the sharp

fall in equity prices at the end of the 1990s and, more recently, in response to the financial crisis (Figure 5). This, by creating expectations of future low interest rates, almost certainly dragged down long-term interest rates. Thus, a prolonged period of exceptionally low (or high) policy rates would be expected to lower (raise) long-term interest rates, and hence the interest-rate-growth differential, contemporaneously.⁶

Figure 5. **A measure of the slope of the yield curve**

Difference between short and long-term interest rates, average across country groups, percentage points



Note: Short-term interest rates are the rate on 3-month Treasury bills (or similar) and long-term rates the interest rate on 10-year government bonds.

Source: OECD Economic Outlook, June 2011, and OECD calculations. See Annex A1 for further details.

3.5. A fiscal risk premium related to government indebtedness

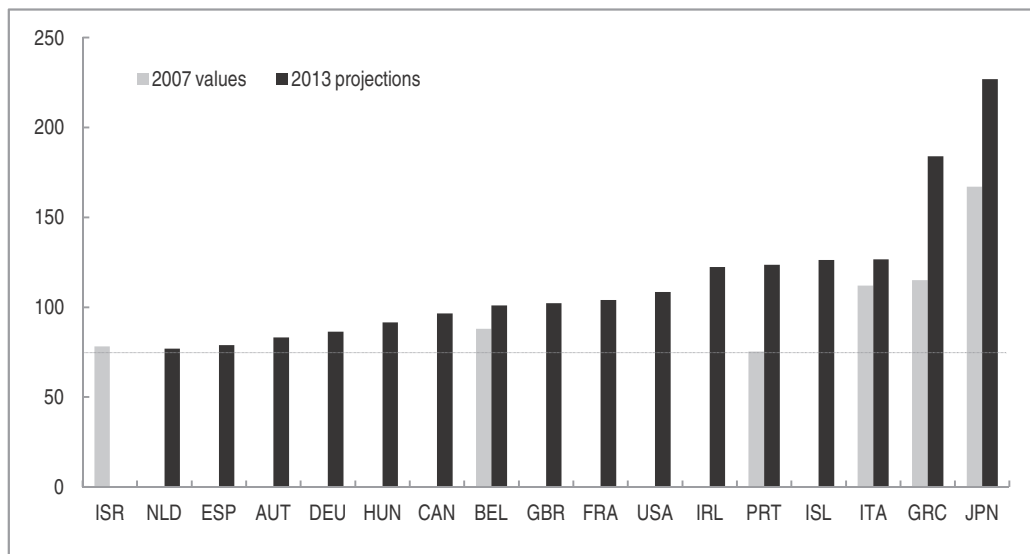
There is a large and controversial empirical literature that examines the impact of public deficits and debt on long-term government bond yields.⁷ Drawing on this literature, an assumption which has been adopted for the purpose of recent long-term OECD projections is that when gross government indebtedness passes a threshold of 75% of GDP then long-term interest rates increase by 4 basis points for every additional percentage point increase in the government debt-to-GDP ratio—an assumption consistent with the findings of Égert (2010) and Laubach (2009).⁸ Although such thresholds are inevitably somewhat arbitrary, it is clear that the number of countries with debt-to-GDP ratios above this ratio has risen substantially in the aftermath of the recent crisis (Figure 6).

Nevertheless, it is clear from the recent experience of euro area countries that concerns about government indebtedness vary not only with the magnitude of indebtedness, but with the general perception of risk in financial markets (see for example Haugh *et al.*, 2009), so that identifying such effects in time series analysis over long estimation periods is inherently difficult.

3.6. European Monetary Union

The European Monetary Union (EMU) led to a narrowing of spreads among member countries (Figure 7) probably because indebted countries did not have the option to tackle fiscal problems through a lax monetary policy, higher inflation and currency depreciation,

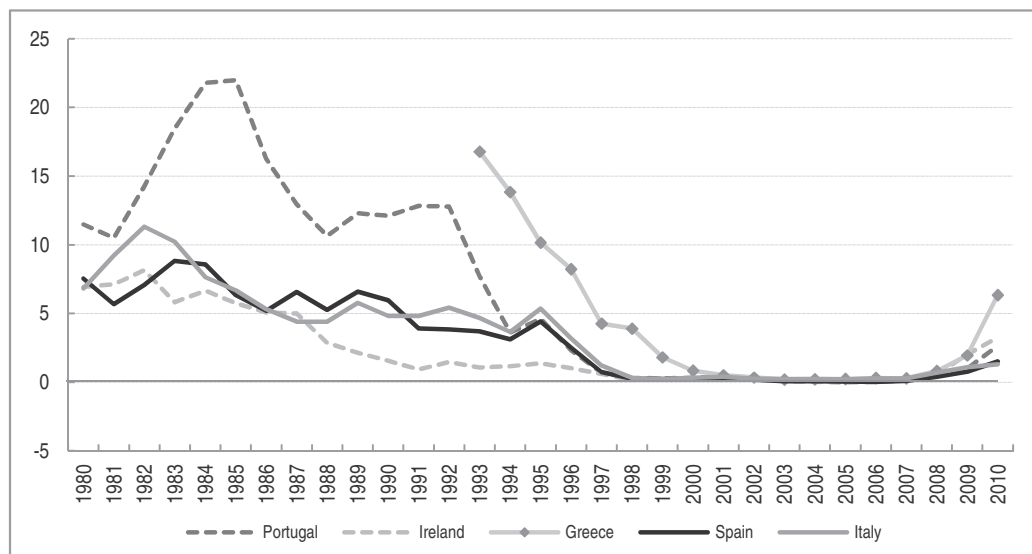
Figure 6. **OECD countries for which gross government debt exceeds 75% of GDP**
Percentage of GDP



Note: Although reported in the chart, Hungary (HUN) and Israel (ISR) have not been included in the empirical analysis.
Source: OECD Economic Outlook, November 2011, and OECD calculations.

Figure 7. **Interest rate spreads on 10-year government bonds for selected EMU countries**

Difference in rate compared with German bonds, percentage points



Source: OECD Economic Outlook, June 2011, and OECD calculations.

and default was thought unlikely. Although the euro did not come into creation until 1999 (with notes and coins only introduced in January 2002) it is clear that the anticipation of EMU was having an effect on spreads in the late 1990s. For the purposes of the empirical work the possible effect of EMU on the interest-rate-growth differential of member countries is considered from 1998 onwards through the inclusion of a time dummy variable.⁹ In the wake of the 2008-09 financial crisis as fiscal positions in many countries have dramatically worsened, spreads have widened with growing concerns about the

adequacy of institutional arrangements for a lender-of-last resort to heavily indebted member countries which come under extreme pressure from financial markets. For this reason the EMU time dummy is not extended beyond 2008.

4. Empirical analysis

In order to assess the relative importance of the various explanations discussed in the previous section, annual panel regressions explaining the interest-rate-growth differential (as defined in Section 2 above) are run for selected OECD countries for which a long time span of data is available, mostly covering the period 1980-2010.¹⁰ A potential problem in estimation is that the inclusion of a lagged dependent variable may lead to biased estimates (Nickell, 1981), although because the time dimension here is relatively large (exceeding 30), the extent of the bias is likely to be small (see for example, Baltagi and Griffin, 1997). Nevertheless, in order to correct for any possible bias, the bias corrected least squares dummy variable estimator for dynamic unbalanced panel data models proposed by Bruno (2005) has been applied.¹¹

The simplest panel regression, equation (1) in Table 2, explains the interest-rate-growth differential in terms of its own lag, a 5-year standard deviation of inflation measured according to the GDP deflator and the lagged difference between a 3-month interest rate (a Treasury bill rate or similar) and the 10-year government bond rate (see Table 3 for summary statistics).¹² The estimated coefficients are all statistically significant

Table 2. **Panel regression results explaining the interest-rate-growth differential for selected OECD countries**

Sample 1980-2010, Dependent variable (irl_g), bias-corrected LSDV estimates¹

	(1)	(2)	(3)	(4)	(5)	(6)
(irl - g) ₋₁	0.6898***	0.6440***	0.6695***	0.6720***	0.6026***	0.5790***
SD ₅ (Π)	0.3683***	0.3178***	0.2848***	0.2751**	0.2582**	0.3731***
(irs - irl) ₋₁	0.1740***	0.1480***	0.2127***	0.2113***	0.2009***	0.1837***
Global savings glut	–	–0.5602***	–0.5113**	–0.5423***	–0.7007***	–0.8906***
Debt > 75	–	–	0.0134*	0.0082	0.0137*	0.0180***
Dum2009 – 10 * Debt > 75	–	–	–	0.0175*	–	–
(irl ^{DEU} – g) ₋₁	–	–	–	–	0.4333***	0.4382***
Number of observations	641	641	592	592	592	592
Average number of time periods	28	28	26	26	26	26
Number of countries	23	23	23	23	23	23

***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

1. Bias correction initialised by the Anderson and Hsiao estimator, with a level of accuracy up to $O(N^{-2}T^{-2})$. The standard errors of the coefficients have been obtained with a bootstrap analysis, using 100 iterations.

Notes: Key to variables: (irl - g) = the interest growth differential, see also Table 1 and Section 2; SD₅(Π) = 5-year standard deviation of inflation, where the latter is measured by the change in the GDP deflator; (irs-irl) = the slope of the yield curve measured as the difference between short- and long-term interest rates, see also Section 3.4 and Figure 5; “Global savings glut” = Combined current account surpluses of Asian emerging economies and oil exporting countries, see also Section 3.3 and Figure 4; Debt > 75 = zero if gross government debt as a share of GDP is less than 75%, otherwise is equal to the excess of this share above 75%; Dum200910 = a dummy variable taking the value unity in the post-crisis years of 2009 and 2010 and zero elsewhere; (irl^{DEU} – g) is the difference between German long-term interest rates and own-country growth. For further details of all variables used see Annex A1.

For equation (6), the explanatory variables SD₅(Π), “Global savings glut” and Debt > 75 are all multiplied by a dummy variable defined as (1-EMU), where EMU takes the value of unity for all non-German EMU countries over the period 1998-2008. Essentially, the role of this variable is to exclude the effect of the variables SD₅(Π), “Global savings glut” and Debt > 75 on non-German EMU countries over the period 1998-2008.

Source: OECD calculations based on OECD Economic Outlook, June 2011, IMF World Economic Outlook Database, September 2011 data.

Table 3. **Summary statistics of the explanatory variables used in the regressions**

	1980-95	1996-99	2000-08	2010
STANDARD DEVIATION OF INFLATION ¹				
G7 countries				
Upper quartile	1.99	0.90	0.75	0.99
Median	1.45	0.65	0.60	0.85
Lower quartile	1.07	0.45	0.44	0.66
Selected OECD countries²				
Upper quartile	2.57	1.39	1.31	1.53
Median	1.66	0.94	0.71	1.12
Lower quartile	1.18	0.59	0.48	0.81
Selected EMU countries³				
Upper quartile	2.26	1.70	0.97	1.13
Median	1.51	1.18	0.63	1.01
Lower quartile	1.14	0.80	0.47	0.68
SLOPE OF THE YIELD CURVE ⁴				
G7 countries				
Upper quartile	0.32	-0.53	-0.52	-2.12
Median	-0.51	-1.47	-1.00	-2.42
Lower quartile	-1.16	-1.85	-1.24	-2.80
Selected OECD countries²				
Upper quartile	0.58	-0.53	-0.61	-2.02
Median	-0.32	-1.47	-0.98	-2.39
Lower quartile	-1.11	-1.97	-1.14	-2.80
Selected EMU countries³				
Upper quartile	0.21	-0.93	-0.96	-2.25
Median	-0.64	-1.82	-1.00	-2.53
Lower quartile	-1.27	-2.03	-1.07	-4.01
GLOBAL SAVINGS GLUT ⁵				
Mean	-0.06	0.07	0.68	0.79

1. Five-year standard deviation of inflation based on the change in the GDP deflator.

2. Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.

3. Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain.

4. Difference between a 3-month short-term interest rate (usually the Treasury bill rate or similar) and the interest rate on 10-year government bonds.

5. The current account surpluses of emerging Asian economies and major oil exporters expressed as a percentage of world GDP.

Source: OECD Economic Outlook, June 2011, IMF World Economic Outlook Database, September 2011, and OECD calculations. See Annex A1 for further details.

and with the expected signs. They imply that a fall in the standard deviation of inflation by 1 percentage point, which is about the typical reduction observed between the periods 1980-95 and 2000-08, will eventually lead to a decline in the interest-rate-growth differential of just over a percentage point (Table 4).

A difference between short and long-term interest rates of 1 percentage point will depress the interest-rate-growth differential by 0.6 percentage points. This implies that on average the unusually low policy rates in the pre-crisis 2000s may have reduced the interest-rate-growth differential by just under $\frac{1}{2}$ percentage point relative to the period 1980-95. Given the further steepening of the yield curve since the advent of the crisis, it

Table 4. The implied long-run effect of explanatory variables

Long-run effect of a unit change in the explanatory variable on the interest-rate-growth differential calculated on bias corrected LSDV estimates, percentage points

	(1)	(2)	(3)	(4)	(5)	(6)
$SD_5(II)$	1.19	0.89	0.86	0.84	0.65	0.89
$(irs - irl)_{-1}$	0.56	0.42	0.64	0.64	0.51	0.44
Global savings glut	–	–1.57	–1.55	–1.65	–1.76	–2.12
Debt > 75	–	–	0.04	0.03	0.03	0.04
Dum 2009 – 10 * Debt > 75	–	–	–	0.05	–	–
$(ir^{DEU} - g)_{-1}$	–	–	–	–	1.09	1.04

Source: OECD calculations based on the results reported in Table 2.

also implies that a normalisation of the yield curve from conditions prevailing in 2010 might be expected to increase the interest-rate-growth differential by around 1 percentage point.¹³

A proxy measure of the global saving glut is taken to be the sum of current account surpluses in Asian emerging markets and non-OECD oil exporters (see Section 3.3 and Annex A1). When this variable is added, equation (2) in Table 2, the coefficients on the existing explanatory variables remain statistically significant, but the size of the effect from the inflation variability variable falls [comparing equations (1) and (2) in both Table 2 and Table 4]. The new variable has the expected sign and is statistically significant, and implies that the emergence of the global savings glut in the 2000s reduced the interest-rate-growth differential by about 1¼ percentage points across all OECD countries. The global savings glut hypothesis, as originally formulated by Bernanke (2005), particularly focused on the effect on US interest rates, however variant equations (not reported here) did not find a statistically significantly larger effect on the United States compared with other OECD countries. As previously mentioned in Section 3.3, the global savings glut variable is inevitably a crude proxy measure because it is not really possible to measure an *ex ante* global savings-investment imbalance. An alternative explanation of the significance of this variable is that it is picking up some other effect which differentiated the 2000s from earlier decades, for example it might be picking up a general under-pricing of risk in financial markets.

Rather than conduct an exhaustive search (or fishing expedition) of different ways in which government indebtedness might impact on the differential, it was decided to include it in a form which would most easily allow the effect of debt on interest rates assumed in recent OECD *Economic Outlook* to be tested. Thus, the extent to which general government debt-to-GDP ratio exceeds 75% was included as an explanatory variable (for those countries/periods in which the debt ratio was less than 75% the variable takes the value of zero), see equation (3) in Table 2. This debt variable is statistically significant and implies a marginal effect such that each percentage point in debt in excess of 75% eventually raises the interest-rate-growth differential by 4 basis points, which coincidentally is what is assumed in recent *Economic Outlook* exercises. However, the fragility of this result is underlined by the inclusion of an additional variable, measured as the product of the same debt variable and a post-crisis dummy variable, see equation (4) in Table 2, which implies that the pre-crisis effect of debt is much weaker and statistically insignificant and the post-crisis debt effect much larger; thus pre-crisis, a percentage point increase in the debt ratio above the 75% threshold implied an increase in the differential of 3 basis points, whereas post-crisis it implies an increase of 8 basis points. Further

regressions, not reported here, suggest that the increased effect from indebtedness in the post-crisis period is mostly accounted for by the euro area countries. This result is consistent with the finding that interest rate spreads may be more sensitive to perceived imbalances within a currency union because of the inability of individual member countries to freely issue currency to finance increased indebtedness (de Grauwe, 2011).

A final pair of regressions explore the effect that European Monetary Union had on the interest-rate-growth differential (Table 2, equations 5 and 6). Given the evidence that EMU led to a striking convergence of long-term interest rates (Figure 7), a lagged variable in the differential between German long-term interest rates and own-country growth for all EMU countries in the sample over the period 1998 to 2008 was included. The long-run coefficient on this new variable is close to unity, implying that German long rates were a powerful attractor for long-term interest rates in other EMU countries over the period 1998-2008. The fit of this equation is included by excluding the influence of the inflation variability, global savings glut and debt variables for non-German EMU countries over the period 1998-2008. Arguably the influence of lower inflation variability and the global savings glut variable is already included in German long-term interest rates and so if this is an attractor for other EMU long-term rates there is no need to include the effect separately. The improved significance of the debt variable, when EMU countries are excluded for the period 1998-2008, further suggests that the effect of government indebtedness on fiscal risk premia was suspended for these countries over the period 1998-2008, an effect which is more difficult to rationalise.

Also of interest is that the long-run effect of most of the explanatory variables for non-EMU countries is little affected by these EMU variant equations (Table 4), with the possible exception of the effect of the global savings glut variable which has a slightly larger and more statistically significant effect.

Notes

1. The focus of this paper is on explaining the interest-rate-growth differential of some OECD economies since 1980. The corresponding differential for developing countries is typically much lower, and usually negative, which mainly appears to be the consequence of financial repression (Escolano et al., 2011 and IMF, 2011a). The experience of OECD countries prior to 1980 is excluded from the empirical analysis because the widespread use of financial repression measures (Reinhart and Sbrancia, 2011) coupled with the large inflation shades of the 1970s suggests that the experience of interest rates prior to 1980 will not be informative of the experience since then.
2. An illustration of the lack of any analytical foundation for projecting the differential is that, for the purpose of making medium-term fiscal projections to 2030 for the “Advanced Economies”, the IMF assume in their regular *Fiscal Monitor* publication that “up to 2015, an interest-rate-growth differential of 0 percentage points ..., broadly in line with WEO assumptions, and 1 percentage point afterwards, regardless of country-specific circumstances” (IMF, 2011b), yet there is little or no justification or discussion of the basis for this assumption despite its importance.
3. This ignores stock-flow adjustments which have been particularly important over the crisis period, see IMF, 2011b.
4. The baseline projection is consistent with a rise in the interest-rate-growth differential to just under 2 percentage points by 2026. The lower debt path would be consistent with an interest-rate-growth differential of around zero percentage points which is similar to that experienced by the United States over the last decade, whereas the high debt path would be consistent with a differential rising to about 4 percentage points.
5. The sharp drop in forward rates in the United Kingdom on the day the Bank of England was granted operational independence, is also cited as further evidence of this effect (Wright, 2011).

6. The slope of the yield curve is also a well-known predictor of GDP growth, however this effect is not captured in the regressions estimated here because GDP growth in the interest-rate-growth differential is de-trended.
7. See Box 4.5 in OECD (2010) for a selective survey.
8. Égert (2010) finds that the difference between short-term and long-term interest rates appear to be a non-linear function of public debt for the G7 countries (excluding Japan) in recent years. The estimation results indicate a 4 basis point increase in long-term rates relative to short-term rates for each percentage point of GDP in public debt above 76%. Laubach (2009) focuses on the United States and finds that long-term yields increase about 25 basis points per percentage point increase in the projected deficit-to-GDP ratio, and 3 to 4 basis points per percentage point increase in the debt-to-GDP ratio.
9. In May 1998, the 11 countries that would initially participate in EMU were selected and, in June 1998, the ECB was created.
10. The panel is unbalanced, because there are some countries for which data are not complete over the full sample period. The results for individual country regressions are not presented as in many cases estimated coefficients were statistically insignificant. Further details are given in Annex A1.
11. Indeed, a simple least squares estimation with country fixed effects (with no correction for the presence of a lagged dependent variable) gives similar results, as reported in Annex A2, to those reported in the main body of the paper based on the estimator proposed by Bruno (2005).
12. The results are robust to using different measures of inflation, such as ones based on the Consumer Price Index or Private Consumption Expenditure Deflator. For further details on the variables used in the estimation see Annex A1.
13. This calculation assumes that in the absence of cyclical influences, long-term interest rates would be expected to exceed short-term rates by about $\frac{1}{2}$ percentage point because of a term premium.

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ANNEX A1

Data description

The data used in this article cover selected OECD member countries over the period 1980-2010. These countries were selected to maximise the time span of the panel dataset so that the maximum number of observations per variable would be 713. However, due to the gaps in the data for some countries, particularly Greece and Iceland, the effective number of observations used in each regression is slightly lower. The exact country coverage of the variables is presented in Table A1.1.

Table A1.1. **Details on data availability**

Variable	Start date	End date	Exceptions to the starting date
Interest rate – growth differential $(ir - g)_t$ dependent variable	1980	2010	Portugal and New Zealand (1981), Switzerland (1982), Korea (1983), Greece (1994), Iceland (1992)
Short-term interest rate minus Long-term interest rate $(irs - ir)_t$	1980	2010	Denmark (1981), Sweden (1983), Ireland (1985), Greece (1994), Iceland (1993), Korea (1992)
Standard deviation of inflation $SD_5(\pi)_t$	1980	2010	Greece (1997)
Global savings glut	1980	2010	
Debt 75	1980	2010	Australia (1988), New Zealand (1993), Greece and Portugal (1995), Ireland, Iceland (1998)
German long-term interest rates – own-country growth differential $(ir_{DEU} - g)_t$ for non-German Euro area countries	1980	2010	Portugal (1981) and Greece (1994)

Most of the data used in this article are taken from the recently published OECD *Economic Outlook Database* No. 89, released in June 2011. Data used to construct the measure of the “global savings glut” are extracted from the IMF *World Economic Outlook* (WEO) database, released in September 2011.

Although various information on the variables used in the empirical analysis are provided in different sections of the main text, some extra details on the definition and construction of these variables are given below.

The simple model, corresponding to equation (1) in Table 2, includes the following variables:

- The *interest-rate-growth differential as dependent variable* defined as the difference between the levels of the interest rate on 10-year government bonds and nominal potential GDP growth.* In the case of Norway, potential GDP estimates refer to the mainland economy,

* Potential growth is estimated using a production function approach as described in Beffy *et al.*, 2006.

while in the case of Germany, a long time series for potential growth is explicitly constructed by splicing the growth rates of nominal potential GDP from 1991 on those of West Germany.

- *Inflation volatility* is measured as a five-year standard deviation of inflation, where the latter refers to the change in the GDP deflator.
- The *slope of the yield curve* is calculated as the difference between short-term interest rates (generally three-month Treasury bill rate) and long-term interest rates on 10-year Treasury bonds.

This model is subsequently extended with the inclusion of one or more of the following variables:

- A proxy measure of the *global savings glut* in equation (2) in Table 2, obtained by combining current account surpluses of Asian emerging economies and main oil exporting countries expressed as percentage of world GDP. Specifically, the two country groups selected from the WEO were “Developing Asia” and “Middle East and North Africa” (for more details on the groups composition see Table A1.2).

Table A1.2. List of countries composing the different aggregates considered in the empirical analysis

Country aggregate	Component countries
Selected OECD countries	Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.
G7	Canada, France, Germany, Italy, Japan, United Kingdom, United States.
Selected EMU countries	Austria, Belgium, Finland, France, Greece, Ireland, Italy, The Netherlands, Portugal, Spain.
Developing Asia	Afghanistan, Bangladesh, Bhutan, Brunei, Cambodia, China, Fiji, India, Indonesia, Kiribati, Lao People's Democratic Republic, Malaysia, Maldives, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Samoa, Solomon Islands, Sri Lanka, Thailand, Democratic Republic of Timor-Leste, Tonga, Tuvalu, Vanuatu, Vietnam.
Middle East and North Africa	Algeria, Bahrain, Djibouti, Egypt, Islamic Republic of Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Qatar, Saudi Arabia, Sudan, Syrian Arab Republic, Tunisia, United Arab Emirates, Republic of Yemen.

- A variable measuring high government indebtedness is included in equation (3) of Table 2, and constructed for each country as the excess of the general government *debt-to-GDP* ratio when this share is above the threshold of 75% of GDP, and zero otherwise.
- A dummy variable taking value unity in the post-crisis years of 2009 and 2010 and zero elsewhere is used in equation (4) of Table 2 to construct the interaction term that allows for the testing of a differential effect from debt in the post-crisis years.
- A lagged variable measuring the differential between German long-term interest rates and other own-country growth in other EMU countries over the period 1998-2008 is considered in equation (5), Table 2.
- Finally, a dummy variable taking value unity for Euro area countries-with the exception of Germany-from 1998 to 2008 included and zero elsewhere, is used to exclude the influence of inflation volatility, global savings glut and debt variable for non-Germany EMU countries over that specific period from equation (6) in Table 2.

ANNEX A2

Least squares panel estimation results

Table A2.1 below reports the results of a least squares dynamic panel regression estimated with country fixed effects (with no correction for the presence of a lagged dependent variable) and Table A2.2 reports the long-run effects of the explanatory variables derived from those estimates. These tables can be compared with Tables 2 and 4, respectively, in the main text, although the differences are generally quite small.

Table A2.1. Panel regression results explaining the interest-rate-growth differential for selected OECD countries

Sample 1980-2010, Dependent variable (irl – g), uncorrected LSDV estimates

	(1)	(2)	(3)	(4)	(5)	(6)
(irl – g) ₋₁	0.6755***	0.6270***	0.6497***	0.6513***	0.5880***	0.5698
SD ₅ (II)	0.3602***	0.3082***	0.2641***	0.2561**	0.2343***	0.3482
(irs – irl) ₋₁	0.1906***	0.1641***	0.2330***	0.2315***	0.2209***	0.2069
Global savings glut	–	–0.6184***	–0.5829***	–0.6084***	–0.7675***	–0.9272
Debt > 75	–	–	0.0126**	0.0063	0.0126**	0.0179
Dum2009 – 10 * Debt > 75	–	–	–	0.0184**	–	–
(irl ^{DEU} – g) ₋₁	–	–	–	–	0.3952***	0.4041
R-Squared within	0.53	0.54	0.54	0.55	0.56	0.57
S.E. of regression	1.77	1.76	1.65	1.65	1.63	1.61
Total panel observations	654	654	604	604	604	604
Country fixed effects	yes	yes	yes	yes	yes	yes

Source: OECD calculations based on OECD Economic Outlook, June 2011, IMF World Economic Outlook Database, September 2011 data.

Table A2.2. The implied long-run effect of explanatory variables

Long-run effect of a unit change in the explanatory variable on the interest-rate-growth differential based on uncorrected LSDV estimates, percentage points

	(1)	(2)	(3)	(4)	(5)	(6)
SD ₅ (II)	1.11	0.83	0.75	0.73	0.57	0.81
(irs – irl) ₋₁	0.59	0.44	0.67	0.66	0.54	0.48
Global savings glut	–	–1.66	–1.66	–1.75	–1.86	–2.16
Debt > 75	–	–	0.04	0.02	0.03	0.04
Dum 2009 – 10 * Debt > 75	–	–	–	0.05	–	–
(irl ^{DEU} – g) ₋₁	–	–	–	–	0.96	0.94

Source: OECD calculations based on the results reported in Table A2.1.

Fiscal consolidation: What factors determine the success of consolidation efforts?

by
Margit Molnar*

The global economic and financial crisis exacerbated the need for fiscal consolidation in many OECD countries. Drawing lessons from past episodes of fiscal consolidation, this study investigates the economic environments, political settings and policy measures conducive to fiscal consolidation and debt stabilisation using probit, duration, truncated regression and bivariate Heckman selection methods. The empirical analysis builds on the earlier literature and extends it to include new aspects that may be of importance for consolidating governments. The empirical analysis confirms previous findings that the presence of fiscal rules – expenditure or budget balance rules – is associated with a greater probability of stabilising debt. Crucial in determining the causal link behind the association, the results also reveal an independent role for such rules over and above the impact of preferences for fiscal prudence. Also, while the analysis confirms that spending-driven adjustments vis-à-vis revenue-driven ones are more likely to stabilise debt, it also reveals that large consolidations need multiple instruments for consolidation to succeed. Sub-national governments, in particular state-level governments can contribute to the success of central government consolidation, if they co-operate. To ensure that state-level governments do co-operate, having the right regulatory framework with the extension of fiscal rules to sub-central government levels is important.

JEL classification: E62; H2; H5; H6; H7

Keywords: Fiscal consolidation; taxation; government spending; fiscal rules; fiscal federalism

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In the aftermath of the economic and financial crisis many OECD countries face substantial fiscal consolidation needs. In this context, taking stock of past consolidation episodes can provide insights into what policy and institutional measures were most conducive to successful consolidations. A *consolidation episode* is a period of fiscal adjustment, whose start and end are defined by thresholds in terms of the size of the change in the underlying cyclically-adjusted primary balance. The period between the start and the end is the *length* of the episode expressed in years and the cumulated improvement in the underlying cyclically-adjusted primary balance during the consolidation episode is the *size* of the consolidation, expressed as a share of potential GDP. The *intensity*, in turn, is the average improvement in the underlying cyclically-adjusted primary balance (as a ratio of potential GDP) in a unit time period, which is a year. The intensity of a consolidation episode is obtained by dividing its size by its length. The success of consolidation is defined here as debt stabilisation one, two and three years after the end of the consolidation episode.

The analysis of past consolidation episodes between 1960-2009 builds on and extends earlier OECD work by Ahrend et al. (2006) and Guichard et al. (2007). It uses probit, duration, truncated regression and bivariate Heckman selection methods to investigate consolidations, highlighting the different ingredients that affect how much consolidation is undertaken and whether it is successful in terms of stabilising debt. The estimations consider five aspects of fiscal consolidations:

- What conditions make governments start fiscal adjustments?
- What determines how long adjustments last?
- What determines the size of adjustments?
- What determines the intensity (the annual average consolidation over the consolidation episode) of the adjustment?
- What makes fiscal retrenchments successful in the sense of stabilising the debt/GDP ratio?

The study, while building on earlier literature, attempts to obtain robust results using a wide sample of definitions and measures of consolidation and its success. Also, it explores most aspects of consolidations seen in the literature and investigates the impact of a large set of conditions including domestic and external economic and political settings, monetary and exchange rate environments and fiscal institutions. The main findings, summarised in Table 1, are the following:

- Fiscal rules are, in general, associated with fiscal consolidation episodes that are successful in stabilising debt, though there is no evidence that they influence the size or the intensity of consolidation. Budget balance rules appear to lengthen the duration of consolidations.
- The composition of consolidation measures seems to be related to its success. Expenditure based consolidations appear to be more effective in stabilising debt. However,

the specific consolidation measures that lead to success seem to differ by the type of consolidation (i.e. small or large, gradual or “cold turkey”) and by the horizon of debt stabilisation (i.e. debt stabilises one, two or three years after the consolidation episode ends). Very large consolidations tend to be achieved by multiple instruments, including both revenue and spending items.

- Strong growth appears to matter for stabilising debt, though less for the size or intensity of consolidations. Low growth rates may lead to protracted consolidation episodes.
- Declining interest rates seem to increase the probability of success and the duration of consolidation, though have no robust impact on the start, size or intensity of the consolidation.
- The political setting also appears to matter for the success of consolidation: non-centrist governments are less likely to stabilise debt than those closer to the centre. The orientation of government does not seem to affect the duration of consolidation. In some specifications, strong governments further from the centre tend to engage in smaller and less intensive consolidation.
- Newly-elected governments seem to be more likely to start a fiscal adjustment programme and have a positive effect on duration.
- Consolidations by state-level governments tend to increase the probability of success of central government retrenchment efforts, but this is not the case for consolidations at the local government level (not reported in Table 1).

The rest of this study is structured as follows: Section 1 summarises the main findings from the empirical literature. This is followed by a short discussion of the methods used, the main definitions of consolidation episodes and data used in the analyses (Section 2). Section 3 presents detailed results for the econometric analysis of different aspects of consolidation and, finally, Section 4 concludes by discussing the implications of the findings for fiscal consolidation.

1. A review of the literature

The literature on fiscal consolidation episodes has identified major determinants of the likelihood of starting fiscal consolidation and its success, as well as several other attributes. The major questions of interest addressed by the fiscal consolidation episode literature are i) in which circumstances are fiscal adjustments likely to start and ii) in which circumstances are they successful. For the start of consolidations, initial conditions including the macroeconomic environment and political economy settings appear to be decisive. For the likelihood of success, a broader set of conditions have been tested. Not surprisingly, given that the channels through which policy effects come through may differ across episodes, the literature is inconclusive on some of the policies. A large part of the literature focuses on the composition of consolidation, primarily whether it should be based on expenditure cuts or revenue increases. While there seems to be consensus on the larger role for expenditure cuts, the results are less homogenous at the more disaggregated level. Tackling politically-sensitive budgetary items, however, seems to be a crucial ingredient of successful consolidations. Fewer studies deal with the role of the policy mix or structural and institutional conditions in determining the success of consolidation. Moreover, the applicability of past consolidation experiences may be limited as policymakers now face additional challenges such as repairing banking sectors and coping with weak global demand. The present consolidation may also be distinct owing to its

Table 1. **Summary of the empirical results**

Policy variables	Start	Duration	Size	Intensity	Success
Fiscal rules					
Expenditure rule					+++
Budget balance rule					+++
Expenditure and balanced budget rule					+++
Strength of fiscal rules (for the EU)					+++
Composition of consolidation					
Spending cut versus revenue increase share					+++
Housing and community amenities spending cut share			+++++		...
Social protection spending cut share			+.+.+		
Economic environment variables					
GDP growth			+....	+....	+++
Exchange rate (lagged change)		-----	-	...-.	+..
Interest rate (lagged change)			+	+	---
Interest rate differential (lagged change)	+				
Implicit interest on government debt (lagged change)		-----			
Inflation (lagged)	-	-----	.+.+	++.++	---
Length of consolidation			+++++		
OECD30 budget balance/GDP (lagged change)	+++++				
Initial debt ratio		...-	+	+	
Initial underlying primary budget balance	-----	-----	-	...-	
Change in the debt ratio (lagged)				+	
ERM			.+.+	...+	
EU 1992-1998			-	+...-	
EU 1999-2009					
Political setting variables					
Elections (lagged)	.+++.	+++++	.-...		
Strong left-leaning government	-...-		...-.	...-	---
Strong right-leaning government	-		...-	...-	..-

Notes: The direction of significant effects is indicated by plus and minus signs, a non-significant effect by a dot.

In the columns for the start, duration, size and intensity of consolidation, the results for five thresholds are indicated in the following order: i) very small: continuous improvement in the budget balance (i.e. the episode lasts as long as the budget balance improves), ii) medium-sized: 1 percentage point fall in the budget balance/GDP ratio in a single year or in two years, with at a minimum a 0.5 percentage point fall in the first year, iii) large 1: 1.5 percentage points fall in the budget balance/GDP ratio in a single year or in two years with at a minimum a 1.25 percentage points in each, iv) large 2: 1.5 percentage points fall in the budget balance/GDP ratio in a single year or in three years with less than a 0.5 percentage point deterioration in any year and v) very large: 2 percentage points fall in the budget balance in a single year or in two years with a minimum of 1.5 percentage points in each.

In the column for success, the signs are indicated for three different definitions of success in the following order: i) debt stabilises one year; ii) two years; and iii) three years after the consolidation episode ends. The fiscal rule variables in the success equations are entered sequentially.

The methods used are: probit for the start and survival analysis for the duration of the consolidation, truncated regression for the analysis of the size and intensity of the consolidation and the bivariate Heckman selection model for the success of a consolidation in stabilising debt.

required size and how widespread consolidation needs are. These features may imply the need for a broader set of policy tools to achieve consolidation.

Fiscal consolidation is more likely to be launched when fiscal conditions are weak and the domestic economy is doing well relative to other economies (Table 2). Weak public finance conditions are found to be an important trigger of consolidation (Barrios *et al.*, 2010; Guichard *et al.*, 2007; European Commission, 2007; Von Hagen and Strauch, 2001). In contrast to the intuition that fiscal actions only take place when the authorities are forced by circumstances to embark on a consolidation path, von Hagen and Strauch (2001) and the European Commission (2007) found that positive output gaps increase the probability of

Table 2. **A literature review of what determines the start of fiscal consolidation**

Dependent variable: Start of a consolidation episode (binary)	Guichard et al. (2007)	EC (2007)	von Hagen and Strauch (2001)	Ahrend et al. (2006)	Barrios et al. (2010) probit	Barrios et al. (2010) Heckman 2-step
Initial budget balance (CAPB)	–	–				
Debt-to-GDP ratio			+		+	–
Increasing debt ratio		+				
Need for adjustment (difference between current CAB& the one needed to bring the debt ratio to zero over 30 years)				+		
Output gap		+	+	0		
Weak international environment			–			
Tight monetary conditions in the previous year (index)			–			
Increase in OECD structural government balance			+			
Fiscal rules		0				
Effective budgetary procedures		+				
Exchange rate depreciation				+		
Elections	+	0				
Size of majority in parliament		0				
Long-term interest rates (domestic-foreign reference)	+					
Pension reform (Rodolfo de Benedetti Foundation), dummy		0				
Employment protection legislation dummy		0				
Unemployment benefits dummy		+				
Labour market reform dummy		+				
Product market reform dummy		0				
Number of countries	24	27	20 (OECD)	24	35	35
Time period	1978-2005	1970-2006	1960-1998	1980-2005	1970-2008	1970-2009
Number of episodes	85	146	65	83	235	235
Method used	Probit	Probit	Probit	Probit	Probit	Heckman 2-step

Note: The negative and positive signs mean negative and positive effect, respectively, while a zero means no significant effect was found.

launching a retrenchment.¹ Von Hagen and Strauch (2001) also found a negative impact for the international environment, which, combined with the positive coefficient on domestic cyclical conditions, implies that governments are more likely to undertake consolidation efforts when the domestic economy is doing well relative to other economies. Von Hagen and Strauch (2001) also found evidence of peer pressure: an increase in the OECD structural government balance has a strong positive effect on the likelihood to start a consolidation

The duration of fiscal consolidations is affected by the composition of the adjustment, initial conditions and consolidation fatigue. Von Hagen et al. (2002) found that when output was below potential but improving, a tightening fiscal stance in other countries and an increasing contribution by spending, in particular transfers and wage expenditures, to the total consolidation increase the likelihood that the consolidation episode will continue. Guichard et al. (2007) and Ahrend et al. (2006) confirmed the importance of a negative output gap to continuing an adjustment programme. On the other hand, Tsibouris et al. (2006) found no significant effect. Von Hagen et al. (2002) also found evidence of consolidation fatigue by showing that the longer an episode lasts, *ceteris paribus*, the greater the likelihood that the adjustment process will be reversed. This finding was confirmed by Guichard et al. (2007) and Ahrend et al. (2006).

In general, gradual consolidations tend to be more successful than a cold shower adjustment, but at high and sharply rising debt levels and in a low-growth environment a cold shower may be more effective (Barrios *et al.*, 2010; European Commission, 2007). A gradual retrenchment, however, is not successful in the case of consolidations following sharp debt increases. Moreover, Barrios *et al.* (2010) found that monetary and economic conditions may be playing a role in determining the consolidation strategy. Cold showers may be the right choice if initial debt levels and interest rates are high and GDP growth low, while the opposite conditions would suggest proceeding gradually.

Boltho and Glyn (2006) highlight the differences in consolidation efforts in the 1980s and 1990s: while in the 1980s, inflation and balance-of-payment problems constituted the greatest threat following the oil shocks, in the 1990s, long-term debt sustainability became the major concern. In addition, the run up to the EMU provided an impetus to consolidation efforts. Among the few studies looking at the impact of financial crises on the start or the probability of success of fiscal consolidations, Barrios *et al.* (2010) found that the fall-out from the crises may hinder the necessary retrenchment. Undertaking consolidation once the financial crisis is resolved and choosing a cold shower strategy increases the chance to succeed. This may be related to the use of public funds that the repair of the financial sector often necessitates and as long as the cost of bailouts is unclear, fiscal consolidation programmes may not be credible.

The impact of high debt levels on the probability of successful consolidation hinges upon model specifications. For example, Barrios *et al.* (2010) using two different approaches find either a positive or negative net impact of debt.

Monetary conditions including exchange rate and interest rate movements also have a bearing on fiscal consolidation, though the literature exploring this is scant and inconclusive. Exchange rate depreciation may support the consolidation process by leading to competitiveness gains and export-led growth. This channel is more likely to work for small open economies. The experience of OECD countries shows, however, that depreciation does not necessarily help consolidations succeed. Several studies find no significant impact (Alesina and Perotti, 1997, Guichard *et al.*, 2007 and Barrios *et al.*, 2010) or a significant albeit small positive impact (Lambertini and Tavares, 2005). Lambertini and Tavares (2005) observed that exchange rate depreciation, which boosted competitiveness, often preceded fiscal consolidation episodes in OECD countries over 1970-99. A fall in relative unit labour costs before and during successful consolidations boosted competitiveness (Alesina and Perotti, 1997). While nominal depreciation was observed in both successful and unsuccessful consolidation episodes, it was only in the case of successful ones where nominal depreciations had an impact on competitiveness. This may be related to the composition of fiscal adjustments, in particular the greater weight given to cuts in government wages and employment in successful consolidations, thereby inducing wage moderation. Ahrend *et al.* (2006) found that monetary policy easing at the initial stage of fiscal consolidation contributes to offset the contractionary impact of fiscal consolidation. Von Hagen and Strauch (2001) found that monetary easing may entice governments to start fiscal adjustments, but this does not necessarily lead to successful adjustments.

The composition of fiscal consolidation matters for the probability of success of consolidations: retrenchments based on expenditure cuts are found to be more effective (Alesina and Ardagna, 1998, 2009; von Hagen *et al.*, 2002; Guichard *et al.*, 2007; Barrios *et al.*,

2010). A possible explanation for the higher effectiveness of spending cuts versus tax increases is that the former are often coupled with reforms that enhance the effectiveness of budgetary procedures (European Commission, 2007). Von Hagen and Strauch (2001) examined the probability of a consolidation to be expenditure based and found that a small output gap, both domestically and internationally, a tight fiscal stance in other countries and a high debt-to-GDP ratio increase the probability of a consolidation episode to be expenditure based. Revenue-based consolidations can also be effective, if there is room to increase the revenue-to-GDP ratio, in particular if the revenue types that are less harmful for growth (such as user fees, environmental taxes, property taxes and value-added taxes) are under-exploited (Tsibouris *et al.*, 2006). Surprisingly, Alesina and Perotti (1995) found that the small share of successful adjustments due to increases in tax revenues comes almost exclusively from corporate income taxes and not indirect taxes.

Past empirical work typically finds that cutting current government spending is more conducive to successful consolidation (Alesina and Ardagna; 2009). Guichard *et al.* (2007) found that social spending and transfers are areas where spending cuts should be focused to achieve a successful consolidation. Alesina and Perotti (1995 and 1997) found that fiscal adjustments should focus on cuts in welfare spending and government wages, if they are to be successful. However, European Commission (2007) found, that in the 1990s, the positive impact of cutting primary expenditure on the likelihood of success became weaker. This could be due to past consolidations harvesting the “low hanging fruits”. Interestingly, if the analysis focuses on the European Union (27 members), spending on social protection, health and education continue to increase during consolidation periods, while the bulk of the cuts are done in economic affairs (which comprise subsidies, gross fixed capital formation, capital transfers and intermediate consumption) and housing and community amenities (European Commission, 2007).²

The literature is not conclusive on which types of fiscal rules and institutions affect consolidation programmes. Guichard *et al.* (2007) found a beneficial effect from a combination of expenditure and budget balance rules. The European Commission (2007), on the contrary, found no significant impact of expenditure rules in the European Union, though this study did not verify the combined effect with budget balance rules. However, effective budgetary procedures appear to increase the probability of success (European Commission, 2007). Barrios *et al.* (2010) did not find a significant impact of budget deficit rules on the likelihood of successful consolidation.

Successful consolidations may be accompanied by changes in the distribution of income. Alesina and Perotti (1997) and Alesina and Ardagna (1998) observed that during successful consolidations, the profit share often increases. Alesina and Ardagna (1998) showed that the profit share increases not only during but also in the aftermath of consolidations. Mulas-Granados (2005) found that fiscal consolidations are associated with higher income inequality, though less so for revenue-based adjustments than for expenditure-based ones.

Few studies find convincing evidence on how political factors affect consolidation. Alesina and Perotti (1995) found that coalition governments are mostly unsuccessful in attaining lasting adjustment. The same authors also found that left- and right-wing governments are equally likely to carry out successful adjustments, while centrist governments are less likely to do so. Guichard *et al.* (2007) showed that consolidations are more likely to start after elections in OECD member countries, while the European

Commission (2007) did not find a significant effect for the EU countries over a similar time period. Alesina and Perotti (1995) did not find a significant impact of the closeness of elections on either the likelihood of strong adjustments or their success.

2. Empirical approach, definitions and data

Most of the literature applies similar estimation techniques to identify the major determinants of success or failure and various attributes of fiscal consolidations. The main estimation tools include probit, duration models and OLS, and more rarely the Heckman probit two-step estimator. Estimates of the determinants of the start and success of consolidations may be biased if not controlling for the correlation between the decision to consolidate and the likelihood to achieve a successful consolidation (Barrios *et al.*, 2010). In contrast to this standard set (or some subsets of it) of estimation methods applied in the literature to investigate past consolidation episodes, there is considerable variation across the measures of fiscal consolidation, the definitions of the start of consolidation, the size of consolidation and of what constitutes a successful consolidation (Table 3).

Earlier studies such as Alesina and Perotti (1995, 1996) and Alesina and Ardagna (1998) defined a fiscal consolidation episode using the so-called Blanchard index, which calculates a cyclically-adjusted budget balance assuming an unchanged unemployment rate with respect to the previous year. In more recent studies the cyclically-adjusted primary balance is used (Tsibouris *et al.*, 2006). The major shortcoming of the cyclically-adjusted primary balance is that it can also reflect one-offs and accounting distortions (Koen and van den Noord, 2005), revenue fluctuations due to asset prices (Girouard and Price, 2004) and growth surprises (Larch and Salto, 2005). To address these issues, past analyses have typically only used large changes. There is, however, a trade-off in setting thresholds high as it can exclude longer periods of moderate adjustment. To overcome many of these issues, in the analyses below, the cyclically-adjusted underlying primary balance is used. This measure, in addition to correcting for fluctuations in business cycles, also takes into account one-offs. Different definitions of the budget balance were used in the analysis (such as the cyclically-adjusted underlying primary balance, the cyclically-adjusted primary balance, the unadjusted primary balance, adjusted fiscal balance and the unadjusted fiscal balance), though only results for the cyclically-adjusted underlying primary balance are reported in the paper. The results obtained when using the cyclically-adjusted primary balance were similar.

The definition of a consolidation episode is crucial as different thresholds and budget data may lead to different findings. Accordingly, to obtain robust results, five thresholds are used. These thresholds cover several types of consolidation episodes from very small ones defined as any improvement in the budget balance that may occur over a number of years to very large ones of at least 2 percentage points of GDP in a given year. The thresholds applied for consolidation episodes are: i) very small: continuous improvement in the budget balance (*i.e.* the episode lasts as long as the budget balance improves), ii) medium-sized: 1 percentage point fall in the budget balance/GDP ratio in a single year or in two years, with at a minimum a 0.5 percentage point in the first year, iii) large 1: 1.5 percentage point fall in the budget balance/GDP ratio in a single year or in two years with at a minimum a 1.25 percentage point in each, iv) large 2: 1.5 percentage point fall in the budget balance/GDP ratio in a single year or in three years with less than a 0.5 percentage point deterioration in any year and v) very large: 2 percentage point fall in the budget balance in a single year or in two years with a minimum of 1.5 percentage

Table 3. Definitions used to define features of fiscal consolidations

	Start of consolidation		Continuation	Stop	Success
	Definition 1	Definition 2			
Ahrend et al., 2006	At least 1 percentage point of potential GDP in one year	At least 1 percentage point of potential GDP in two years with at least 0.5 percentage point in the first year	Cyclically-adjusted primary balance improves (can decline 0.3 percentage point in a year if in the following year it increases by more than 0.5 percentage point)	Cyclically-adjusted primary balance stops increasing or improves by less than 0.2 percentage point of GDP in one year and then deteriorates	
Alesina and Perotti, 1995	Blanchard fiscal impulse is between – 1.5 and – 0.5% of GDP	Blanchard fiscal impulse is less than 1.5% of GDP			Three years after the debt/GDP ratio is 5 percentage points lower
Alesina and Ardagna, 2009	At least 1.5 percentage points of GDP in one year				Cumulative debt/GDP improvement is greater than 4.5 percentage points
Alesina and Perotti, 1997	At least 1.5 percentage points of GDP in one year	At least 1.5 percentage points of GDP in 2 years with each more than 1.25 percentage points			
Ardagna, 2009	At least 2 percentage points of potential GDP in one year	At least 2 percentage points of potential GDP in two years with each more than 1.5 percentage points			
Barrios et al., 2010	At least 1.5 percentage points of potential GDP in one year	At least 1.5 percentage points of potential GDP in three years, with no annual deterioration larger than 0.5 percentage point			
EC, 2007	At least a 1.5 percentage points of GDP in one year	At least 1.5 percentage points of potential GDP in three years, with no annual deterioration larger than 0.5 percentage point			Three years after the cyclically-adjusted primary balance does not deteriorate by more than 0.75% of GDP in cumulative terms
Guichard et al., 2007	At least 1 percentage point of potential GDP in one year	At least 1 percentage point of potential GDP in two years with each more than 0.5 percentage points	Cyclically-adjusted primary balance improves (can decline 0.3 percentage point in a year if the following year it increases by more than 0.5 percentage point)	Cyclically-adjusted primary balance stops increasing or improves by less than 0.2 percentage point of GDP in one year and then deteriorates	
Tsibouris et al., 2006	Uninterrupted improvement in the primary budget balance			Primary balance deteriorates or debt ratio increases	
von Hagen et al., 2002				Cyclically-adjusted primary balance deteriorates	
von Hagen and Strauch, 2001	Cyclically-adjusted balance at least 1.25 percentage points of potential GDP in 2 years	Cyclically-adjusted balance at least 1.5 percentage points of potential GDP and positive in the preceding and following year			Two years after the government balance is at least 75% of the balance in the first year

points in each. Different thresholds imply different numbers of consolidation episodes and different durations (Table 4).

In the following empirical work several definitions of consolidation have been used. The choice is not always innocuous. To highlight this, the main characteristics of past consolidations using two different approaches to defining the episodes (annual tightening of the underlying primary balance by at least 1.5% of GDP or a gradual but continual tightening of the underlying primary balance over several years) are:

- **Size:** The overall amount of tightening on average does not differ significantly between the two definitions, being around 3% of GDP in both cases. The largest consolidations for episodes based on the annual tightening are almost 9% of GDP whereas they approach 11% of GDP for episodes based on sustained tightening.
- **Pace:** In consolidations greater than 1.5% of GDP tightening of the underlying primary balance in a given year, the average tightening is 2.3% of GDP (reaching over 4% in Hungary in 2007 and Sweden in 1996). If the consolidation is defined as a sustained tightening of the underlying primary balance, the average pace of tightening is slower at just under 1% of GDP annually.
- **Length:** when the consolidation is defined as the underlying primary balance tightening of more than 1.5% of GDP in a single year, the consolidation typically lasts a single year, though around one-third of episodes maintain that pace into a second year. When the consolidation episode is defined as a sustained tightening, the average length is almost four years with the longest reaching 14 years (Greece between 1985 and 1999, when excluding the small reversal in 1995).
- **Composition:** The composition of changes in underlying spending and revenues suggests that revenues contributed more than spending on average to consolidations based on the tightening in a given year (almost 2% of GDP for revenue increases relative to almost 1% of GDP for spending). For sustained consolidations, the contribution is more balanced, with a slightly greater contribution from spending (–2% of GDP) than revenue (1.5% of GDP).
- **Outcome for debt:** For both definitions of consolidation, the level of debt on average changes by a modest amount during the consolidation (rising by around 2% of GDP). However, the ranges are substantial, varying from a reduction of GDP by 12% to an increase of GDP by over 24% for consolidations based on the tightening in a given year. For consolidations based on the sustained tightening definition the variation is even more pronounced, ranging from a reduction of GDP by 25% to an increase of GDP by 40%.

There is a wide variation in the definition of the success of fiscal consolidation, which can be related to its impact on deficits, debt or growth performance. The European Commission (2007) uses a cyclically-adjusted primary balance based criterion, Guichard et al. (2007) classify a consolidation episode as successful, if its size is large enough to stabilise the debt-to-GDP ratio. Barrios et al. (2010) use the public debt level as a measure of success: a fiscal consolidation is considered as successful if it brings debt down by at least 5 percentage points of GDP in the three years following the episode. In this study, three definitions for the success of consolidation are used: debt stabilises i) the year after, ii) two years after and iii) three years after the episode ends.

The analyses used an unbalanced panel data set of 28 OECD member countries³ over 1960-2009. Most macroeconomic and fiscal variables were obtained from the OECD *Economic Outlook Database*. The left-hand side variables are the various conditions of consolidation episodes (their start, length, size and intensity) defined above using the cyclically-adjusted

Table 4. **The number and length of consolidation episodes defined by the five thresholds**

	(1) Very small consolidation threshold		(2) Medium-sized consolidation threshold		(3) Large and sharp consolidation threshold		(4) Large and long consolidation threshold		(5) Very large consolidation threshold	
	No. of episodes	No. of episode years	No. of episodes	No. of episode years	No. of episodes	No. of episode years	No. of episodes	No. of episode years	No. of episodes	No. of episode years
Australia	5	15	4	8	1	1	2	7	1	1
Austria	9	11	5	6	3	4	3	5	3	4
Belgium	6	16	4	8	3	5	3	10	2	4
Canada	6	14	3	8	3	6	4	9	2	3
Czech Republic	4	7	4	6	2	3	2	4	2	3
Denmark	5	13	4	8	2	5	3	6	3	4
Finland	6	13	8	8	6	6	4	10	4	4
France	6	14	2	2			2	4		
Germany	3	11	2	3			2	3		
Great Britain	5	14	3	7	2	4	2	6	1	1
Greece	5	15	5	12	4	8	7	10	4	4
Hungary	3	7	2	4	1	3	1	3	1	3
Iceland	8	16	5	10	2	2	4	7	2	2
Ireland	7	18	4	10	2	4	4	8	2	3
Italy	8	15	5	10	3	4	5	9	2	2
Japan	6	15	3	5	1	1	2	7		
Korea	6	16	2	2	1	1	3	3		
Luxembourg	3	10	3	6	2	3	2	6	2	3
Netherlands	9	14	6	9	3	3	6	10	2	2
New Zealand	5	10	3	5	3	3	3	4		
Norway	6	13	4	9	3	5	3	7	3	4
Poland	4	5								
Portugal	8	11	5	8	4	6	4	8	3	4
Slovak Republic	3	8	3	4	2	3	2	6	1	1
Spain	5	16	5	7	1	1	2	6	1	1
Sweden	6	19	6	10	5	6	4	10	1	2
Switzerland	3	11	4	6	1	1	3	5		
United States	6	15	4	10			3	7		
Total	156	362	108	191	60	88	85	180	42	55

Notes: Thresholds applied for consolidation episodes: i) very small: continuous improvement in the budget balance (i.e. the episode lasts as long as the budget balance improves), ii) medium-sized: 1 percentage point fall in the budget balance/GDP ratio in a single year or in two years, with at a minimum a 0.5 percentage point in the first year, iii) large 1: 1.5 percentage points fall in the budget balance/GDP ratio in a single year or in two years with at a minimum a 1.25 percentage points in each, iv) large 2: 1.5 percentage points fall in the budget balance/GDP ratio in a single year or in three years with less than a 0.5 percentage point deterioration in any year and v) very large: 2 percentage points fall in the budget balance in a single year or in two years with a minimum of 1.5 percentage points in each. Budget balance measure: underlying cyclically-adjusted primary balance.

underlying primary balance (and four alternative measures of budget balance, not reported in this paper) except in the case of analyses examining the conditions of success, which is defined as debt stabilisation, hence it uses the debt ratio. For explanatory variables, data from various aspects of the conditions surrounding fiscal adjustments were used: i) to reflect the fiscal background, the debt-to-GDP ratio, the size of the budget balance, the change in the debt ratio; ii) to capture external conditions, the OECD budget balance; iii) to explore the monetary environment around consolidations, the nominal effective exchange rate, the change in the inflation rate, the change in long-term interest rates, the interest rate differential, a dummy variable saying whether the country is in the Exchange Rate Mechanism (ERM), a euro area dummy capturing whether the country is member of the euro zone, a dummy for euro-area

countries between 1992-98 and a separate one for 1999-2009; iv) to test the importance of political economy settings, the election year dummy, the strength of left-leaning and right-leaning governments; v) to capture the overall economic setting, the GDP growth rate, and vi) to investigate the impact of the composition of consolidation, over 20 revenue and expenditure items were used from the *Government Finance Statistics Database* of the IMF. The budget balance and debt variables are scaled by GDP. As fiscal consolidation itself affects many of the economic environment factors that are included in the analysis, such variables were entered with a lag to reduce the simultaneity problem.

Long-term interest rate differentials are measured relative to German rates for European countries and relative to US rates for other countries. The United States and Germany, as well as Japan and the United Kingdom, are excluded from the sample for the calculation of average responses. Long-term interest rate differentials are a better proxy for the perceived sustainability of fiscal policies than absolute interest rate levels, which also reflect cyclical and other influences on global bond markets.

In the analyses two variables capturing the political orientation and the stability of government are used as in Égert (2010): the strength of right-leaning and left-leaning governments. The value is higher the further left or right the government's political stance (i.e. very left wing or very conservative) of the political spectrum and the stronger its political standing is (the strongest is a single party majority government).

The analysis also considers the role of fiscal rules in consolidations. The impact of the two relatively widely-used fiscal rules, the expenditure rule and budget balance rule is examined. Dummy variables indicate whether i) expenditure rules, ii) budget balance rules or iii) the combination of expenditure and budget balance rules⁴ are in place and iv) an indicator capturing the strength of fiscal rules,⁵ which is only available for the EU countries, is tested.

The sub-national analyses used budget balance data for state-level and local governments obtained from the *OECD National Accounts Database*. The budget balance data were adjusted for cyclical fluctuations applying the Hodrick-Prescott filter.

The inclusion of the above variables in the various regressions was based on earlier literature but with the purpose of having a more comprehensive picture of the different aspects of consolidations. As a result, the number of variables in general tends to be larger than in most of the earlier literature. Variables that had not been applied in earlier literature were introduced in all analyses. These include the strength variables of government orientation, which, intuitively, may have a bearing not only on the start but also on the different attributes and the outcome of a consolidation episode.

3. Empirical results

3.1. The start of consolidations

The first question of interest when exploring the conditions of fiscal consolidations is what triggers them. Intuitively, responsible governments would turn favourable global and/or domestic economic conditions into an opportunity to embark on a consolidation path supported by these conditions to make the process less painful. Alternatively, governments may have no choice but to wait for such conditions owing to, for instance, credibility effects or their commitment to prudent fiscal conduct. Newly-elected governments may also be more willing to undertake reforms to prove to voters that they made the right choice. In addition, there needs to be political unity and a decisive stance on consolidation within the government to start this painful set of reforms.

To examine the determinants of the start of consolidation episodes, more specifically of the probability of the start, probit analysis was used (Table 5). In the table, the results for the

Table 5. **Determinants of the start of fiscal consolidation**

Type of consolidation (see note to the table)	Probit estimation				
	(1) Very small consolidation threshold	(2) Medium-sized consolidation threshold	(3) Large and sharp consolidation threshold	(4) Large and long consolidation threshold	(5) Very large consolidation threshold
Left-hand side variable: binary variable indicating the start of a consolidation					
Explanatory variables					
Debt/GDP (lagged)	0.00	0.00	0.00	0.00	0.00
Budget balance/GDP (lagged)	-0.03***	-0.02***	-0.01***	-0.02***	-0.01***
Change in the debt ratio (lagged)	0.00	0.00	0.00	0.00	0.00
Change in OECD30 budget balance/GDP (lagged)	0.04**	0.08***	0.04**	0.08***	0.02*
Change in nominal effective exchange rate (lagged)	-0.34	-0.07	-0.13	-0.17	0.04
Change in inflation (lagged)	-0.94	-0.34	-0.51	-0.30	-0.53*
Interest rate differential (lagged)	0.00	0.00	0.01	0.00	0.01**
Election year (lagged)	0.05	0.09***	0.04*	0.04*	0.01
Strong left-leaning government	-0.02**	-0.01	-0.01	-0.01	-0.00*
Strong right-leaning government	-0.01	-0.01**	-0.01***	-0.01**	-0.01***
Number of observations	553	553	553	553	553

Notes: Budget balance measure: underlying cyclically-adjusted primary balance. Thresholds applied for consolidation episodes: i) very small: continuous improvement in the budget balance (i.e. the episode lasts as long as the budget balance improves), ii) medium-sized: 1 percentage point fall in the budget balance/GDP ratio in a single year or in two years, with at a minimum a 0.5 percentage point in the first year, iii) large 1: 1.5 percentage points fall in the budget balance/GDP ratio in a single year or in two years with at a minimum a 1.25 percentage points in each, iv) large 2: 1.5 percentage points fall in the budget balance/GDP ratio in a single year or in three years with less than a 0.5 percentage point deterioration in any year and v) very large: 2 percentage points fall in the budget balance in a single year or in two years with a minimum of 1.5 percentage points in each.

Significance levels: * significant at 10%; ** significant at 5%; *** significant at 1%.

Reported coefficients are the marginal effects (i.e. the change in probability of the left-hand side variable if the explanatory variable increases by one unit).

underlying adjusted primary balance are indicated, but replacing this with the adjusted primary balance did not change the results. The reported coefficients are the marginal effects (i.e. the change in probability of the left-hand side variable if the explanatory variable increases by one unit). The main findings concerning the **start** of a consolidation are:

- An important driver to start a consolidation is a country's need to consolidate, which is captured by the initial size of budget deficits. Initial debt levels and increases in debt do not appear to provide incentives to consolidate.
- Monetary conditions can help trigger the start of a consolidation. High interest rate differentials before the consolidation episode appear to matter for the start of very large consolidations.⁶ This is not surprising as large interest differential may, *inter alia*, be a signal of the need to consolidate. However, a depreciating exchange rate does not appear to matter.
- Fiscal consolidation in other countries appears to have an impact on adjustment programmes, indicating a kind of peer pressure.
- Political economy factors can also influence the start of a consolidation. Newly-elected governments are more likely to launch adjustment programmes. Governments that are far from the centre and stronger are less likely to undertake a consolidation programme (this aspect is captured by the variables interacting with the location of the government in the political spectrum on either side, respectively, with the variable reflecting the political standing of the government).

3.2. The duration of consolidations

Once consolidation started, the next concern is how long it will last, how big and how intense it will be or in other words whether it will be a “cold shower”, bringing about large reductions in the budget deficit in a relatively short time or a more gradual process. The length of consolidation episodes is intuitively influenced by economic conditions during consolidation, both external and domestic, but political economy considerations may also play a role. For instance, reform fatigue may reduce incentives to produce quick results in the consolidation process or new governments may be for or against consolidation depending on their political agenda. More importantly, countries lacking credibility or in times of reduced global risk appetite may need to produce quick and visible results to regain confidence of international investors.

To investigate the shape of consolidation episodes, in particular their length, duration analysis was applied. To estimate what determines the length of consolidation episodes, parametric methods were used that assume a continuous parametric distribution for the probability of failure, in this case the stopping of consolidation, over time. The shape of this probability of experiencing the failure event at time t conditional on having survived to this time (called hazard rate) needs to be decided to estimate the model. Theory can provide little guidance as the shape of time dependency is conditional on the covariates in the model.⁷ The variation in terms of duration of episodes in the dataset suggests that the exponential parametric model is unlikely to be the right choice. Also, there is no reason to assume that the conditional probability of experiencing the event of stopping the episode is monotonic. Therefore, model selection methods were applied to determine the type of distribution. The generalised gamma model was estimated, which is flexible with two shape parameters and nests the exponential, the Weibull and the log-normal model as special cases. Wald tests were then used to test the values of the shape parameters that resulted in rejecting the exponential and Weibull models while the log-normal distribution could not be rejected. Estimation results assuming log-logistic distribution appeared similar and the Akaike-information criterion (AIC) also suggested the same choice. The estimated model is therefore the log-normal with the survival function of:

$$S(t) = 1 - \Phi\left\{\frac{\ln(t) - \mu}{\delta}\right\}$$

where $S(t)$ denotes the survival function, t is time, Φ is the standard normal cumulative distribution function, δ is a shape parameter and $\mu = X\beta$, where X is the set of explanatory variables. All covariates are time-varying and lagged to reduce the simultaneity problem.

The accelerated failure time specification was used for the model, as the duration model with a log-normal distribution can only be interpreted in this format. Actually, the interpretation of the results is straightforward in this specification as the sign of the coefficient indicates how a covariate affects the logged survival times.⁸ Thus, a positive coefficient increases the logged survival time and hence the expected duration of the consolidation episode. By the same token, a negative coefficient decreases the logged survival time and hence the expected duration of an episode. The budget balance measure used for the analyses is the underlying adjusted primary balance, but the use of the adjusted primary balance leads to similar results. The main findings concerning the **duration** of a consolidation are (Table 6):

- A major determinant of the length of a consolidation appears to be the size of the budget deficit.

- Monetary conditions can have an effect on the duration of a consolidation. A depreciating exchange rate provides a favourable environment for competitiveness gains and lengthens the duration of the consolidation episode. Falling inflation, similarly, tends to increase the duration of the episode. A decrease in the implicit interest paid on debt also appears to lengthen the episode. Replacing this variable by long-term interest rates (not reported) leads to the same result.
- Newly-elected governments tend to continue consolidations. The orientation of the government does not seem to matter for the length of the episode.
- The composition of fiscal consolidation does not appear to have a bearing on its length. This holds for over 20 spending and revenue items examined at both the aggregate and disaggregated level. These findings are not reported in the table.
- The duration of a consolidation episode appears to be largely uninfluenced by the level of debt.
- Adding fiscal rules (sequentially) results in insignificant coefficients on the exchange rate and interest rate variables, while showing no significant effect for fiscal rules either (not reported). This could be due to the interaction between fiscal rules and macroeconomic variables that may work through the disciplining effect of fiscal rules or may be related to an omitted variable reflecting the government's commitment to prudent macroeconomic policies.

Table 6. **Determinants of the length of fiscal consolidation**

Survival data analysis

Explanatory variables	Type of consolidation (see note to the table)				
	(1)	(2)	(3)	(4)	(5)
	Very small consolidation threshold	Medium-sized consolidation threshold	Large and sharp consolidation threshold	Large and long consolidation threshold	Very large consolidation threshold
Left-hand side variable: survival time (logged)					
Debt/GDP (lagged)	0.00	0.00	0.00	-0.00*	0.00
Budget balance/GDP (lagged)	-0.02***	-0.04***	-0.04***	-0.04***	-0.04***
Change in implicit interest on government debt	-0.09***	-0.11***	-0.11**	-0.13***	-0.12**
Change in inflation	-4.10***	-4.79***	-5.64***	-4.38***	-5.63***
Change in exchange rate, NEER, lagged	-0.52*	-0.81**	-1.09**	-0.93**	-0.32
Election year dummy, lagged	0.11***	0.10**	0.25***	0.15***	0.21**
Strong left-leaning government	0.01	0.00	0.00	0.00	0.00
Strong right-leaning government	0.00	0.00	0.00	0.00	0.02
Constant	8.68***	9.83***	11.15***	9.55***	10.42***
Observations	572	572	572	572	572

Notes: Budget balance measure: underlying cyclically-adjusted primary balance. Thresholds applied for consolidation episodes: i) very small: continuous improvement in the budget balance (i.e. the episode lasts as long as the budget balance improves), ii) medium-sized: 1 percentage point fall in the budget balance/GDP ratio in a single year or in two years, with at a minimum a 0.5 percentage point in the first year, iii) large 1: 1.5 percentage points fall in the budget balance/GDP ratio in a single year or in two years with at a minimum a 1.25 percentage points in each, iv) large 2: 1.5 percentage points fall in the budget balance/GDP ratio in a single year or in three years with less than a 0.5 percentage point deterioration in any year and v) very large: 2 percentage points fall in the budget balance in a single year or in two years with a minimum of 1.5 percentage points in each.

Significance level: * significant at 10%; ** significant at 5%; *** significant at 1%.

The log-normal distribution was assumed for the parametrisation of the conditional probability of experiencing a failure at time t conditional on surviving until time t , as both the AIC model-selection criterion and the nested Wald-test supported the log-normal (and log-logistic) forms versus the often used Weibull, Gompertz or exponential distributions. As the log-normal distribution assumes an accelerated failure time form, the interpretation of the coefficients is straightforward: a unit increase in the explanatory variable is associated with an increase equivalent to the size of the respective coefficient in the logged survival time.

3.3. The size of consolidations

Another important attribute relating to the shape of fiscal consolidations is their size. Governments in need of producing quick results to regain credibility are likely to aim at larger squeezes. Institutional commitments may also act as a force to increase the size of the adjustment. In some cases, however, the consolidation need may be too large to produce fast results and thus may need longer time. The size of consolidation is the cumulated improvement in the underlying cyclically-adjusted primary balance during the consolidation episode, expressed as a share of potential GDP.

The determinants of the size of consolidations were investigated using the truncated regression model, as the size, by definition, is truncated. While changes in the underlying cyclically-adjusted primary balance may take negative values, consolidation is defined as an improvement in that balance; hence the lower part of the distribution of the size variable (which is the dependent variable) is truncated. Defining consolidation by the least restrictive threshold, *i.e.* any improvement in the underlying cyclically-adjusted primary balance, implies that consolidation is related to self selection. In the case of the other four thresholds, however, the choice of those thresholds introduces additional bias. The underlying cyclically-adjusted primary budget balance was used, but adjusted primary budget balance measures lead to similar results. The main findings concerning the **size** of a consolidation are (Table 7):

- The length of the consolidation episode appears to be a major determinant of its size, perhaps reflecting that it takes longer to achieve larger consolidations.
- Countries in the ERM tended to undertake larger consolidations compared with other countries.
- How the consolidation is achieved appears to matter for the size of the consolidation. Cuts focused on social protection and housing and community amenities spending seem to boost the size of consolidations.⁹ The robustness of these findings could not be fully checked, however, owing to small sample size for some specifications. A larger share of spending cuts relative to tax increases does not appear to affect the size of the consolidation (not reported).¹⁰
- There is weak evidence that newly-elected governments pursue less consolidation and that left-leaning governments pursue smaller consolidations.
- Monetary conditions do not seem to play an important role in determining the size of a consolidation. Exchange-rate depreciation boosts the size of only very large consolidations, while interest rates and inflation do not seem to matter much.
- The size of the deficit and the debt burden do not seem to be particularly important in determining the size of the consolidation.
- Fiscal rules do not appear to affect the size of consolidation (not reported).

Another potential issue that may arise in the estimation of the determinants of the size of consolidations is selection bias. Selection bias may stem from the possibility that the conditions that make governments decide to consolidate also influence the size of consolidation. To correct for such potential selection bias, the Heckman selection model was also applied and the results broadly correspond to those of the truncated regression model (not reported).

Table 7. **Determinants of the size of fiscal consolidation**

Truncated regression model

Explanatory variables	Type of consolidation (see note to the table)				
	(1) Very small consolidation threshold	(2) Medium-sized consolidation threshold	(3) Large and sharp consolidation threshold	(4) Large and long consolidation threshold	(5) Very large consolidation threshold
Left-hand side variable: cumulated size of consolidation during the episode					
Explanatory variables					
Debt level (lagged)	0.00	0.00	0.00	0.00	0.01*
Budget balance (lagged)	-0.09	-0.10	-0.06	-0.12	-0.08*
Debt level (lagged change)	-0.04	0.01	0.02	-0.02	0.06
Length	1.53***	1.77***	2.56***	1.52***	2.24***
GDP growth rate (lagged)	15.05*	2.59	-0.39	5.39	-1.42
Nominal effective exchange rate (lagged change)	0.01	-0.01	-0.04	-0.01	-0.08***
Core CPI (lagged change)	0.32	0.37**	0.05	0.50*	0.17
Long-term interest rate (lagged change)	-0.28	-0.06	0.03	-0.10	0.06**
Elections in previous year	-0.93	-0.85**	-0.10	-0.44	0.29
ERM	0.67	1.03**	0.13	2.24***	0.34
Euro area 1992-98 dummy	1.04	-0.50	0.05	-1.26	-1.12***
Euro area 1999-2009 dummy	-0.64	-0.07	0.37	-0.62	0.15
Strong left-leaning government	-0.04	0.01	-0.15***	0.04	-0.09**
Strong right-leaning government	-0.06	-0.02	-0.07**	-0.08	-0.04
Constant	-18.63**	-3.69	0.28	-6.76	1.46
Observations	115	80	44	61	27

Notes: Budget balance measure: underlying cyclically-adjusted primary balance. Thresholds applied for consolidation episodes: i) very small: continuous improvement in the budget balance (i.e. the episode lasts as long as the budget balance improves), ii) medium-sized: 1 percentage point fall in the budget balance/GDP ratio in a single year or in two years, with at a minimum a 0.5 percentage point in the first year, iii) large 1: 1.5 percentage points fall in the budget balance/GDP ratio in a single year or in two years with at a minimum a 1.25 percentage points in each, iv) large 2: 1.5 percentage points fall in the budget balance/GDP ratio in a single year or in three years with less than a 0.5 percentage point deterioration in any year and v) very large: 2 percentage points fall in the budget balance in a single year or in two years with a minimum of 1.5 percentage points in each. The size of consolidation is the cumulated improvement in the underlying cyclically-adjusted primary balance during the consolidation episode, expressed as a share of potential GDP.

Significance level: * significant at 10%; ** significant at 5%; *** significant at 1%.

3.4. The intensity of consolidations

Determined jointly by the duration and the size of consolidation, intensity is the third attribute often used to characterise the shape of consolidation episodes. Intensity of a consolidation episode is defined as the annual average size of the reduction of the underlying cyclically-adjusted budget balance. The intensity of a retrenchment defines whether it is a “cold shower”, achieving large improvements in the budget balance in a short time or a gradual process phasing in expenditure cuts and revenue increases over a longer time span.

The determinants of the intensity of consolidations were investigated using the truncated regression model, as the intensity, by definition, is truncated. As intensity is defined as the ratio of the size to the length of the consolidation episode and given that the lower part of the distribution of the size variable is truncated, as discussed above, the same applies for the intensity variable. The underlying cyclically-adjusted primary budget balance was used, but

adjusted primary budget balance measures led to similar results. The determinants of the **intensity** (annual average consolidation over the episode) of consolidation episodes are very similar to those of their size. The main findings are (Table 8):

- The intensity of large, but not smaller consolidation episodes appears to depend on the size of the deficit in the previous year. The debt burden or an increase in debt levels only appears to matter for very large consolidations.
- Economic growth appears to be only relevant for the intensity of very small consolidations.
- Inflation seems to have a positive effect on the intensity of the consolidation episode. This may be because governments may have a certain consolidation target and, notwithstanding the reduction of the debt ratio in the short term as a result of the pick-up in inflation, inflation makes it easier to control expenditures that are set in nominal terms, and hence to reach such targets, they had better intensify their consolidation efforts. Exchange rate depreciation and rising long-term interest rates are associated with more intense, very large consolidations.
- Elections do not seem to matter for the intensity of consolidations. There is some evidence suggesting that both left- and right-leaning governments undertake less intense consolidations, though this is found for only a few consolidation thresholds.
- Fiscal rules do not seem to matter for the intensity of fiscal consolidation (not reported).

Table 8. **Determinants of the intensity of fiscal consolidation**

Truncated regression model

Explanatory variables	Type of consolidation (see note to the table)				
	(1) Very small consolidation threshold	(2) Medium-sized consolidation threshold	(3) Large and sharp consolidation threshold	(4) Large and long consolidation threshold	(5) Very large consolidation threshold
Left-hand side variable: intensity (annual average size of consolidation measures)					
Explanatory variables					
Debt/GDP (lagged)	0.00	0.00	0.00	0.00	0.01**
Budget balance/GDP (lagged)	-0.04	-0.05	-0.03	-0.08**	-0.05*
Change in the debt ratio (lagged)	-0.03	0.01	-0.01	0.00	0.07***
Growth rate (lagged)	6.34*	0.93	-1.00	3.72	-1.86
Change in exchange rate, NEER, lagged	0.01	-0.01	-0.03*	-0.01	-0.06***
Inflation (lagged change)	0.20*	0.23***	0.04	0.20**	0.35**
Long-term interest rates (lagged change)	-0.11	-0.02	0.00	-0.01	0.05**
Election year dummy (lagged)	-0.40	-0.22	0.04	-0.26	0.19
ERM	0.07	0.24	0.02	0.73***	0.36
euro_9298	0.96**	0.01	0.17	-0.32	-0.91***
euro_9909	-0.16	0.02	0.37	-0.25	0.06
Strong left-leaning government	0.00	-0.01	-0.07**	-0.01	-0.07***
Strong right-leaning government	-0.02	-0.02	-0.03	-0.05**	-0.03
Constant	-6.05	0.35	3.35	-2.46	4.05*
Observations	115	80	44	61	27

Notes: Budget balance measure: underlying cyclically-adjusted primary balance. Thresholds applied for consolidation episodes: i) very small: continuous improvement in the budget balance (i.e. the episode lasts as long as the budget balance improves), ii) medium-sized: 1 percentage point fall in the budget balance/GDP ratio in a single year or in two years, with at a minimum a 0.5 percentage point in the first year, iii) large 1: 1.5 percentage points fall in the budget balance/GDP ratio in a single year or in two years with at a minimum a 1.25 percentage points in each, iv) large 2: 1.5 percentage points fall in the budget balance/GDP ratio in a single year or in three years with less than a 0.5 percentage point deterioration in any year and v) very large: 2 percentage points fall in the budget balance in a single year or in two years with a minimum of 1.5 percentage points in each.

Significance level: * significant at 10%; ** significant at 5%; *** significant at 1%.

Another potential issue that may arise in the estimation of the determinants of the intensity of consolidations is selection bias. Selection bias may stem from the possibility that the conditions that make governments decide to consolidate also influence the intensity of consolidation. To correct for such potential selection bias, the Heckman selection model was also applied and the results broadly correspond to those of the truncated regression model (not reported).

3.5. The success of consolidations

The major issue of interest when investigating the various attributes and conditions of consolidations is what makes them successful. As discussed in a previous section, success is defined in different ways in the literature, but its objective should be to stabilise and ultimately to reduce debt. It is not sufficient to embark on a fiscal adjustment programme, but the circumstances surrounding the carrying out of the programme such as the global and the domestic economic environment as well as the domestic political climate and institutional setting may determine the outcome of the efforts.

The determinants of the success of a consolidation were examined using the Heckman bivariate selection model, which corrects for the selection bias stemming from the fact that the conditions that make governments decide to consolidate also influence the outcome of consolidation. This method was applied in Barrios *et al.* (2010) that also examines the factors determining the success of fiscal consolidations. To account for episodes of different durations, the probit model was also applied. The definition of success is debt stabilisation following the consolidation episode, with a couple of thresholds for the number of years after which debt stabilises following a consolidation. The major findings concerning the probability of **success** in stabilising debt are (Table 9):

- Economic growth appears to help debt stabilisation. This may come partly through the denominator effect.
- An easing of monetary conditions captured by the change in the long-term interest rate seems to increase the probability for a consolidation to stabilise debt. Moderating inflation similarly appears to increase the probability of success of a consolidation. This is somewhat surprising as inflation normally reduces the real debt burden. A possible explanation is that once consolidation has started, rising inflation may increase incentives to consolidate as it becomes easier to control expenditures that are set in nominal terms. This bodes well with the finding that moderating inflation also increases the intensity of consolidation. Alternatively, moderating inflation may represent positive confidence effects that increase the probability of stabilising debt. A depreciating exchange rate may help as well, but the evidence is not strong.
- The further governments are away from the centre, the less likely they seem to stabilise debt. This finding is more robust for strong left-leaning governments than strong right-leaning ones.
- Fiscal rules appear to be associated with successful consolidations, regardless whether an expenditure rule, a budget balance rule or a combination of the two is in place. In addition, stronger rules seem to be more effective.
- Fiscal adjustment programmes during or immediately following banking crises¹¹ appear to be less likely to result in stabilising debt (not reported).

Table 9. **Determinants of the success of fiscal consolidation**

Bivariate Heckman selection model

Explanatory variables	Debt stabilises at t + 1				Debt stabilises at t + 2				Debt stabilises at t + 3			
	Expenditure rules	Balanced budget rules	Expenditure and balanced budget rules	Fiscal rules index	Expenditure rules	Balanced budget rules	Expenditure and balanced budget rules	Fiscal rules index	Expenditure rules	Balanced budget rules	Expenditure and balanced budget rules	Fiscal rules index
Left-hand side variable: binary variable indicating the success of a consolidation												
Growth rate	12.07***	12.87***	12.01***	17.73***	8.1***	8.85***	8.28***	14.44***	7.21***	8.33***	7.47***	15.71***
Long-term interest rate (change)	-0.10**	-0.09**	-0.10**	-0.13*	-0.18***	-0.17***	-0.18***	-0.39***	-0.23***	-0.22***	-0.23***	-0.56***
NEER depreciation dummy	0.21*	0.22*	0.19	0.56***	0.14	0.16	0.13	0.25	-0.06	-0.07	-0.10	0.01
Inflation (change)	-0.29***	-0.25***	-0.28***	-0.42***	-0.28***	-0.26***	-0.28***	-0.47***	-0.24***	-0.22***	-0.24***	-0.38***
Strong left-leaning government	-0.04*	-0.06***	-0.04*	-0.06*	-0.08***	-0.10***	-0.08***	-0.14***	-0.07***	-0.08***	-0.06***	-0.21***
Strong right-leaning government	-0.03*	-0.02	-0.02	0.02	-0.04**	-0.03*	-0.03**	0.00	-0.05***	-0.04***	-0.04***	-0.05
Expenditure rules dummy	0.44***				0.32**				0.42***			
Balanced budget rules dummy		0.59***				0.50***				0.60***		
Expenditure and balanced budget rules dummy			0.55***				0.51***				0.67***	
Fiscal rules index for the EU countries				0.16*				0.32***				0.51***
Constant	-12.36***	-13.51***	-12.33***	-17.87***	-8.05***	-9.12***	-8.27***	-14.10***	-7.21***	-8.65***	-7.49***	-15.46***
Observations	542	542	542	282	545	545	545	293	548	548	548	304

Notes: Budget balance measure: underlying cyclically-adjusted primary balance. t denotes the last year of the consolidation episode.

Significance levels: * significant at 10%; ** significant at 5%; *** significant at 1%.

Reported coefficients are the marginal effects (i.e. the change in probability of the left-hand side variable if the explanatory variable increases by one unit). The coefficients of the selection equation variables are not shown in the table but tests confirmed the selection bias in most cases.

- Consolidations based on spending cuts are more likely to stabilise debt. In some results, debt is stabilised a year after the consolidation episode is over, but soars again two or three years after the end of consolidation. This suggests that such stabilisations may have been only temporarily successful, i.e. unable to reverse the debt accumulation process effectively. Very large consolidations only stabilise debt temporarily if they are spending driven. A reduction in social security spending and government wages likewise only stabilises debt temporarily if the consolidation is large (not reported).

Although the direction of causality between fiscal discipline and fiscal rules is difficult to establish in a cross-country analysis, findings in the literature based on Canadian, Swiss and US data tend to support a role for fiscal rules in underpinning prudent fiscal behaviour even when voters' preferences (based on observed preferences from micro-level data) are taken into account.¹² Assessing whether fiscal rules themselves contribute to fiscal consolidation creates difficulties. Empirical work often finds that the presence of fiscal rules increases the probability of stabilising debt. However, the causality of the relationship is often not assessed. For example, the finding may reflect underlying government or population attitudes towards indebtedness, which leads governments concerned about debt stabilisation (and reduction) to adopt fiscal rules as part of their fiscal consolidation programmes. In cross-country studies, assessing governments' attitudes to fiscal restraint presents considerable difficulties as comparable measures of preferences are missing.¹³

So-called regression discontinuity design (RDD) offers one way to identify whether the fiscal rules as distinct from underlying preferences affect fiscal outcomes. The hypothesis was that if fiscal rules have a distinct effect on the outcome of consolidation, then such an effect will be statistically significant even after controlling for all time- and country-specific aspects – which should *inter alia* capture voters' preferences – that potentially influence the outcomes. RDD – by controlling for country-specific trends – can pinpoint whether the introduction of a fiscal rule has an impact over and above the impact of unchanged or smoother changes in preferences for fiscal probity.¹⁴ As in addition to year and country dummies, the country-specific trends together with their second and third order terms can be assumed to capture country- and time-specific variation in the sample, no other variables capturing the consolidation environment were introduced except fiscal rules, which were the major point of interest. Four model specifications were applied: a model i) with only year and country dummies, ii) with also country-specific time trends, iii) with country-specific time trends and their second-order terms in addition to the year and country dummies and iv) year and country dummies and country-specific time trends and their second and third-order terms. All four specifications were applied to three right-hand side variables: debt stabilising i) one ii) two and iii) three years after the consolidation episode, resulting in twelve models to estimate. Then the two fiscal rules (expenditure and balanced budget rules) doubled the number of estimations to total 24. The results in all the 24 model specifications support the independent role of spending or budget balance rules in explaining debt stabilisation, after controlling for the other potential country- and time-specific influences. That is the coefficient on the fiscal rule variable was significant after controlling for the time- and country-specific circumstances in all 24 cases, albeit in four cases only at the 10% threshold of significance.¹⁵

3.6. The impact of sub-central fiscal behaviour on central consolidation

Central governments that tend to assume a large share in the burden of fiscal consolidation may need to count on the support of sub-central governments. Although in

some cases sub-central fiscal behaviour is kept under control by fiscal rules, central governments may be forced to cover deficits and assume debt created by sub-central levels of government, which may frustrate efforts to consolidate.

For the analysis, fiscal balances were cyclically adjusted using the Hodrick-Prescott filter and their impact on the start, size, length and success of central government consolidation efforts was examined. In order to assure comparability, consolidation was defined as an improvement in the cyclically-adjusted central government and social security budget balance (using only cyclically-adjusted central government balances does not alter the results). In this section therefore, the notion of the central government refers to the combined central government and social security system accounts.

For most consolidation aspects, the actions of sub-central levels of government do not appear to make much difference. The start of fiscal consolidation, defined as any improvement in the budget balance does not seem to be influenced by sub-central fiscal behaviour.¹⁶ Sub-central government behaviour does not appear to affect the length, size and intensity of consolidation episodes consistently.

The contribution of sub-central governments to the success of a consolidation programme initiated by a central government does seem to matter in some cases.¹⁷ Success was defined as stabilisation of government debt one, two and three years following the consolidation episode. Similarly to the earlier analyses of the determinants of the probability of success, the bivariate Heckman selection method was used to correct for the potential selection bias stemming from the fact that circumstances that make a government start consolidation, may also affect the outcome of consolidation. The results for these regressions (Table 10) suggest that consolidations by state-level governments tend to increase the probability of success of central government retrenchment efforts.¹⁸ This finding holds when consolidation is defined as stabilisation of government debt two or three years following the start of the consolidation. Consolidations at the local government level do not appear to have a consistent effect on the success of consolidation.

Table 10. **Sub-central governments and success in stabilising debt**

	Debt stabilises at t + 1	Debt stabilises at t + 2	Debt stabilises at t + 3	Debt stabilises at t + 1	Debt stabilises at t + 2	Debt stabilises at t + 3
Left-hand side variable: binary variable indicating the success of a consolidation						
Explanatory variables						
Growth rate	8.80***	3.80	2.30	7.77***	5.13***	4.65***
Long-term interest rates (change)	-0.14***	-0.20***	-0.13***	-0.06***	-0.09***	-0.11***
NEER depreciation dummy	0.04	0.06	0.07	0.15***	0.1**	0.02
Inflation (change)	-0.11	-0.08**	-0.02	-0.06***	-0.07***	-0.07***
Strong left-leaning government	-0.01	-0.04**	-0.03*	-0.02**	-0.03***	-0.03***
Strong right-leaning government	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01*
State-level government budget balance (change)	0.34	0.71***	0.73***			
Local government budget balance (change)				-0.41**	-0.32*	-0.19
Observations	145	164	183	472	473	474
LR-test of independent equations	7.35***	7.39***	12.75***	4.35**	1.8	1.43

Notes: The budget balance measures are cyclically-adjusted using the Hodrick-Prescott filter.

Significance levels: * significant at 10%; ** significant at 5%; *** significant at 1%.

The regressions use the bivariate Heckman selection model. Reported coefficients are the marginal effects (i.e. the change in probability of the left-hand side variable if the explanatory variable increases by one unit). The coefficients of the selection equation variables are not shown in the table but tests confirmed the selection bias in most cases.

However, some evidence suggests that they reduce the probability of a successful central government consolidation effort. This finding is statistically significant when debt stabilises in the following year, but less so when debt stabilises in subsequent years. In part, the differences in the findings may be due to the differences in the samples with all countries having local governments, but only a sub-set with state-level governments.¹⁹ Alternatively, the finding may either reflect that, given the services local governments typically provide, a sharp tightening may be unsustainable without central government providing additional support or, alternatively, that an overall consolidation effort requiring significant tightening at the local level is more serious and will take longer for debt to stabilise.

4. Conclusions

The analysis of past consolidation episodes suggests that there are certain policies that may be conducive to debt stabilisation. This section provides a brief discussion of the policy measures and economic environment factors as well as the political settings that appear to support debt stabilisation, encourage governments to start to consolidate, boost the size and the intensity of consolidation episodes, and prompt governments to continue the adjustment once started.

Fiscal rules are one of the policy measures found to be associated with a higher probability of stabilising debt. The rationale for fiscal rules is related to the reluctance of governments to commit to fiscal discipline and the room governments have to abandon their announced plans before implementation. To counteract these problems, explicit targets and fiscal rules can play an important role, though they are difficult to design (Box 1). Fiscal rules can constrain government spending, spending of revenue windfalls, the budget balance or debt, or a combination of them. The empirical work in this paper

Box 1. Fiscal rules: Design, implementation and creative accounting issues

Given the multiple targets fiscal policy needs to take into account, optimal fiscal rules can be derived theoretically, but they are too complex to implement. In addition, fiscal rules should allow for some flexibility over the cycle, but too much flexibility may undermine them (Wyplosz, 2008). Striking a balance between stringency and flexibility also involves an additional implementation issue: the exact cyclical position of the economy may be hard to determine, so that it is also difficult to judge at any point in time whether the government is complying with the fiscal rules. Owing to these implementation and design issues, Wyplosz (2005 and 2008) proposed that a fiscal council should serve as a surrogate for a fiscal policy rule. He argues that fiscal councils could be a powerful watchdog. There could be an intermediate way, with a fiscal council monitoring compliance with fiscal rules as well as taking up other functions, such as providing independent forecasts and analysis of and recommendations for fiscal policy.

Fiscal rules may, in some circumstances, encourage creative accounting. This is more likely when complying with the rules results in credibility gains for the government and the risk of being caught is low (for instance, owing to a low level of fiscal transparency) or when the social cost of being caught is low (if, for instance, the electorate is accustomed to creative accounting by the government). Creative accounting is less likely when the social cost of missing fiscal targets is high or when the probability of being discovered is high. A high probability of being discovered fosters genuine fiscal consolidation (Koen and van den Noord, 2005 and Milesi-Ferretti, 2000).

indicates that countries that have either expenditure or budget-balance rules or a combination of the two are more likely to stabilise debt. The causality could also run the other way, as governments that are more committed to debt stabilisation are more likely to adopt fiscal rules. However, an independent role of spending or budget balance rules in explaining debt stabilisation was also found. In addition, more comprehensive fiscal rules – that is the larger part of government activity and the larger number of government levels they cover *inter alia* – are more likely to help stabilise debt. However, in this case, owing to lack of data, the direction of causality could not be established and therefore it can well be the case that governments that commit to debt stabilisation adopt more comprehensive fiscal rules.

The composition of the fiscal adjustment can also matter for the probability of its success. Very large consolidations, that need to be pursued now by many countries, have a higher probability of success, if achieved by multiple instruments. Past evidence suggests that a mix of reducing various spending items – including subsidies, government wages and social protection – and of increasing several revenue items helps.

- The empirical evidence shows that if the adjustment is spending rather than tax driven, debt is more likely to stabilise and this stabilisation is lasting. However, very large consolidations stabilise debt only temporarily if they are exclusively spending driven. Similarly, cutting government wages only helps stabilise debt temporarily if the consolidation is large. A reduction in social security spending can increase the probability of consolidations of any size to succeed. But in the case of very large consolidations, the debt ratio will only stabilise temporarily, suggesting that large cuts in social security spending may not be sustainable. There is some evidence that cutting subsidies may help stabilise debt, though it only applies for very large consolidations. Relying on cuts of social protection spending and on housing and community amenities may boost the size of the consolidation, though they do not seem to matter for its probability to succeed. Finally, the composition appears to have little bearing on the duration of the consolidation.
- Revenue-based consolidations are often considered to be less effective due to the ratchet effect on spending and to the adverse impact on growth compared with expenditure-based ones. A focus on indirect taxes reduces the probability for immediate debt stabilisation, though this impact fades away after a year. There is some weak evidence that relying on business taxes for fiscal adjustment may help achieve debt stabilisation temporarily, but for very large programmes it hampers debt stabilisation over the medium term.

The economic environment in which consolidation takes place can affect the probability of its success. In the empirical analyses, economic growth and falling interest rates appear to help stabilise debt. Growth reduces debt partly through the denominator effect, while declining interest rates help stabilising debt through reducing debt servicing costs and cushioning the contractionary impact of consolidation. Growth appears to matter less for the size or intensity of adjustment. Falling interest rates similarly do not seem to have an impact on the start, size or intensity of the adjustment. The depreciation of the nominal effective exchange rate seems to be conducive to reducing debt, which may work through competitiveness gains boosting exports, though this effect is short lived. It also appears to lengthen the consolidation episode, but has no bearing on the size or the intensity of the episode. Moderating inflation also seems to help debt stabilisation, though favours a less intense and more protracted process.

The political setting also seems to matter for the success of consolidation: some evidence suggests that centrist governments appear more likely to stabilise debt. Newly-elected governments seem to be more likely to start a consolidation and also to continue it. However, as in the case of the policy variables, the findings related to the political environment are also susceptible to omitted variable problems and reverse causality. For instance, if the electorate cares about fiscal discipline, it elects governments that are more likely to provide such discipline.

The attitude of sub-central governments towards central government consolidation appears to affect its probability of success. In particular, state-level governments can increase the probability of success and the stabilisation of national debt if they consolidate during central government consolidation episodes. To ensure that state-level governments do co-operate, the right regulatory framework with the extension of fiscal rules to sub-central government levels may be effective.

Notes

1. European Commission (2007) noted that the *ex post* output gaps used in the analyses may not necessarily reflect the assessment of the cycle at the time.
2. The study by the European Commission (2007) is the first one to look at cuts in expenditure at the 2-digit COFOG (classification of functions of government) level. Categories at this level include general public services; defence; public order and safety; economic affairs; environmental protection; housing and community amenities; health; recreation, culture and religion; education; and social protection.
3. The 28 countries are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Great Britain, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland and the United States. New OECD member countries such as Chile, Estonia, Israel and Slovenia and old member states without comparable fiscal accounts i.e. Mexico and Turkey are not included.
4. Fiscal rules dummy variables are based on Sutherland *et al.* (2005) and are extended until 2009.
5. The EU fiscal rule index is available for all EU member states for the years 1990-2008. It summarises five aspects of fiscal rules: i) statutory base of the rule, ii) room for setting or revising objectives, iii) nature of the body in charge of monitoring and enforcing fiscal rules, iv) enforcement mechanisms of the rule and v) media visibility of the rule. These five aspects make up the fiscal rules strength index. In the following step, these indices are multiplied by the coverage of general government finances by the respective rule and these products are added up into the fiscal rule index. If two or more rules are applied to the same government sector, the one with the higher strength score gets a weight of 1 and the second and additional rules get a 0.5 weight. The rationale behind this weighting is that more fiscal rules applied to the same government sector have a larger impact than a single one, but the marginal benefit from the second rule is smaller than that of the first, strongest rule.
6. Long-term interest rate differentials are measured relative to German rates for European countries and relative to US rates for other countries. The United States and Germany, as well as Japan and the United Kingdom, are excluded from the sample for the calculation of average responses.
7. In fact, time dependency indicates how the probability of experiencing an event at time t (conditional on surviving till time t) changes with time after conditioning on covariates.
8. Just the other way around in proportional hazard models where the sign of the coefficient indicates how a covariate affects the hazard rate. In those models, a positive coefficient increases the hazard rate and therefore reduces the expected duration of an episode.
9. While cutting spending on social protection may boost incentives to work, to return to work or to work longer, the finding that cuts for housing and community amenities matter is more of a surprise (though not unprecedented in the literature: EC, 2007 has a similar finding for the EU27 countries).
10. The spending and revenue items were introduced into the regressions sequentially.

11. Banking crises are captured by dummy variables with a value of 1 indicating a crisis year and 0 otherwise. The dummy variables are based on Laeven and Valencia (2008) and are extended until 2009.
12. Krogstrup and Wälti (2008) and Dafflon and Pujol (2001) are examples of the literature finding a causality between fiscal rules and fiscal discipline.
13. Within countries such as Canada, Switzerland and the United States, voters' preferences are used to control for the incentives sub-central governments face in pursuing fiscal prudence.
14. Country-specific time trends and their second and third-order terms were inserted in the regressions.
15. The results are available from the author upon request.
16. Although higher balances at the local or the joint local and state level in the year before the consolidation seemed to increase the probability of the central government starting fiscal retrenchment, these results are driven by three countries: Austria, Spain and Switzerland.
17. Sub-central governments do not appear to affect the length, size and intensity of consolidation episodes.
18. The ability of state-level governments to consolidate may be affected by central government transfers, as pointed out by a referee. To correct for potential endogeneity bias, while also taking into account potential selection bias, the following steps were taken: i) the selection equation of the Heckman model was estimated and the inverse Mills-ratio obtained, then ii) another probit model was used to estimate the probability of success (i.e. stabilisation of debt) with the obtained inverse Mills ratio as explanatory variable; this probit was an IV model with transfers instrumenting sub-central behaviour. The standard errors were corrected by clustering. The results show that even after controlling for endogeneity (the Wald test that the correlation parameter ρ is equal to zero was rejected) the coefficient on the change of the cyclically-adjusted budget balance at the state level is highly significant and positive when success is defined as debt stabilising one or two years after consolidation. With the definition of debt stabilising three years after the consolidation episode, however, the coefficient was not significant. For cyclically-adjusted budget balance changes at the local level no significant coefficients were obtained.
19. Sensitivity tests that restrict the sample to those countries with state level governments or only those countries without state level governments suggests that some of the results are sensitive to the inclusion of Canada and Korea.

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Avoiding debt traps: Fiscal consolidation, financial backstops and structural reforms

by

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and Paul van den Noord*

In this article we develop a simple and stylised analytical framework, which is both tractable and feasible to estimate, capturing several key dimensions of the sovereign debt crisis in Europe. We use it to examine if and how a combination of fiscal consolidation, structural reform and financial backstops can help countries, notably the southern euro-area countries, to escape from the debt trap. Our analysis confirms that the loss of fiscal policy space in countries trapped in bad dynamics inevitably requires that fiscal action be directed towards consolidation despite some output loss in the short run. In particular, reducing debt levels breeds stronger growth and results in lower sovereign risk premia. We identify also a very important role for structural reform to help countries escape from bad dynamics. Last but not least, we find that financial backstops are helpful, but only to “buy time”. This additional time must be used productively, for fiscal consolidation and structural reforms to bear fruit as well as to make progress with institutional reforms of the European monetary union.

JEL classification codes: E62, C33, C62

Key words: Fiscal policy, sovereign debt, multiple equilibria

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In the current macroeconomic environment economies may find themselves trapped in a “bad equilibrium”. One often hears the case made of periphery countries in the euro area being in such a “bad equilibrium”, characterised by the simultaneous occurrence of, and adverse feedbacks between, high and growing fiscal deficits and debt, high risk premia on sovereign debt, slumping economic activity and plummeting confidence. Remedies to break the downward spiral and escape debt traps generally include financial firewalls to prevent contagion and structural reforms to boost growth. The role of fiscal policy is less clear; whereas consolidation may help to put debt on a sustainable path, negative demand effects may, on the other hand, generate offsets and could exacerbate the downturn, adding to the risk premiums, and thus deepen the “bad equilibrium”.¹

These general mechanisms on their own are well understood, but how they interact in a consistent dynamic setting is less clear. In this article we provide a simple analytical framework to fill this gap. We develop a simple version of a model with two solutions – a stable and an unstable one – combining a negative relationship between debt and growth inspired by the seminal work of Reinhart and Rogoff (2010) and the government’s inter-temporal budget constraint. We extend this model to make it more realistic by adding the effects of fiscal policy and interest rates on growth and by introducing an interest rate equation. We estimate the core parameters of the model and use the estimates to identify, empirically, the two solutions and then simulate the policies that can help a country caught in bad debt and growth dynamics to recover. This model embeds three relevant sets of policy variables in a monetary union: structural reform, fiscal consolidation and the use of financial backstops to reduce sovereign bond yields.

We start with a brief account of stylised developments since the onset of the crisis. We then elaborate the theoretical model, report the estimation results of a panel regression analysis and finally examine the comparative static and dynamic responses to fiscal, structural and financial policies. The final section concludes.

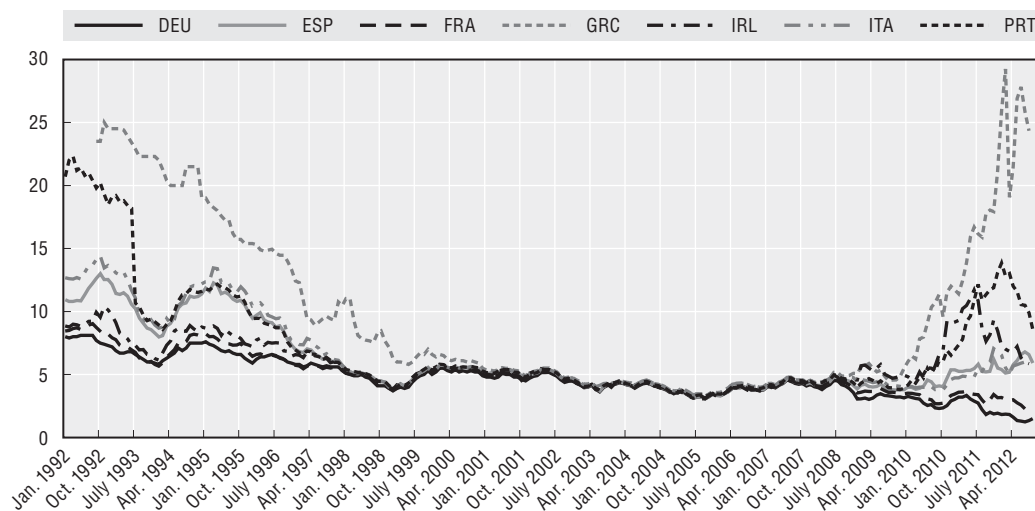
1. A brief review of the main issues

Over the past few years, even prior to the outbreak of the global financial crisis, new stylised facts have emerged in the macroeconomic environment. Public debt has grown significantly in almost all advanced economies. Partly this was a consequence of the drop in public revenues caused by the recession, and partly it was due to large public efforts, especially in some countries, to deal with banking crises. This has generated a negative feedback on growth with the possibility of a vicious circle of high debt, low growth and unsustainable public debt dynamics. Fragility has spilled over to banks which hold substantial amounts of sovereign debt in their balance sheets, especially in the euro area. This has, in turn, weighed negatively on confidence as the risk of a possible twin crisis affecting sovereign debt and credit markets simultaneously has become more significant. As has become painfully obvious, confidence can affect growth significantly. Simulations by the OECD (2011) point to a chain of causation which goes from confidence (in both

business and household) to financial markets, and next to the real economy. This relationship can affect growth positively or negatively and it can lead to significant differences in performance.

The increased role of confidence in driving macroeconomic performance suggests that we are operating in a world of multiple solutions, both stable and unstable. These may result in a strong overreaction of markets, especially in the euro area where national banking woes and sovereign stress are strongly intertwined. Take interest rates on sovereign bonds for example (Figure 1). After the crisis of the EMS in 1992, and in the run up to monetary union, these converged significantly and spreads practically disappeared for a number of years. After the outbreak of the crisis, markets overreacted in the opposite direction amplifying risk assessment and contributing to the emergence of vicious circles and a fragmentation of monetary and financial markets along national lines.

Figure 1. **Sovereign bond yields in the euro area**
(monthly averages, 10-year maturities)



Source: OECD Analytical Database.

More generally, in OECD economies, for quite some time, markets have underpriced risk and favoured excessive risk taking including in private debt accumulation. During the so-called great moderation in the United States they have fuelled credit and housing booms and strengthened the perception that private debt was, after all, sustainable. An indication of this is the persistence of a negative interest rate-growth rate differential for OECD economies (Turner and Spinelli, 2011). In the euro area, this general pattern has taken the form of the expansion of current account (saving-investment) imbalances (OECD, 2012a) which was fed largely through the banking sector, unsustainable investment, and housing booms in deficit countries and the outflow of capital from surplus countries. Eventually – triggered by the financial crisis that erupted in the United States – booms turned to bust and the financial system in Europe ran into serious trouble, taking sovereigns down in its wake.

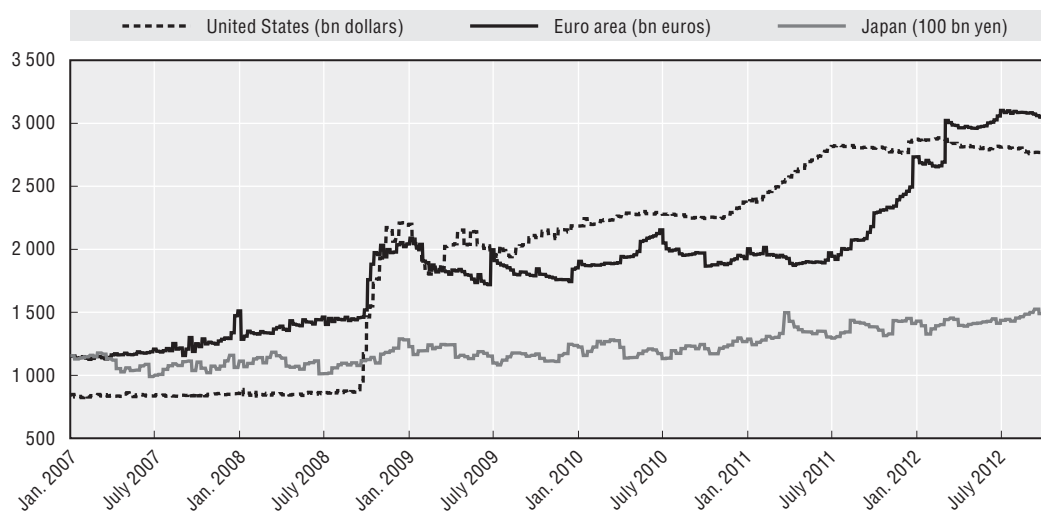
Dealing with such a situation is posing severe policy challenges. The loss of fiscal policy space inevitably requires that fiscal action is directed towards consolidation. Benefits of fiscal consolidation are long term, as reducing debt levels breeds stronger

growth, but also short term, to the extent that credible fiscal consolidation programmes may boost market confidence which translates into lower risk premia. However, in the short term the negative impact on demand may adversely affect market confidence to the extent that it depresses growth and hence debt sustainability. In practice, which of the two effects of fiscal consolidation prevails is an empirical issue largely dependent on the size of the fiscal multiplier.

Monetary policy in many advanced economies has reached the zero bound and, since the crisis, monetary authorities have introduced “unconventional” measures to deal with the recession. The balance sheets of major central banks have expanded accordingly (Figure 2). However, in a situation of financial fragility where disequilibria may spiral out of control, monetary authorities can fulfil an additional function with respect to supporting economic activity (in a framework of price stability and anchored inflation expectations), the “lender of last resort” function which can include both sovereign debt and credit markets. Such provision of a financial backstop is particularly relevant in situations in which, like the euro area crisis, contagion effects can be very significant and affect several channels at the same time.

The available policy toolkit also includes structural reforms. Structural reforms, which consist of a large number of different measures, can have a significant impact on growth (OECD, 2012a), but the benefits of growth require time to materialise in full.

Figure 2. **Central bank liabilities (in local currency)**



Source: Federal Reserve; Bank of Japan; European Central Bank.

Since the beginning of the crisis many countries have enacted structural reforms, often in tandem with fiscal consolidation measures (OECD, 2012b). This bodes well for the future, but time may be too short for the benefits of structural reforms to materialise and for markets to appreciate such improvements and translate them into lower risk premia. If markets are patient, debt sustainability would be easier and favourable dynamics could be set in motion where lower risk premia and higher growth reinforce each other. But if markets are impatient, such good dynamics may never be feasible. Rather, bad dynamics, characterised by higher risk premia and lower growth, may prevail, leading countries towards explosive debt.

This calls for co-ordinated action where available policy tools, fiscal, financial, and structural policies must operate in co-ordination to allow economies to move towards a high-growth and low-debt equilibrium. What such a co-ordinated solution might look like is the subject of the rest of this article.

2. A simple model of growth and debt

In this section we provide a simple yet consistent analytical framework to analyse the interactions described in the previous section. It is inspired by a model developed by Duesenberry (1958) to analyse the Great Depression which had many characteristics similar to the current situation. We start off with the exposition of the model, which we subsequently use to analyse the stabilisation properties of three policy levers: structural reforms, financial backstops and fiscal consolidation.

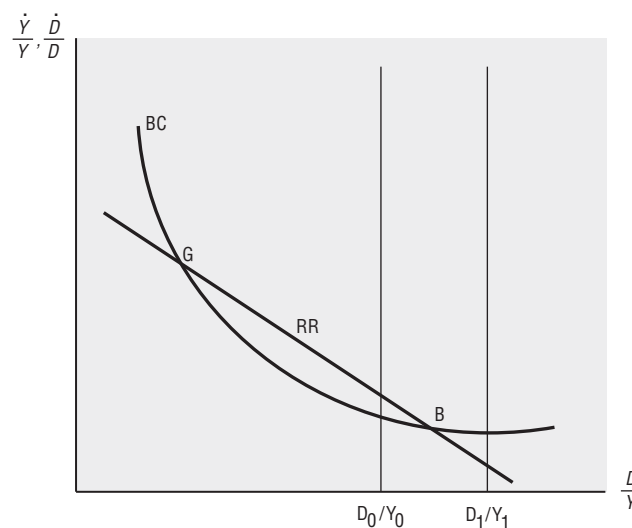
2.1. Assumptions and specification

The model has three equations. The first equation describes a negative relationship between public debt and economic growth (Y = output, D = real government debt and an over-dot indicates the change in the variable):

$$\frac{\dot{Y}}{Y} = a - b \frac{D}{Y} \quad (1a)$$

This equation is depicted in Figure 3 as the downward-sloping straight line RR . RR stands for Reinhart and Rogoff (2010) who have recently tested this relationship empirically. This negative relationship can be explained, *inter alia*, by adverse expectations with regard to future taxation associated with high public debt. It may also capture the effect of sovereign stress spilling over to banks which hold substantial amounts of sovereign debt on their balance sheets, in turn weighing negatively on the cost of financing for the private sector and on confidence and growth. Growth is positively affected by the

Figure 3. “Good” and “bad” growth and debt dynamics



Note: The horizontal axis measures the public debt to GDP ratio and the vertical axis the growth rates of public debt and output. RR is the relationship between growth and debt and BC the government's budget constraint. If the debt ratio is located right from the intersection B , it derails while output growth falls at an accelerating pace. Left of B the debt ratio converges towards G .

exogenous impact of structural reforms captured by parameter a . To keep the model simple we abstract from inflation, hence real and nominal variables are identical, and we also ignore potential output.

Growth equation (1a) can be augmented with the impact on growth of financial conditions (to the extent this is not already captured by the debt ratio) proxied by the (real) interest rate r , and the fiscal policy stance proxied by the primary deficit as a share of GDP p :²

$$\frac{\dot{Y}}{Y} = a - b \frac{D}{Y} - fr + gp \quad (1b)$$

According to this relationship, a higher interest rate depresses growth and a larger fiscal deficit supports (and by extension fiscal consolidation weakens) growth, with the associated semi-elasticities represented by the parameters f and g , respectively. These are just the first-order effects of interest rates and fiscal policy on growth. There are second-order effects that run through the government's budget constraint, which is the second equation of the model and in fact an identity. It relates the primary deficit as a per cent of GDP p to the interest rate r and public debt D :

$$\dot{D} = rD + pY \quad (2a)$$

Dividing the two sides of the equation by D yields:

$$\frac{\dot{D}}{D} = r + \frac{p}{D/Y} \quad (2b)$$

This is the hyperbolic relationship between real growth of debt and the debt ratio depicted as BC (as in budget constraint) in Figure 3.³ As the debt ratio increases, the real growth of debt approaches asymptotically the real interest rate. If the debt ratio is located in the interval between points G and B (for example at a level indicated by D_0/Y_0), output growth will exceed the growth of debt, and hence the debt ratio is falling until point G (for “good” dynamics) is attained: this is a stable steady state. However, if the debt ratio is located to the right of point B (e.g. if the debt ratio equals D_1/Y_1), the growth of debt exceeds output growth. Beyond the point B (indicating “bad” dynamics) debt keeps growing while output growth keeps falling, hence the debt ratio is on an explosive path.

What is not shown in Figure 3 (for the sake of simplicity) is that if the debt ratio is on an explosive path the real interest rate is bound to increase, thus adding momentum to the debt explosion. To capture this effect we need to introduce an interest rate equation, which is the third equation of our stylised model. Specifically, we assume that the interest rate responds to the growth in the debt ratio and an (exogenous) factor h . Therefore:

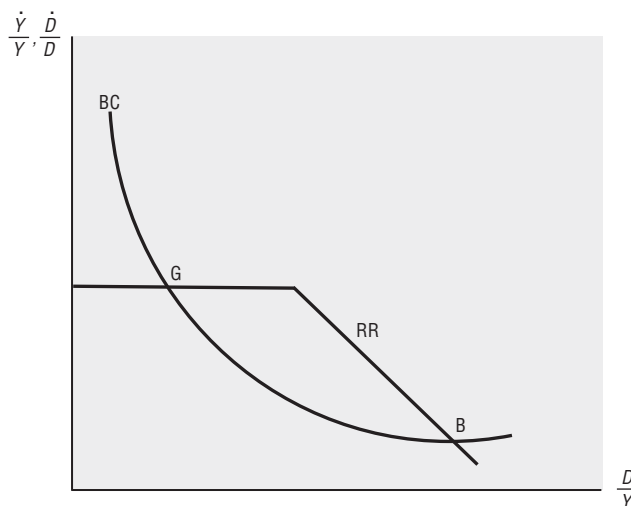
$$r = h + c \left(\frac{\dot{D}}{D} - \frac{\dot{Y}}{Y} \right) \quad (3)$$

The rationale for including the growth rate of the debt ratio as an explanatory variable is that we see this as a good measure of the sustainability of public finances. Specifically, we expect an accelerating debt ratio to raise the probability of default (for real or as perceived by the markets), i.e. the faster the increase in the debt ratio, the higher the risk premium. The parameter h under normal circumstances represents long-term neutral interest rates, but in stress situations also captures the impact of swings in market sentiment and contagion effects (in as much as these are unrelated to local debt dynamics) as well as financial backstops to offset such sentiment and contagion effects. These components will be disentangled in the estimated version below. As we shall see these factors seem to play an important role in the recent euro area sovereign debt dynamics.

In sum, our model points to three potentially explosive feedback mechanisms: i) between the debt ratio and growth; ii) between the debt ratio and the interest rate; and iii) between growth and the interest rate. Specifically, a high debt ratio depresses growth, which in turn boosts the debt ratio, etc., a high interest rate pushes up debt which gives a higher interest rate, etc., and a higher interest rate depresses growth which pushes up the debt ratio and hence the interest rate, etc. These feedbacks will be explosive if the initial debt ratio is “right of B” or converge (to the “good” solution G) if it is located “left of B”.

It is possible to derive formal expressions for the debt positions that correspond to the solutions G and B, but before we do so we need to address an important technical consideration. The negative correlation between debt and growth has been explained in different ways (Cecchetti *et al.*, 2012, Elmeskov and Sutherland, 2012, Reinhart and Rogoff, 2010 and others), but there is evidence that debt ratios negatively affect growth only beyond a certain threshold. Therefore, the RR schedule may be “kinked”, as depicted in Figure 4. The empirical literature following Reinhart and Rogoff’s seminal paper generally finds the debt threshold to be close to 90% of GDP.⁴ Indeed this is what we find also in our own empirical work (see below). This does not change the basic features of the model, other than that the value of the parameter b in equation (1b) is conditional on the level of the debt ratio.

Figure 4. **Debt threshold**



Ignoring this consideration for now, the steady-state debt ratio (when debt and output grow at the same rate) can be derived by equating the BC and RR equations (1b) and (2b) and equating the growth rates of debt and output in the interest equation (3), which yields:

$$-b\left(\frac{D}{Y}\right)^2 + [a + gp - (1 + f)h]\frac{D}{Y} - p = 0 \quad (4)$$

This has two solutions:

$$\left(\frac{D}{Y}\right)^G = \frac{[a + gp - (1 + f)h] - \sqrt{[a + gp - (1 + f)h]^2 - 4bp}}{2b} \quad (5a)$$

$$\left(\frac{D}{Y}\right)^B = \frac{[a + gp - (1 + f)h] + \sqrt{[a + gp - (1 + f)h]^2 - 4bp}}{2b} \quad (5b)$$

Equations (5a) and (5b) are the solutions G and B, respectively. It is interesting to note that the parameter c , the semi-elasticity of the real bond yield with respect to the growth in the debt ratio, drops out of the equations, which is simply a consequence of the economy assumed to be in a steady state and hence the debt ratio being constant. This implies that the adverse feedback loop from debt via the bond yield on growth does not operate via a change in the “bad” solution B itself but rather by influencing the pace of decline or improvement as the economy is moving away from that solution. That said, *exogenous* increases in the bond yield (an increase in h) will lower the debt ratio corresponding to the “bad” solution B (see below).

For the solutions (5a) and (5b) to be feasible it is necessary that the term under the root sign is positive. At the limit it could be zero in which case only one solution exists, which has a “bad” right side (debt ratio and growth derail right of the solution) and a “good” left side (debt ratio and growth stabilise left of the solution). Whether or not these solutions are feasible is an empirical question, which we will address below. But before we address that issue we will first examine how policy can help a country trapped in bad debt and growth dynamics to recover.

2.2. Policies to escape from “bad” debt and growth dynamics

Within the logic of this model there are three policy levers available for countries to escape from bad debt and growth dynamics: structural reform (affecting a), financial backstops to reduce the bond yield (affecting h), and fiscal policy (p). These policies should not be seen as alternatives, but rather as complements as they can be mutually reinforcing, as will be demonstrated below. The term financial backstops is used here as a shorthand for a multitude of possible policies to contain bond yields, including, in the context of European monetary union, bond purchases by the European Central Bank, official lending (“Troika”) programmes and the recapitalisation of banks to break the adverse feedback loop between banks’ balance sheets and sovereigns.

As depicted in Figure 5, structural reform shifts the RR schedule outward. As a result, a country whose debt ratio D_1/Y_1 was on an explosive path initially, will find itself to the left of the (now shifted) bad solution B’. The country will see its debt ratio fall and growth resume towards the good solution G’. Obviously, however, it takes time for structural reform to exert this virtuous effect on growth and debt, but time is severely lacking when a country is trapped in bad dynamics. Moreover, for structural reform to produce this virtuous effect, confidence must be restored. Think for example of product market liberalisation that opens up new investment opportunities. Without confidence and the availability of affordable funding these opportunities for investment may not be taken up and so higher growth would not materialise. With a financial backstop in place the interest rate could fall, giving some boost to confidence too, and the RR schedule would shift outwards even before structural reforms start to bear fruit.

Financial backstops can help countries to escape from bad debt and growth dynamics also through another channel: via the government budget constraint. This is depicted in Figure 6, illustrating how a fall in the interest rate shifts the BC schedule downward and thus again pushes the bad solution B further to the right, triggering a convergence towards the (now also shifted) good solution G’. Hence, financial backstops boost growth directly (via the private lending and investment channel) as well as indirectly by containing the sovereign debt-interest snowball. Obviously this presupposes that the backstops are not “misused” by the government as a way to sidestep structural reform or fiscal consolidation

(to which we turn next). Furthermore, it is also important that the financial backstop is set up in a way that moral hazard is contained; otherwise the confidence bridge provided by the financial backstop breaks down.

These findings can be formalised by computing the relevant policy multipliers from equation (5b):

$$\partial \left(\frac{D}{Y} \right)^B / \partial a = \left(\frac{D}{Y} \right)^B \frac{1}{\sqrt{[a + gp - (1 + f)h]^2 - 4bp}} > 0 \quad (6)$$

$$\partial \left(\frac{D}{Y} \right)^B / \partial h = - \left(\frac{D}{Y} \right)^B \frac{1 + f}{\sqrt{[a + gp - (1 + f)h]^2 - 4bp}} < 0 \quad (7)$$

These equations confirm the graphical analysis: structural reform and financial backstops help a country to escape from bad debt and growth dynamics (as they “shift the bad solution to the right”). Importantly, these multipliers also confirm that these policies are mutually reinforcing: a rightward shift in the “bad” solution triggered by structural reform raises the multiplier of financial backstops and *vice versa*.

In our stylised model fiscal consolidation works via two channels – output and the government budget constraint. This is similar to financial backstops, which work through the same channels, except that the effects of fiscal consolidation are in opposite directions, with the net effect ambiguous. Fiscal consolidation is represented by a sustained cut in the primary deficit p , which shifts the BC schedule down as depicted in Figure 7. However, as shown in Figure 8 it also implies a negative demand shock, shifting the RR schedule down. The former is potentially stabilising (the bad solution shifts to the right) whereas the latter is potentially destabilising (the bad solution shifts to the left).

It is again possible to derive the relevant multiplier to measure the impact of changes in the primary deficit p on the bad solution, which reads:

$$\partial \left(\frac{D}{Y} \right)^B / \partial p = \left[g \left(\frac{D}{Y} \right)^B - 1 \right] \frac{1}{\sqrt{[a + gp - (1 + f)h]^2 - 4bp}} \begin{matrix} > \\ \leq \end{matrix} 0 \quad (8)$$

Whether an increase in the primary deficit gives a lower bad debt ratio (beyond which the economy becomes unstable) or the reverse is indeed ambiguous and depends on the initial level of the bad solution and on the “Keynesian” fiscal demand multiplier g . When

both are large, such that $g \left(\frac{D}{Y} \right)^B > 1$, fiscal expansion (an increase of p) will have a favourable impact on the bad solution i.e. it will shift it to the right. This is a situation where the country has fiscal space available to effectively boost the economy out of bad debt and growth dynamics through fiscal expansion. But if either of the two is small (the Keynesian fiscal impact on growth is small and the initial bad solution for the debt ratio is small, for instance, because the country suffers from a bad reputation in financial markets as gauged by a high value of the parameter h), such that $g \left(\frac{D}{Y} \right)^B < 1$, fiscal expansion will exacerbate the bad dynamics trap. Fiscal consolidation is then the appropriate policy, possibly in combination with structural reform and financial backstops (since these increase the multiplier (8) and hence the effectiveness of fiscal consolidation).

Figure 5. **The impact of structural reform and financial backstops through the output channel**

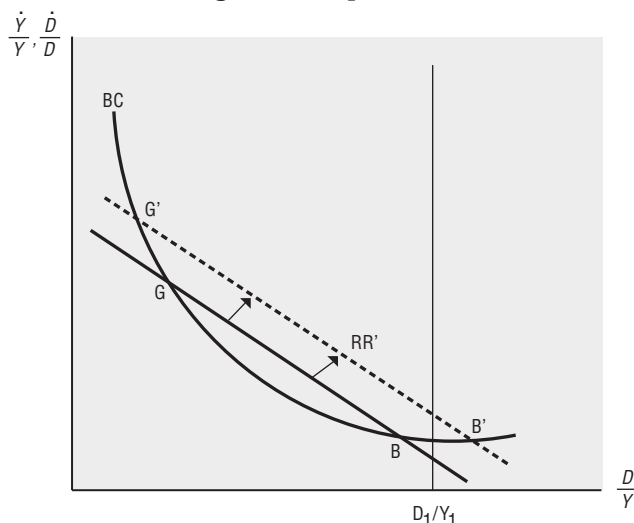
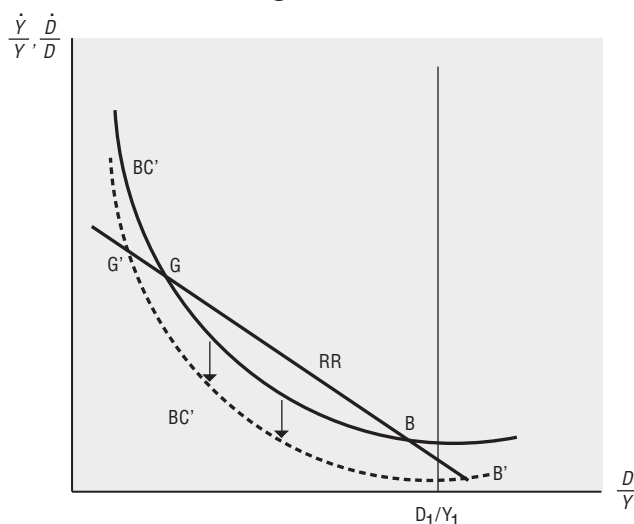


Figure 6. **The impact of financial backstops through the government budget channel**



Where exactly the bad solution ends up after fiscal consolidation is thus an empirical question: our theory cannot predict this. There is a vast though inconclusive literature on the subject, prompted by Giavazzi and Pagano (1990) who argued that fiscal consolidations can be expansionary, based on a number of case studies. According to Perotti (1999) the odds of an expansionary effect of fiscal consolidation increase with the extent of the initial fiscal predicament, in line with our finding that the initial position of the “bad debt ratio” matters for the stabilisation properties of fiscal policy. SVAR modelling work by Tenhofen, Heppke-Falk and Wolff (2011) yields evidence of a strong positive growth impact of public investment, but other fiscal shocks are found to have very little net impact on growth. However, more recently there have been additional views and evidence that the fiscal demand multiplier may be positive and large (of the order of one or more), and fiscal consolidation destabilising, at least in depressed economies (see, for example, De Long and Summers, 2012 and IMF, 2012).

Figure 7. **The impact of fiscal consolidation through the government budget channel**

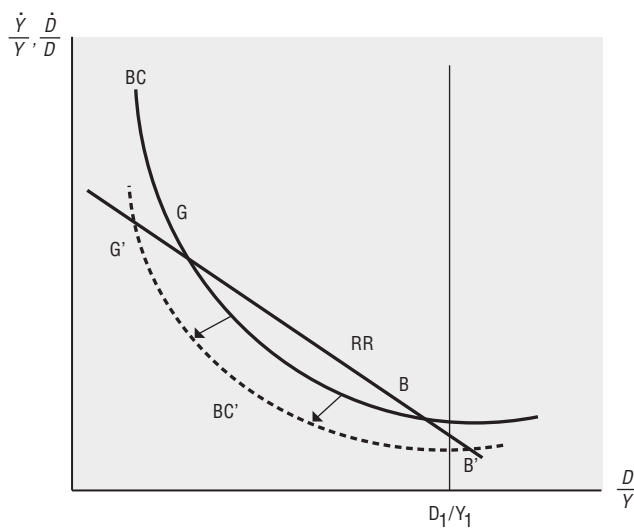
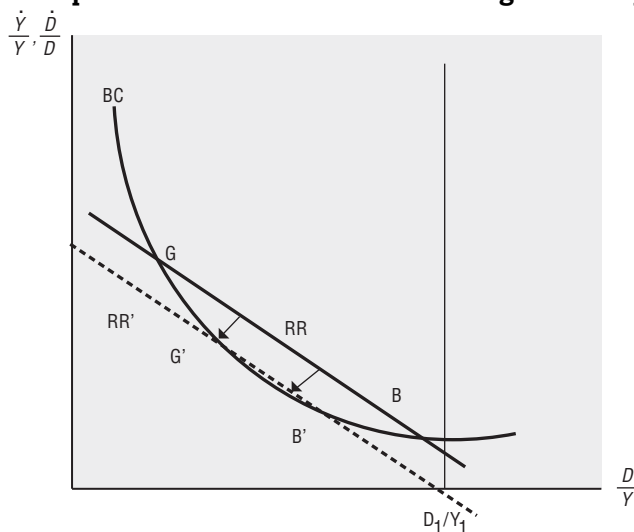


Figure 8. **The impact of fiscal consolidation through the output channel**



To sum up, the effect of fiscal policy on the growth path of the economy is ambiguous and strongly depends on the initial conditions. It is therefore of crucial importance to empirically calibrate the model so as to be able to assess the need for, and effectiveness of, fiscal consolidation alongside other policy tools when countries are trapped by bad debt and growth dynamics. We turn to this in the sections below.

3. Panel estimates

In this section we report estimation results for the growth and interest rate equations (1b) and (3) which we will use as the basis for simulations of both shocks and policy responses in the next section. The data for GDP growth, public debt, primary deficit, interest rates and control variables are obtained from the *OECD Economic Outlook 90 Database*. More details on the variables used can be found in the Data Annex. The estimations are based on a sample of 28 OECD countries and data spans for up to 52 years, from 1960 to 2011.⁵ We use annual data.

We purposefully use as broad a sample as possible, in order not to make results dependent on an arbitrarily chosen period or group of countries. However, in this way the sample is unbalanced: for some countries the data go back to the 1960s, whereas for others, it only goes back to the 2000s. The exact composition of the panel also depends on the estimation method due to a different use of lags. If characteristics of countries with a shorter series differ in a systematic way, having an unbalanced panel may result in a sample bias, but we nevertheless think that having a larger and longer sample brings about important benefits. In any case, in our empirical approach we at all times control for country fixed effects, taking much of this problem away. Moreover, when we test the robustness of our results to shortening the time period, the conclusions remain largely unaltered.

3.1. The growth equation

We estimate the following equation:

$$\bar{g}_{i,t+n} = \alpha + \beta_1 \frac{D_{i,t}}{Y_{i,t}} + \beta_2 M_{i,t; \text{debt} > T} * \left(\frac{D_{i,t}}{Y_{i,t}} - T \right) + \gamma \frac{P_{i,t}}{Y_{i,t-1}} + \theta r_{i,t} + \delta' X_{i,t} + \mu_i + \vartheta_t + \varepsilon_{i,t} \quad (9)$$

where $\bar{g}_{i,t+n} = \frac{1}{n} \sum_{k=1}^n \frac{\dot{Y}_{i,t+k}}{Y_{i,t+k-1}}$, i denotes a country and t denotes time. All the main variables of

interest are expressed in per cent or percentage points. The dependent variable $\bar{g}_{i,t+n}$ is n -year forward-overlapping moving average of annual real GDP growth rates, between year $t+1$ and $t+n$. Varying the future time span allows us to distinguish between potentially differing short-term and medium/long-term effects of the explanatory variables on growth. We set n to 1, 3 and 5. This approach also partly addresses the problem of endogeneity due to reverse causality and simultaneity between GDP growth, public debt and primary deficit. Whereas we claim that debt and primary deficit affect growth, it may also be the case that low growth leads to increases in public debt and primary deficit via automatic stabilisers and induced policy reactions. Therefore, by keeping the two policy variables at time t and moving the growth rate forward in time, endogeneity is weakened. Similar measures of growth have been used in Checherita and Rother (2010) and Cecchetti et al. (2011). In addition, our preferred specification rests on instrumental variable estimation so as to address any remaining endogeneity.

The term $\frac{D_{i,t}}{Y_{i,t}}$ in equation (9) represents public debt as a share of GDP, which in the third term on the right-hand side is interacted with a dummy variable M , indicating whether the public debt is above the threshold T . This recognises the fact that the effect of debt on growth may be non-linear. In order to avoid a discrete jump in the estimated regression line at the point where public debt equals the threshold, T is subtracted. This ensures that the growth equation is kinked like the one depicted in Figure 4. The $\frac{P_{i,t}}{Y_{i,t-1}}$ and $r_{i,t}$ measure the primary deficit as a share of (lagged)⁶ GDP and the real long-term interest rate on government bonds, respectively. μ_i stands for country-fixed effects and ϑ_t for time-fixed effects.

Finally, $X_{i,t}$ stands for a vector of controls. Here we follow the growth regressions literature and include a standard set of controls as, for example, reported in Barro and Sala-i-Martin (2004) to capture conditional convergence. It is important to note, however, that our approach

differs from standard growth regressions in that we use GDP growth as opposed to per capita GDP growth as the dependent variable. This is done in order to be consistent with the model presented in Section 2. Nevertheless, we include population growth and GDP per capita as controls, which essentially boils down to an analogous specification.

The controls in our case include: *inflation rate* to control for macroeconomic stability; the logarithm of the *initial GDP per capita*, to control for the catching up effect; *investment (gross capital formation) as a share of GDP* to measure capital formation and to serve as a proxy for the saving rate; *mean years of schooling* to measure human capital; *trade openness* measured as the sum of total exports and imports as a share of GDP; *population growth* and the *dependency ratio* to control for the evolution of labour supply; and a *banking crisis indicator*, to control for potential negative effects on growth in years of banking crises as predicted by Reinhart and Rogoff (2009).

The banking crisis variable is based on the data on systemic banking crises constructed by Laeven and Valencia (2008 and 2010).⁷ In constructing the banking crisis indicator we follow Cecchetti et al. (2011); it takes a value of zero if in the subsequent n years there is no banking crisis, and the value of $1/n$, $2/n$, and so forth, if a banking crisis occurs in one, two, etc., of the subsequent n years. The banking crisis indicator is, therefore, the only regressor which is not predetermined with respect to the future average growth rate.

Table 1 reports the estimation results for three different averages of future GDP growth rates: five-year forward average, three-year forward average and a one-year forward growth rate. In columns (2), (4) and (6) we report fixed effects results. Due to the overlapping nature of our dependent variable, the error term follows a moving-average process, therefore we use a robust procedure to compute the standard errors of our coefficient estimates; the standard errors are also clustered by country. Despite the future growth rate on the left-hand side, there may still be endogeneity bias remaining if the growth rate and sovereign debt are jointly determined by a third, omitted variable. Therefore, in columns (1), (3) and (5) we report the results from the instrumental variable GMM estimation, implemented in stata by the `xtivreg2` of Schaffer (2010). To instrument for the sovereign debt ratio and primary deficit ratio, we use their 1-3 period lags. Reported standard errors are robust to heteroskedasticity and autocorrelation of the order 5, 3 or 2, in columns (1), (3) or (5), respectively. GMM IV is our preferred specification, and is also used later in the simulations of the model for policy analysis. The reported fixed-effects estimation results primarily serve as a robustness check.

At the bottom of the Table 1 we list the estimated threshold effect. This is the level of debt where the kink in the growth equation appears. The estimation procedure of the threshold follows Hansen (1999); for each specification we search over a grid of different thresholds to find the one that minimises the residual sum of squares. We then take the estimated threshold effect as given, and use it to estimate the model. The estimated threshold effects in all cases are close to 90%, consistent with findings by other researchers. Reinhart and Rogoff (2010) find that for the level of debt ratio above 90%, the average growth rate falls, whereas below that threshold, the relationship between government debt and GDP growth is weak. A point estimate for the threshold close to 90% for the effect of public debt on growth is also reported in Cecchetti et al. (2011) and Checherita and Rother (2010). Kumar and Woo (2010), on the other hand, consider two externally-imposed thresholds at 30% and 90% debt levels, and they find that beyond the 90% level, debt becomes harmful to growth.

Table 1. **Estimated growth equations**

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
	GMM IV	FE	GMM IV	FE	GMM IV	FE
	Five year forward of GDP growth rate (%)		Three year forward of GDP growth rate (%)		One year forward of GDP growth rate (%)	
Government debt/GDP (%)	-0.000271 (0.00493)	-0.000546 (0.00775)	0.00204 (0.00563)	-0.000555 (0.00762)	0.0135* (0.00710)	0.00213 (0.00741)
Government debt and threshold dummy	-0.0274*** (0.00818)	-0.0276** (0.0122)	-0.0269*** (0.00874)	-0.0285*** (0.0103)	-0.0258*** (0.00963)	-0.0293*** (0.00898)
– interaction						
Primary deficit/lagged GDP (%)	0.0116 (0.0201)	0.0177 (0.0213)	0.0389 (0.0263)	0.0239 (0.0265)	0.0596 (0.0405)	0.0105 (0.0335)
Real long-term interest rate	-0.0611*** (0.0235)	-0.0288 (0.0264)	-0.122*** (0.0335)	-0.0954** (0.0406)	-0.216*** (0.0447)	-0.155** (0.0577)
Inflation rate (%)	-0.0571** (0.0241)	-0.0483 (0.0325)	-0.119*** (0.0275)	-0.110*** (0.0376)	-0.236*** (0.0431)	-0.206*** (0.0524)
Log of GDP per capita	-9.333*** (0.863)	-8.876*** (1.090)	-9.241*** (0.944)	-8.758*** (1.081)	-6.825*** (1.270)	-6.388*** (1.046)
Gross fixed capital formation/GDP (%)	-0.0605*** (0.0224)	-0.0609* (0.0297)	-0.0492* (0.0295)	-0.0674* (0.0339)	0.0236 (0.0398)	-0.0146 (0.0385)
Mean years of schooling	-0.0688 (0.186)	-0.0974 (0.252)	-0.247 (0.197)	-0.231 (0.233)	-0.587*** (0.216)	-0.483** (0.232)
Trade openness	0.0143** (0.00686)	0.0159* (0.00881)	0.0180** (0.00717)	0.0182* (0.00923)	0.0313*** (0.00927)	0.0214** (0.0102)
Population growth (%)	-0.303 (0.228)	-0.244 (0.259)	-0.402 (0.255)	-0.436 (0.294)	-0.0652 (0.256)	0.0100 (0.257)
Total dependency ratio	-0.0359* (0.0216)	-0.0338 (0.0244)	-0.0477* (0.0248)	-0.0389 (0.0259)	-0.0320 (0.0312)	0.0102 (0.0258)
Banking crisis indicator	-1.659*** (0.325)	-1.765*** (0.399)	-1.771*** (0.330)	-1.778*** (0.395)	-1.645*** (0.399)	-1.644*** (0.460)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant		162.5*** (18.49)		162.9*** (18.59)		119.9*** (18.02)
Effect of government debt/GDP (%)	-0.0277*** (0.000)	-0.0281*** (0.005)	-0.0249*** (0.000)	-0.0291*** (0.001)	-0.0123* (0.061)	-0.0271*** (0.000)
– above threshold (p-value)						
Observations	640	699	696	755	749	808
Number of countries	28	28	28	28	28	28
Debt threshold	91	91	86	86	82	87

Note: *** p < 0.01, ** p < 0.05, * p < 0.1. All regressions use country-fixed effects. Instrumental variables in GMM IV regressions [columns (1), (3) and (5)] are 1-3 period lags of government debt ratio and primary deficit ratio. In GMM IV regressions the reported standard errors are robust to heteroskedasticity and autocorrelation of the order 5, 3 or 2, in columns (1), (3) or (5), respectively. In fixed-effects panel regressions [columns (2), (4) and (6)] the reported standard errors are robust to heteroskedasticity and adjusted for clusters by countries.

According to the results reported in Table 1 the effect of government debt below the threshold is not statistically significant, except perhaps in the short term as indicated in column (5). Above the threshold, on the other hand, the effect is consistently negative and statistically significant, shown in italics towards the bottom of Table 1. First, comparing the coefficients across different specifications one can note that the negative effect of debt on growth becomes stronger over time, that is, the coefficient in column (5) is smaller in absolute value than that in column (1). Therefore, increasing public debt by 1 percentage point this year will on average reduce GDP growth next year by 0.012 percentage points, whereas it will reduce the average annual growth over the next five years by 0.028 percentage points. The effect of debt on growth in the latter case is therefore about twice as large.

The direction of the effects of the primary deficit and the interest rate on growth is also as expected and the longer-run effects are generally weaker than the short-run effects. However, in all cases the effects are statistically not significant, suggesting that these effects are, if anything, weakly positive. Increasing the primary deficit as a share of lagged GDP by 1 percentage point this year increases the growth rate by 0.060 percentage points in the next year, as reported in column (5). This drops down to 0.039 for the average growth rate in the next three years, column (3), and to 0.012 over the next five years, column (1)⁸. In the same way, the real long-term sovereign interest rate has a stronger negative effect on growth in the short term as compared with the medium/long term.

Table 1 also reports the results for other controls. The coefficient of the log of GDP per capita has a negative sign, implying the so called “catch-up” effect. The inflation rate has a negative effect on GDP growth and trade openness has a positive effect, both as expected. A strong and negative effect on growth comes from the banking crisis indicator. For example, a banking crisis one year ahead is expected to reduce the growth rate in that same year by about 1.6 percentage points, as reported in column (5). The rest of the coefficients on controls are statistically not significant. The population (total dependency ratio and population growth) and education variables are slow-moving hence, perhaps in the fixed effects setting, they do not have enough variation. Recall also, that in our case we use GDP growth on the left-hand side instead of per capita GDP growth, therefore, when we compare the coefficient on population growth with other growth regression estimations we should subtract 1 from our result. Doing so, we get somewhat closer to the results reported in Checherita and Rother (2010). The coefficient on investment (gross fixed capital formation) is also not statistically significant, but insignificant coefficients for this variable are reported in similar regressions also by Cecchetti *et al.* (2010) and Checherita and Rother (2010).

3.2. Interest rate equation

We estimate the following interest rate equation:

$$r_{i,t+1} = \sigma + \varphi \left(\frac{\dot{D}_{it}}{D_{i,t-1}} - \frac{\dot{Y}_{it}}{Y_{i,t-1}} \right) + \omega' W_{i,t} + \mu_i + \vartheta_t + \epsilon_{i,t} \quad (10)$$

where, the dependent variable $r_{i,t+1}$ measures the one year forward real long-term interest rate on government bonds, i denotes a country and t denotes time. μ_i and ϑ_t stand for country-fixed effects and year dummies, respectively, and $\epsilon_{i,t}$ is the error term. Again, all the main variables are expressed in per cent or percentage points.

The second term on the right-hand side in equation (10) represents the growth rate of the debt to GDP ratio. As suggested in the theoretical section above, we would expect the long-term sovereign interest rate to increase when debt dynamics worsen. We use the current debt dynamics to estimate the effect on future interest rates. Moving the interest rate one year forward partly solves the problem of simultaneity, given that the current interest rate can have quite a strong impact on current debt dynamics. However, as stressed also by Laubach (2009), it is the expectations of future debt dynamics that are important for determining the interest rate, and can also be used to circumvent the problem of endogeneity. He for example uses projections of fiscal variables several years into the future to estimate the interest rate equation. However, to stick to the model as presented in Section 2, we use the current level of debt growth. Expectations about debt

dynamics are thus incorporated into the country-fixed effect and the error term. Of course, in this way the error term remains correlated with the debt growth term, therefore we again estimate the model using instrumental variable GMM estimation.

The $W_{i,t}$ in equation (10) stands for the controls. In choosing the controls we follow Laubach (2009) and Checherita *et al.* (2010) that estimate similar equations. The *real short-term interest rate* controls for the effect of monetary policy and monetary conditions more generally on long-term interest rates; the *inflation rate* controls for macroeconomic stability and rises in prices, and the measure of *trade openness* allows for the open economy and controls for potential effects of openness on capital flows and interest rates.

On top of this we also include two additional sets of controls. First is the *banking crisis indicator* variable and the *interaction of the banking crisis indicator with the “southern eurozone” dummy*. The “southern eurozone” indicator variable is equal to one for the following countries: Greece, Ireland, Italy, Portugal, Slovakia, Slovenia and Spain; and zero otherwise, from the year they adopted the euro. The second set of controls includes, in addition to the debt growth variable, the *interaction of the debt growth with the “southern eurozone” dummy*.

The rationale for including these variables comes from the discussion in De Grauwe and Ji (2012). They observe that the increase in the debt-to-GDP ratios since 2007 is significantly faster in the United States and the United Kingdom than in the eurozone, yet it is the eurozone that has experienced a severe sovereign debt crisis. They argue that this is because the eurozone countries do not have control over their own money. Thereby, member countries are susceptible to movements of distrust. When such movements of distrust occur, the sovereign spreads are likely to increase significantly without much movement in the underlying “fundamentals” that influence the solvency of the country. In their paper they find that while before the crisis the debt-to-GDP ratios in the eurozone do not seem to have affected the spreads, after 2008, this relationship becomes quite significant, *i.e.* it appears that financial markets are less tolerant towards high debt-to-GDP ratios in the eurozone as compared with the stand-alone countries, and especially so in the eurozone periphery. Evidence discussed in Section 1 is consistent with this view.

To capture this phenomenon we therefore include the banking crisis dummy and interact it with the southern eurozone dummy to see whether in the time of crisis, the sovereign yields in the “southern eurozone” increase more than predicted by fundamentals. On the other hand, the interaction of the debt growth variable with the “southern eurozone” indicator measures whether *changes* in debt growth have stronger consequences for the “southern eurozone” compared with the rest of the OECD countries.

In Table 2 we report the results from the fixed-effects panel estimation, column (2), and the instrumental variables GMM estimation, column (1), our preferred specification.⁹ Instrumental variables used in column (1) are the 1-3 period lags of government debt ratio growth and interactions. The reported standard errors are robust to heteroskedasticity and autocorrelation.

The reported effect of the growth of government debt to GDP ratio on long-term real interest rates in column (1) is of a positive sign, as expected. A rise in debt growth by 1 percentage point increases the next year real long-term interest rate by 6.3 basis points for countries that do not belong to the “EMU south” group. The interaction of the debt growth with the south eurozone dummy shows that for these countries movements in debt have a much larger effect on interest rates compared with the rest of the OECD.

Table 2. **The effect of growth in sovereign debt on long-term interest rates**

	(1)	(2)
	GMM IV	FE
Dependent variable: One year forward real long-term interest rate		
Growth in government debt ratio (%)	0.0628** (0.0263)	0.0159** (0.00669)
Interaction – debt growth and EMU “south” indicator	0.103*** (0.0329)	0.0148 (0.0216)
Banking crisis indicator	-0.126 (0.393)	0.388 (0.310)
Interaction – banking crisis and EMU “south”	1.855* (0.976)	2.844*** (0.926)
EMU “south” indicator	0.431 (0.379)	0.0459 (0.646)
Real short-term interest rate	0.161*** (0.0482)	0.274*** (0.0909)
Inflation rate (%)	-0.261*** (0.0422)	-0.281*** (0.0769)
Trade openness	0.0129 (0.00957)	0.00256 (0.0121)
Year dummies	Yes	Yes
Constant		1.872** (0.736)
Observations	772	821
Number of countries	29	29

Note: GMM IV regressions. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors are in parentheses. All regressions use country-fixed effects and we include year dummies. In GMM IV regression the instrumental variables are 1-3 period lags of government debt ratio growth and its interaction terms. The reported standard errors are robust to heteroskedasticity and autocorrelation of order 2, respectively. In the fixed effects panel regression the reported standard errors are robust to heteroskedasticity and adjusted for clusters by countries.

Interestingly, the banking crisis by itself does not have a statistically-significant impact on the long-term sovereign interest rate, although in the sense of economic significance, the coefficient is quite large. More importantly, however, there is evidence that for the southern euro countries, the banking crisis causes significant stress and, on average, adds about 180 basis points more to the interest rate compared with other countries in times of banking crisis. The results are therefore telling a story that the southern euro area countries in times of banking crisis are, for reasons not related to “fundamentals”, put under higher market pressure and at the same time they need to pay the higher price for any increases in their debt growth. This is evidence for the behaviour of markets as described by De Grauwe and Ji (2012).

4. Policy experiments

The econometric estimates reported in the previous section allow us to identify the empirical values of the parameters in the theoretical model. Once we have empirically estimated the parameters we are able to compute the debt levels that correspond to the “good” and “bad” solutions as well as the multipliers developed in Section 2 (comparative statics). In addition, we are able to set up a dynamic version of the model in discrete time, and use it to run shock and policy simulations (comparative dynamics).

4.1. Comparative statics

Most parameter values in our stylised model can be directly inferred from the estimation results, with the exception of the terms a and h appearing in, respectively, the growth and interest rate equations. These comprise country-specific constant terms as well as the impact of a range of control variables on growth and the interest rate, and hence vary across countries and over time. In addition we need to modify the theoretical model to capture the threshold effect of public debt on growth. Specifically, the relevant growth equation reads:

$$\frac{\dot{Y}}{Y} = a - b_1 \frac{D}{Y} - b_2 M \left(\frac{D}{Y} - T \right) - fr + gp \quad (1c)$$

where M is a dummy variable taking the value 1 if the debt ratio is above the threshold and zero otherwise and b_2 represents the difference in the growth impact of the debt ratio above the threshold, T . This equation can be re-written as:

$$\frac{\dot{Y}}{Y} = a' - (b_1 + b_2 M) \frac{D}{Y} - fr + gp \quad (1d)$$

in which $a' = a + b_2 M \times T$. This gives us a properly adjusted estimate of the constant term in the equation. The debt threshold, i.e. the level of debt where the kink in the growth equation appears, is fixed at 82% of GDP, consistent with our regression results for the GMM IV results for the one-year forward growth equation (our preferred specification).

The numerical parameters inferred from the estimation results, are reported in Table 3. The baseline parameters refer to the parameters excluding the impact of financial crisis and/or the country being part of the “euro area south” in the interest rate equation. The second column in the table presents the parameters that apply to countries in the euro area south whose bond yields and growth rates are affected by the banking and sovereign debt crisis. In line with the regression results, the parameter a is reduced by 0.016 to capture the estimated impact of the banking crisis on growth. Similarly, the parameters c and h are increased by 0.103 and 0.019 to capture the stronger impact of, respectively, growth in the debt-to-GDP ratio and the banking crisis.

These parameter estimates allow us to identify the “good” and “bad” debt ratios and the multipliers developed in Section 3. It should be stressed, however, that these estimates apply to the average of the sample as a whole and not necessarily to individual countries or sub-periods, and obviously are surrounded by uncertainty margins. The results are reported in Table 4. For a primary deficit (p) equalling 0.3% of GDP (which is the sample

Table 3. **Model parameters**

	Whole sample pre-crisis	“Euro area south” crisis
a	0.028	0.012
b_1	-0.013	-0.013
b_2	0.026	0.026
c	0.063	0.166
f	0.216	0.216
g	0.060	0.060
h	0.027	0.046

Note: In the calibrated model fractions are not expressed as percentages, meaning that intercepts of the estimated growth and interest-rate equations are divided by 100.

Table 4. **“Good” and “bad” debt and multipliers under different assumptions**
In per cent

	“Good” debt ratio	“Bad” debt ratio	Multipliers with respect to:		
			a	p	h
Whole sample pre-crisis	69	107	10	-8	-12
$b_2 + 1 \text{ SE}$	69	81	5	-5	-6
$b_2 - 1 \text{ SE}$	69	241	40	-14	-49
$f + 1 \text{ SE}$	75	95	10	-10	-13
$f - 1 \text{ SE}$	63	118	9	-7	-11
$g + 1 \text{ SE}$	69	108	3	-8	-12
$g - 1 \text{ SE}$	70	105	10	-9	-12

Note: SE indicates standard error on panel estimates of the parameters; multipliers measure the impact on the “bad” debt ratio of 10 basis points (0.1 percentage point) changes in a , p or h .

average), the corresponding sample average “bad” debt ratio equals 107% of GDP. This implies that, on average, a country recording a debt ratio above 107% would see its debt ratio spiral out of control and its economy slump in the absence of offsetting policy action. Conversely, the “good” solution to which the debt ratio converges if it is below the 107% threshold turns out to be 69% of GDP. This means that if the debt ratio is in the 69%-107% interval it would, on average, be falling towards 69% (and conversely increasing towards 69% if it is below that level). Again, these are rough orders of magnitude based on estimates that apply exclusively to the sample average, and for illustrative purposes only.

The multiplier analysis in Table 4 shows that, again for the sample as a whole, structural reform yielding a sustained increase in economic growth of 0.1 percentage points per annum raises the bad debt ratio (i.e. moves out the point B) by 10 percentage points. This suggests that the contribution structural reforms brings to debt sustainability can be significant. Similarly, a sustained cut in the risk premium on the interest rate by 10 basis points increases the bad debt ratio by 12 percentage points. A sustained increase in the primary deficit as a share of GDP by 0.1 percentage point reduces the bad debt ratio (beyond which bad dynamics set in) by 8 percentage points. This means that, based on our sample and time period, fiscal expansion, on average, renders the economy less stable. The consequence is that a country caught in bad dynamics should pursue a restrictive fiscal policy.

Table 4 also reports a sensitivity analysis for different assumptions with regard to the estimated model parameters. We have computed the impact of increases or decreases amounting to one standard error for several parameters. The most striking finding is the large sensitivity of the results to variations in the parameter value for b_2 , the semi-elasticity (interaction term) of growth with respect to the debt ratio beyond the “Reinhart-Rogoff threshold” of 82%. This suggests that relatively small changes in the sensitivity of growth to debt can have a substantial impact on macroeconomic stability. This adds a dimension to the original Reinhart-Rogoff findings which focus on the impact of debt on trend growth whereas from our analysis also its impact on macroeconomic stability can be inferred.

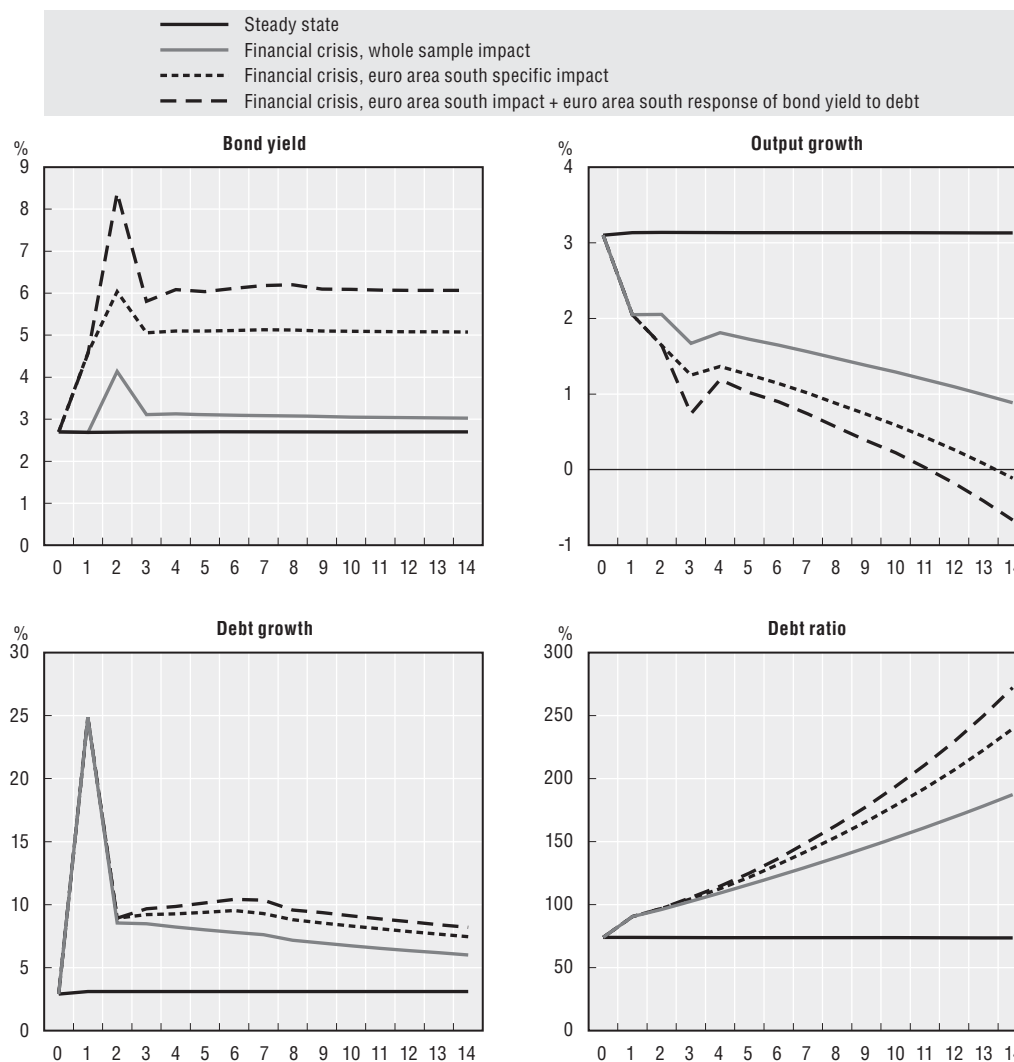
Importantly, adopting the parameter values that apply to “euro area south” countries in crisis (reported in the second column of Table 3) does not yield a feasible solution for the “good” and “bad” debt ratios. In terms of the graphical representation of the theoretical model this means that the BC schedule has shifted so much upward and/or the RR schedule so much downward that they no longer intersect. In other words, without strong and decisive policy actions, these countries can never return to a stable path of debt and growth dynamics, as will be illustrated by our comparative dynamic simulations in the next section.

4.2. Comparative dynamics

The model can be used to carry out dynamic simulations of policy impulses. We focus our attention on the “euro area south” as this is the most interesting case to look at in the current situation. To do so, we first need to set up a baseline trajectory of these economies after the crisis without subsequent policy responses to resolve it, which is done in four steps. All simulations are carried out for a period of 15 years, including the initial year “0”. In a *first* step a simulation is run in which all parameters are fixed at their values for the whole sample as shown in the first column of Table 3.¹⁰ For the initial value of the (exogenous) primary deficit p we again take the whole-sample average (0.3%) and for the initial debt ratio we take the “good” solution of 69%, (slightly above the sample average of close to 60% of GDP) to ensure that these economies start off from a stable equilibrium steady state (see the “steady-state” dark solid lines in Figure 9).¹¹

In the *second* step, the impact of the financial crisis is simulated by decreasing the intercept a in the growth equation in line with the estimation results (equivalent of a once-and-for-all decline in economic growth of 1.6%). In addition, we shock the primary

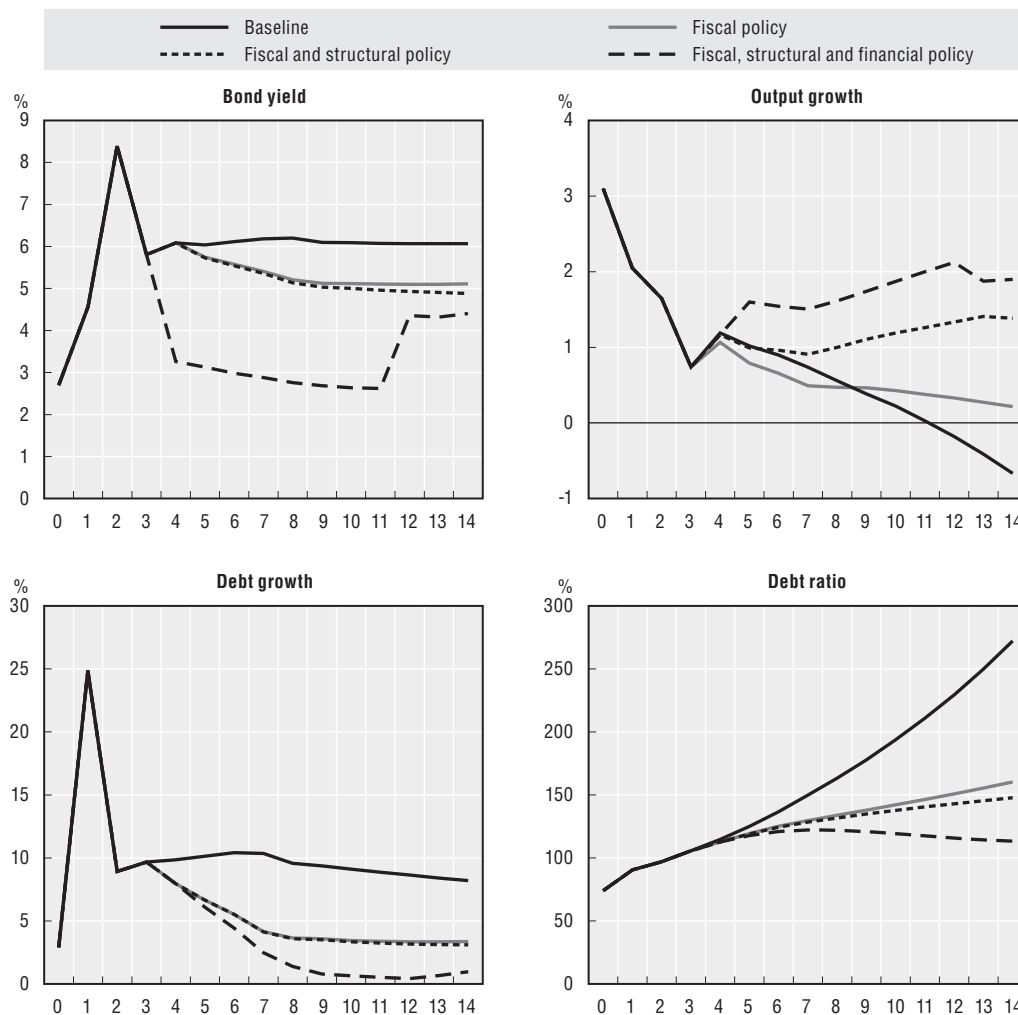
Figure 9. Baseline simulation for the “euro area south”



deficit p by 5% once and for all to reflect the fiscal expansion that countries pursued (both discretionary and by letting automatic stabilisers operate) as activity slumped, and shock the debt ratio by 15% of GDP in period 1 to reflect the fiscal cost of bank rescues. The size of these shocks is roughly calibrated on actual developments in OECD countries in the wake of the acute phase of the financial crisis in 2008/09. As shown in Figure 9, this set of shocks raises the sovereign risk premium initially, to fall back later, though not all the way to its initial (steady-state) level. Growth is declining and the debt ratio explodes: the economy is clearly pushed beyond the “bad” debt solution.

In a *third* step, we shock the sovereign yield (h) to bring it in line with the estimation results for euro area “southern” countries, and in a *fourth* step we increase the parameter that gauges the sensitivity of the sovereign yield to public debt and growth developments (c), again to bring it in line with the estimation results for the group of euro-area “southern” countries. As Figure 10 shows, the resulting baseline for the (average) “euro area south” country sees the sovereign bond yield peak at over 8%, growth slide towards negative territory and the debt ratio heading towards 200% of GDP in ten years time from the initial 69%.

Figure 10. Policy simulation for the “euro area south”



Obviously these results should be interpreted with caution; they indicate expected directions and rough orders of magnitude and should not be interpreted as “forecasts”. The main purpose of this simulation, as noted, is to construct a baseline that broadly gauges the macroeconomic performance of euro area southern countries in the wake of the financial crisis, against which the impact of policy responses can be assessed.

Onto this complete euro area south baseline three policy shocks are superimposed. First, fiscal consolidation is assumed to be implemented roughly in line with the required fiscal consolidation effort to bring public finances back on a sustainable path, on average, in the southern euro area countries for an exogenously given growth rate and bond yield (see OECD, 2012). Accordingly, the primary deficit is cut by 8 percentage points of GDP, in four steps of 2% in each of the years 4, 5, 6 and 7 of the simulation period (fiscal consolidation is thus assumed to start in earnest four years into the crisis again roughly in line with the observed pattern). As shown in Figure 10, due to the negative demand impact of fiscal consolidation, output growth is initially lower than in the baseline, but will eventually recover towards a higher growth path. The bond yield would be permanently lower (by about 100 basis points) and the rise in the debt ratio clearly less steep.¹² The upshot is that fiscal consolidation is crucial for macroeconomic stability over the medium to long run, but also carries short-run costs. Even so, and unlike in OECD (2012), the economy is still on a “bad” path.

Second, structural reform is then assumed to be implemented and beginning to bear fruit in year 4, raising the growth rate eventually by 1%, though in steps of only one-tenth of a per cent every year i.e. the parameter a is increased by cumulative steps of 0.1% per year. This assumes both a strong effort and a large multiplier of structural reform, indeed close to the maximum attainable for a weighted average of distressed euro area countries, based on recent estimates by Bouis and Duval (2011). There are no (net) negative growth effects of structural reform assumed for the initial period, roughly in line with findings in Cacciatore et al. (2012) suggesting that (some forms of) structural reform can be expected to bear fruit from the outset. In this simulation growth-debt dynamics further improve, but the debt ratio is still increasing, suggesting the economy is still “to the right of the bad solution”.

We examine in a *third* simulation how financial support – in addition to other policies – can bring the economy back onto a path towards the “good” debt ratio by lowering the bond yield. There are two dimensions to consider: the size of the impact on bond yields and the duration. As to the size, we assume financial policy to generate a sustained negative shock to h and c bringing the values of these parameters back to the OECD averages reported in Table 3 (i.e. we assume the elimination of the area-specific systemic effect plaguing southern euro members). To determine the required duration of financial support of this size we experimented with different durations (all starting in year 4). The purpose of this simulation is precisely to examine how long it would need to be sustained so as to ensure that the economy tends back to the “good” debt ratio. It turns out that in our model and setting the minimum period to obtain convergence towards that ratio is eight years. This is a very long period of time if the fall in interest rates is to be the result of a temporary intervention. However it may be much more realistic if it is the result of institutional reforms that strengthen monetary union to the point of eliminating risks of break up and “contagion effects” in the weakest members.

As shown in Figure 10, the bond yield substantially falls during this period, to rise again when the support is clawed back. Even so, this operation brings the yield onto a lower path permanently. The growth of the debt ratio is stemmed to eventually stabilise and next follow a slightly downward-sloping path. Output growth is on a gradual recovery path, despite a minor setback when the financial support ends. The upshot is that a sovereign confidence “bridge” with a duration of the order of eight years would engineer a return to the “good” debt ratio, conditional on fiscal and structural policy action as laid out above. However eight years is quite a protracted period which would bear a substantial cost and runs against the intuition that financial backstops are temporary in nature. This suggests that a stronger contribution to debt sustainability should come from structural reforms and fiscal consolidation and that a more permanent fall in interest rates can come as the result of institutional reforms aimed at strengthening the architecture of monetary union.

5. Concluding remarks

In this article we attempt to gauge the processes that trap countries in “bad” dynamics of high and growing fiscal deficits and debt, high risk premia and deep recession. For this we develop a simple and stylised analytical framework, both tractable and easy to estimate, capturing several key dimensions of the current crisis. We use it to examine if and how a combination of fiscal consolidation, structural reform and financial backstops can help countries, notably the southern euro-area countries, to escape from the debt trap. From the analysis we infer the following three main conclusions.

First, financial backstops are helpful to deal with a crisis situation and offsetting the risk of falling into a debt trap. In principle it does not matter whether these backstops are directed toward sovereigns or banks, since their fates are tightly intertwined (sovereigns guarantee banks while banks hold government bonds). However, either way their impact is limited and fades away relatively soon if not followed by permanent and credible solutions to break the feedback loop between banks and sovereigns, i.e. deeper monetary union, including banking, fiscal and political union. In other words financial backstops only “buy time”. Time must be used productively for fiscal consolidation and structural reforms to bear fruit, as well as to launch deep reforms of monetary union.

Second, our analysis confirms that the loss of fiscal policy space of countries trapped in bad dynamics inevitably requires that fiscal action be directed towards consolidation, as reducing debt levels breeds stronger growth and results in lower sovereign risk premia. It also shows that fiscal consolidation initially may depress growth, but not to an extent where this would push a country into bad dynamics or prevent it from escaping from it. So, in a medium-term timeframe the trade-off between “austerity” and growth would not exist. However, in the short run it may well indeed, and this makes the political economy of fiscal consolidation tricky. This is why it is particularly useful for countries trapped in bad dynamics to be able to benefit from a “confidence bridge” through financial backstops.

Third, there is a very important role for structural reform to help countries escape from bad dynamics. Since the beginning of the crisis many countries have enacted structural reform in tandem with fiscal consolidation measures, which bodes well for the future. We find that a boost to growth through structural reforms is key to facilitate the exit from bad dynamics. As in the case of fiscal consolidation, however, the positive impact on growth builds up over time, thus potentially giving rise to a political economy dilemma.

Once again, financial backstops to engineer positive interest-rate-debt-growth dynamics already in the short run may help economies to overcome the high-debt trap. Even more importantly, institutional reforms that strengthen monetary union could bring about a permanent fall in interest rates that greatly facilitates debt sustainability. Therefore, avoiding debt traps in monetary union is likely to require a well-designed and implemented combination of structural reforms, fiscal consolidation and financial measures alongside a deepening of monetary union.

Notes

1. The terminology “good” and “bad” equilibrium, while widely practiced, is in fact inaccurate: the bad equilibrium refers to an unstable solution which hence cannot be qualified as in “equilibrium”. We therefore will hitherto use instead the terms “good” and “bad” solution.
2. We include the level rather than the change of the primary public deficit in this growth equation. This is consistent with the “Robertsonian saving” hypothesis embedded in Duesenberry’s (1958) model. This hypothesis postulates that the next period’s output is determined by the preceding period’s income less net saving (S_n), so $Y_{t+1} = k(Y - S_n)$, where k is a constant. This implies that $\dot{Y}/Y = -kS_n/Y - (1-k)$, so it is the level of net saving as a share of output that determines the next period’s output growth rate. Net saving can be broken down into public net saving as a share of output, i.e. the fiscal position, and private net saving as a share of output, which in turn may be assumed to be a function of the public debt ratio, the real interest rate and wealth effects stemming from structural reforms, as is implicitly assumed in equation (1b).
3. For the sake of simplicity we omit in this specification the impact of other factors on changes in the stock of debt, such as revaluations, the purchase or sale of financial assets by the government, or default.
4. See Cecchetti *et al.* (2011) and Checherita and Rother (2010). Some authors find two thresholds, with debt below the lower threshold favourable to growth and debt beyond the higher threshold harmful to growth; see Kumar and Woo (2010) and Elmeskov and Sutherland (2012) who report thresholds of 30% and 90% and 45% and 66%, respectively.
5. The countries included are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Kingdom and the United States.
6. To see why current primary deficit is taken as a share of lagged GDP, one should observe that the debt growth equation is derived from the expression $\dot{D}_t = r_t D_{t-1} + P_t$, dropping country index i for the moment. Now, dividing this by D_{t-1} and rearranging, we obtain the expression that corresponds to equation (3): $\frac{\dot{D}_t}{D_{t-1}} = r_t + \frac{P_t/Y_{t-1}}{D_{t-1}/Y_{t-1}}$.
7. They “consider a banking crisis to be systemic if two conditions are met: i) Significant signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, and bank liquidations); and ii) Significant banking policy intervention measures in response to significant losses in the banking system”. This variable is originally available up to the year 2009, thus we “update” it by extending the last value in 2009 for another two subsequent years, assuming that the countries in the financial crisis in 2009 remained in the crisis for another two years, and *vice versa*. We think that the error thus committed is not too big.
8. It should be noted that the size of the so-called fiscal multiplier is an ongoing debate, and furthermore, fiscal multipliers may be very different in a booming economy as compared with an economy in crisis, when monetary policy faces a zero lower bound, there is ample economic slack and households face liquidity constraints. To empirically explore this issue further is beyond the scope of this paper, but for readers who want to read more, a good starting point is IMF (2012).
9. Note that due to data availability, compared with the estimation of the growth equation there is one extra country included: Luxembourg. Excluding this country from the interest-rate estimation would not make much difference to the results.

10. The effective interest rate on government debt is assumed to be equal to the five-period moving average of the market yield.
11. We assume that southern euro countries start from the same 69% level of “good” debt. Hence we assume that their specific h and c values are triggered only after the crisis has hit. The lower value for a is not area specific, but applies to the whole sample after the financial crisis has hit.
12. According to OECD (2012) this order of magnitude of fiscal consolidation would be sufficient to stabilise the debt ratio only if economic growth recovers, which is clearly not the case in this simulation.

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Data annex

Source: OECD Economic Outlook 90 Database.

Variables:

GDP growth – annual growth rate of gross domestic product, volumes.

Public debt ratio – general government gross financial liabilities, values, as a share in gross domestic product, values. For some countries (Greece, Ireland, Luxemburg, Portugal and Slovenia), gross public debt, Maastricht criterion, values, extends further back in time, therefore for these countries we back-dated the public debt series. The Maastricht series was multiplied by a factor such that the two series have the same value in the first year that the public debt series appears.

Primary deficit – government primary balance, values. In regressions it is used as a share in lagged gross domestic product, values.

Real long-term interest rate – real long-term interest rate based on lagged GDP deflator, based on the long-term, 10-year government bonds yields.

Real short-term interest rate – real short-term interest rate based on the private consumption deflator, based on short-term, 3-month interbank interest rate.

Inflation – based on the consumer price index.

Gross fixed capital formation ratio – gross fixed capital formation, total, volumes, as a share in gross domestic product, volumes.

Mean years of schooling – measures mean years of schooling for the population of 24-65 years of age. Education data is obtained from Bouis et al. (2011). In the data the information on education is available for every five years only. For the missing values we interpolate the series.

Trade openness – measured as the sum of exports and imports as share in gross domestic product, volumes. Exports and imports are exports of goods and services, volumes, and imports of goods and services, volumes, respectively.

Population – total population obtained from OECD Statistics.

Total dependency ratio – total dependency ratio computed as the sum of the number of those under 15 years of age and the number of those over 64 over the number of 15-64 year olds. Population data are obtained from OECD Statistics.

Banking crisis indicator – based on data on the systemic banking crisis constructed by Laeven and Valencia (2008 and 2010). They “consider a banking crisis to be systemic if two conditions are met: i) Significant signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, and bank liquidations); and ii) Significant banking policy intervention measures in response to significant losses in the banking system”. In constructing the banking crisis indicator we follow Cecchetti et al. (2011), meaning that it takes a value of zero if in the subsequent n years there is no banking crisis, and the value of $1/n$, $2/n$, and so forth, if a banking crisis occurs in one, two, etc., of the subsequent n years.

Do investors disproportionately shed assets of distant countries during global financial crises? The role of increased uncertainty

by

Rudiger Ahrend and Cyrille Schwellnus*

The global crisis of 2008-09 went hand in hand with sharp fluctuations in capital flows. To some extent, these fluctuations may have been attributable to uncertainty-averse investors indiscriminately selling assets about which they had poor information, including those in geographically distant locations. Using a gravity equation setup, this article shows that the impact of distance increases with investors' uncertainty aversion. Consistent with a sudden increase in uncertainty, the negative impact of distance on foreign holdings increased during the global financial crisis of 2008-09. Host-country structural policies enhancing the quality of information available to foreign investors, such as strict disclosure requirements and prudential bank regulation, tended to mitigate withdrawals.

JEL classification: F21, G11, G18

Keywords: Capital flows, gravity model, uncertainty, crisis, financial regulation

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1. Main results

The global financial and economic crisis of 2008-09 highlights that financial stress is often associated with sudden reversals in international capital flows. Such fluctuations may partly reflect that, in times of financial turmoil, information becomes more important for asset allocation decisions as uncertainty-averse investors liquidate assets about which they have poor knowledge (Krishnamurty, 2010; Uhlig, 2010; Milesi-Ferretti and Tille, 2011). From the perspective of recipient countries, this implies that policy measures which improve the availability of information to foreign investors and improve confidence in the soundness of the financial system should result in more stable capital flows.

Even though theoretical models and less formal studies of globalisation often assume frictionless international capital markets, the empirical evidence shows that information frictions, i.e. the cost of collecting information, matter for the geographical allocation of financial assets. It is a well-established fact that a simple gravity model which includes countries' economic size and the distance between them predicts bilateral capital flows at least as well as international trade flows (Portes *et al.*, 2001; Portes and Rey, 2005).¹ This paper follows the standard view in the international capital flows literature that the negative effect of geographical distance on capital flows partly reflects information frictions (Portes *et al.*, 2001; Daude and Fratzscher, 2008; Lane and Milesi-Ferretti, 2008). Even though advances in information and communication technologies have greatly improved formal access to financial information, the empirical evidence suggests that local investors have better access to informal information channels (Hau, 2001; Malloy, 2005; Bae *et al.*, 2008). For instance, local investors may talk to firm representatives, employees, customers and competitors more frequently, or they may form part of a social network of local investors (Hong *et al.*, 2005).²

Financial turmoil may increase the impact of information frictions, thereby triggering disproportionate reductions in investments from geographically distant investors. Financial or macroeconomic shocks can create doubts about the probability distribution of asset returns (i.e. increase Knightian uncertainty), inducing investors to turn to assets about which they have better information (Caballero and Krishnamurty, 2008; Krishnamurty, 2010; Uhlig, 2010). Attracting capital inflows from geographically distant investors who face higher costs of acquiring information may reduce the stability of investments in times of global crises. This paper uses the “natural experiment” of the global financial crisis of 2008-09 to test whether investors from more distant locations indeed reduced their financial asset holdings more than investors from geographically closer areas.

Taking the global financial crisis of 2008-09 as an external shock, the paper further examines structural policy settings that may improve the stability of financial investments from geographically more distant investors. For instance, financial market transparency and stability may moderate the increased impact of geographical distance in times of financial crisis. Similarly, regulatory controls on capital movements could limit the amount

of financial assets foreign investors may repatriate during episodes of financial stress. More generally, financial market regulation may enhance the stability of financial flows.

The paper explores these issues, adding to the existing literature along several dimensions. First, it analyses how geographical distance and national uncertainty aversion interact in shaping foreign investment positions (portfolio equity and debt; FDI; bank loans and deposits). For this purpose, the paper sets up a gravity model including origin- and destination-country fixed effects that appropriately deals with possible omitted variable bias arising in simple cross-section specifications that do not include country fixed effects (Okawa and van Wincoop, 2012). The country-level measure of uncertainty aversion – which has been used in studies on trade (Huang, 2007) and economic development (Huang, 2008) – is based on a value survey of employees holding similar positions across different countries in a large multinational company (Hofstede, 1980, 2001). A second contribution of the paper is to analyse how the distance effect varied during the global financial crisis of 2008-09 as compared with the years immediately preceding it. Analysing how the distance effect varies over time is common in the literature on trade in goods (Disdier and Head, 2008) and services (Head *et al.*, 2009), but no such analysis exists for international investment. An increase in the distance effect during the global financial crisis of 2008-09 could be interpreted as evidence for uncertainty-driven capital outflows. The third and final contribution of the paper is to examine whether structural policy settings that improve the availability of information to foreign investors and improve confidence in the soundness of the financial system influenced the extent of asset withdrawals during the crisis.

The main results of the paper are the following:

- Distance matters for international portfolio allocation.
- The distance effect increases with investing-country uncertainty aversion.
- The distance effect increased significantly during the financial crisis of 2008-09, consistent with the view that uncertainty aversion played a major role.
- There is a clear ranking of the increase in the distance effect across asset classes. Debt securities and bank loans and deposits were more affected than portfolio equity and FDI. This may reflect that portfolio equity and FDI are relatively illiquid investments or that more accurate information on these types of assets is available to investors.
- Accurately measuring the degree and quality of regulation in the financial sector is fraught with difficulties. Nonetheless, indicators of prudential banking regulation, in particular relatively stringent capital adequacy rules and strict information disclosure requirements, appear to have limited the increase in the distance effect during the 2008-09 crisis. By contrast, no such evidence is found regarding other structural features such as financial market development or capital controls.³

The remainder of the paper is organised in the following way. The next section describes the data and outlines the empirical methodology. The empirical results are discussed in Section 3. Section 4 presents robustness and sensitivity checks, and Section 5 concludes with a short discussion of policy implications.

2. Methodology and data

2.1. Methodology

Over the past decade gravity models which have traditionally been used to explain international trade patterns have increasingly been applied to international finance. Essentially, these models explain bilateral capital flows or holdings by the sizes of the two countries and the geographical distance between them. Whereas early contributions estimated *ad-hoc* specifications (Portes *et al.*, 2001; Portes and Rey, 2005), more recent papers have tried to provide theoretical foundations for estimated gravity equations (Martin and Rey, 2004; Okawa and van Wincoop, 2012). These papers model the demand and supply of assets in a general equilibrium framework, with asset trade arising from specific assumptions on asset production and consumer preferences. When trading assets across borders, investors are assumed to incur bilateral trading costs (“financial frictions”), which can be proxied by bilateral variables such as geographical distance or common language and include the cost of acquiring information about foreign assets.

The estimation strategy adopted in this paper is closest in spirit to Okawa and van Wincoop (2012), with this gravity equation taking the following form:

$$X_{od} = \frac{H_o S_d}{H} \frac{P_o \Pi_d}{\tau_{od}} \quad (1)$$

Bilateral asset holdings X_{od} of country o (origin) in country d (destination) are a function of two terms: the first term on the right-hand side of equation (1) ($H_o S_d / H$) is a measure of a country pair’s financial market size, with H_o measuring the total asset holdings of country o , S_d the total supply of assets in country d and H the world holdings of assets. The second term ($P_o \Pi_d / \tau_{od}$) is a measure of relative financial frictions between countries o and d , with τ_{od} measuring the bilateral financial friction, P_o the multilateral or average friction of country o as an origin country, and Π_d the multilateral friction of country d as a destination country.

The intuition for the relative friction term in equation (1) is that bilateral asset holdings depend not only on bilateral financial frictions between partner countries but also on both countries’ frictions with the rest of the world. At a given bilateral friction, a country pair that is financially remote from the rest of the world (high P_o and high Π_d) would be expected to have higher bilateral asset holdings than a less remote country pair. In Okawa and van Wincoop (2012), financially remote countries offer higher risk-adjusted returns in equilibrium, which at a given bilateral friction generates larger bilateral investment.

The empirical counterpart to equation (1) for a panel of bilateral financial asset holdings takes the following form:

$$\ln(X_{odt}) = \sum_{m=1}^M \beta_m Z_{od}^m + \gamma_{ot} + \gamma_{dt} + \varepsilon_{odt} \quad (2)$$

Z_{od}^m are observable proxies for time-invariant bilateral financial frictions, such as the logarithm of geographical distance or a dummy variable for membership in the same currency union. γ_{ot} and γ_{dt} are time-varying origin and destination country fixed effects that account for the unobservable and time-varying multilateral frictions terms in equation (1). In the theoretical model of Okawa and van Wincoop (2012) the multilateral frictions terms are functions of the bilateral frictions terms and are thus likely to be correlated empirically. Omitting the multilateral frictions terms in a “naive” gravity-

equation setup without origin and destination fixed effects may therefore result in a serious omitted-variable bias. Moreover, the time-varying origin and destination country fixed effects capture the variation in investment related to all observable or non-observable fixed and time-varying country characteristics such as country size or the growth outlook. These variables can therefore be omitted from the estimated equation without biasing the coefficients of the included explanatory variables.

Equation (3) modifies the baseline gravity model in equation (2) to test the hypothesis that the effect of distance on bilateral asset positions varies with uncertainty aversion in the investing country:

$$\ln(X_{odt}) = \sum_{m=1}^M \beta_m Z_{od}^m + \beta_U \text{dist}_{od} \cdot \text{UAI}_o + \gamma_{ot} + \gamma_{dt} + \varepsilon_{odt} \quad (3)$$

As in equation (2), observed bilateral financial frictions are captured by the Z_{od}^m . dist_{od} denotes the logarithm of the geographical distance between countries o and d , and UAI_o denotes an uncertainty aversion index in country o . The coefficient of interest, β_U , measures here how the distance effect, which can be interpreted as a measure of information frictions, varies with the uncertainty aversion index in the investing country UAI_o .

Equation (4) examines whether the distance effect increased during the global financial crisis of 2008-09:

$$\ln(X_{odt}) = \beta_c \text{dist}_{od} \cdot \text{crisis}_t + \gamma_{od} + \gamma_{ot} + \gamma_{dt} + \varepsilon_{odt} \quad (4)$$

Crisis_t is a dummy that takes value 1 in the years 2008-09 and 0 otherwise. The coefficient β_c measures here the extent to which the distance effect changed during the global financial crisis of 2008-09. In this specification the recipient-country-year fixed effects fully account for domestic valuation changes in the recipient country, *e.g.* for fluctuations in the recipient-country's stock market index. Moreover, as asset holdings are expressed in US dollars, the recipient-country-year fixed effects also capture exchange-rate-induced valuation changes. As a result, the coefficient β should capture only foreign investors' active portfolio reallocation strategies.

Finally, the paper investigates how structural policy settings shaped the increase in the distance effect during the global financial crisis of 2008-09, using the following specification:

$$\ln(X_{odt}) = \beta_k \text{dist}_{od} \cdot \text{crisis}_t \cdot \text{pol}_d^k + \beta_c \text{dist}_{od} \cdot \text{crisis}_t + \gamma_{od} + \gamma_{ot} + \gamma_{dt} + \varepsilon_{odt} \quad (5)$$

The coefficient of interest in this specification is β_k , which measures how the increase in the distance effect during the global financial crisis of 2008-09 varied with structural policy setting pol_d^k in the destination country. The term $\text{dist}_{od} \cdot \text{crisis}_t$ denotes the simple interaction between geographical distance and the crisis dummy already featured in equation (4) above.

2.2. Data

This paper constructs a comprehensive database of stocks of the four asset categories constituting the financial account, namely portfolio equity and debt, FDI, as well as bank loans and deposits. For portfolio investments the IMF's Consolidated Portfolio Investment Survey (CPIS) is used, which reports bilateral portfolio equity and debt investments for

74 reporting countries and 231 partner countries for the years 2001-2009.⁴ Information on bilateral FDI stocks is taken from the *OECD International Direct Investment Database*, which covers 34 reporting countries and 217 partner countries. For bilateral bank loans and deposits BIS Locational Banking Statistics (ILB) are used, which are available for 25 reporting countries and 205 partner countries.

Financial centres are excluded from the regressions reported in the main part of the paper.⁵ The rationale is that financial centres act as pure intermediaries that are neither the true source nor the true destination of foreign investments. Several checks on the sensitivity of the results to the precise list of excluded financial centres are conducted in Section 4.

The data contain a substantial number of observations equal to zero.⁶ In the baseline specifications these observations are dropped as the dependent variable is specified as the logarithm of the bilateral investment position. The rationale is to focus on how the magnitude of positive bilateral investment positions varies with changes in the explanatory variables rather than on changes from zero to positive holdings. To assess whether the logarithmic transformation of the gravity equation biases the estimated coefficients, including because zero reported trade flows are dropped, several robustness checks are conducted in Section 4.

The estimation covers two periods, namely the years 2005-06 and 2008-09. For the results reported in the main text the pre-crisis distance effect is estimated using the end-of-year asset positions in 2005-06 and the distance effect during the crisis using the asset positions in 2008-09. While it is possible to use only one year for each period, using two years has the advantage of limiting measurement error in bilateral capital stocks. The sensitivity to using only one year for each period is assessed in Section 4.

The country-level measure of uncertainty aversion used in this paper is taken from Hofstede (1970, 2001). It is based on a survey that asks around 90 000 employees of a large multinational company in 50 countries, holding similar positions in marketing and customer service, several questions to assess their attitudes toward uncertainty and ambiguity. Recent studies on international trade (Huang, 2007) and economic development (Huang, 2008) have used the Hofstede measure of uncertainty avoidance as an explanatory variable, showing that uncertainty avoidance has a significant impact on the geographical structure of exports and the industrial composition of growth.⁷

Further explanatory variables include the bilateral Z_{od}^m variables in equation (2) which measure geographical and cultural proximity (geographical distance, common language, common border) and are taken from CEPII's distance database. The pol_d^k in equation (5) measure structural policies and other destination country characteristics. They include income per capita from the World Bank World Development Indicators and financial development indicators (private credit to GDP and liquid liabilities to GDP) from Beck and Demirgüç-Kunt (2009). They further include measures of banking regulations in different areas, including capital adequacy and information disclosure requirements, obtained by extending the database of Ahrend et al. (2009) to non-OECD countries; indicators of capital flow restrictions taken from Schindler (2009), Brune (2006) and Quinn and Toyoda (2008); and the measures of overall institutional quality provided by *The World Bank Governance Indicators Database*.

3. Empirical results

3.1. Baseline

The results for the baseline specification (1) estimated for the years 2005-06 are reported in Table 1.⁸ As all regressions control for investing-country-year and recipient-country-year fixed effects, the effect of GDP as a proxy for countries' economic sizes is not separately identifiable. Distance, common language, common border, colonial relationship in the past and membership in the euro area vary along both the investing- and recipient-country dimensions.

Table 1. **Baseline specification**

Equation (2)
2005-06

Dependent variable	(1) Total portfolio	(2) Portfolio equity	(3) Portfolio debt	(4) FDI	(5) Loans and deposits
Distance	-0.425*** (0.083)	-0.522*** (0.097)	-0.513*** (0.104)	-1.096*** (0.103)	-1.262*** (0.131)
Common language	0.413*** (0.136)	0.160 (0.143)	0.664*** (0.176)	0.273 (0.185)	-0.156 (0.193)
Common border	0.297* (0.166)	0.438*** (0.168)	0.131 (0.218)	0.111 (0.202)	0.085 (0.273)
Colony	0.192 (0.169)	0.424** (0.188)	0.062 (0.214)	1.100*** (0.230)	1.251*** (0.229)
Euro area	1.198*** (0.139)	0.664*** (0.142)	1.392*** (0.194)	0.117 (0.196)	0.413* (0.229)
Observations	1 353	1 353	1 353	1 353	1 353
R-squared	0.91	0.91	0.86	0.79	0.80

* Significant at 10%; ** significant at 5%, *** significant at 1%.

Notes: Includes investor-year and recipient-year fixed effects. Robust standard errors clustered at the country pair level in parentheses.

Together, the country fixed effects and the proxies for bilateral frictions explain 80-90% of the variation in bilateral asset holdings. In line with results by Daude and Fratzscher (2008), the estimated distance elasticity is around -0.5 for portfolio holdings and around -1 for FDI and loans and deposits. One reason may be that, for the latter, information frictions play a more important role in asset allocation decisions.⁹ The fact that, controlling for other dimensions of distance such as common language, common border or colonial relationship, geographical distance comes out strongly significant for all asset types may suggest that distance by itself is a significant component of bilateral information frictions.¹⁰

Assuming that geographical distance partly measures information frictions for each class of assets, the distance effect should increase with uncertainty aversion. As the cost of information acquisition increases with distance, uncertainty-averse investors should invest mainly at home or in geographically proximate locations. Kasa (2000), for instance, illustrates how the interaction of information frictions with uncertainty-averse investors may explain the negative correlation between distance and foreign asset holdings (Portes et al., 2001). Based on the country-level measure of uncertainty aversion of Hofstede (1980, 2001), it is possible to conduct a formal test of this hypothesis by estimating equation (3) above, which augments the baseline gravity equation with the interaction between distance and Hofstede's (1980, 2001) uncertainty-avoidance index (UAI).¹¹ Table 2 reports the coefficients of this interaction term for four different asset classes.¹²

Table 2. **The distance effect increases with uncertainty aversion**

Specification: Equation (3)

2005-06

Dependent variable	(1) Total portfolio	(2) Portfolio equity	(3) Portfolio debt	(5) Loans and deposits	(6) Total portfolio
Distance	-0.508*** (0.090)	-0.585*** (0.108)	-0.575*** (0.107)	-1.239*** (0.132)	-2.046*** (0.495)
Common language	0.387*** (0.136)	0.140 (0.143)	0.646*** (0.174)	-0.149 (0.191)	0.433*** (0.133)
Common border	0.206 (0.168)	0.368** (0.169)	0.063 (0.217)	0.110 (0.272)	0.179 (0.166)
Colony	0.206 (0.170)	0.434** (0.190)	0.072 (0.212)	1.247*** (0.225)	0.256 (0.162)
Euro area	0.980*** (0.142)	0.498*** (0.149)	1.230*** (0.204)	0.473* (0.243)	0.892*** (0.144)
Distance * UAI	-0.366*** (0.090)	-0.279*** (0.089)	-0.271** (0.122)	0.100 (0.121)	-0.177* (0.101)
Distance * Income per capita					0.600***
Observations	1 353	1 353	1 353	1 353	1 353
R-squared	0.89	0.89	0.84	0.73	0.81

* Significant at 10%; ** significant at 5%, *** significant at 1%.

Notes: The reported distance coefficient relates to the country with mean log UAI (and mean log income per capita in column 6). Includes investor-year and recipient-year fixed effects. Robust standard errors clustered at the country pair level in parentheses.

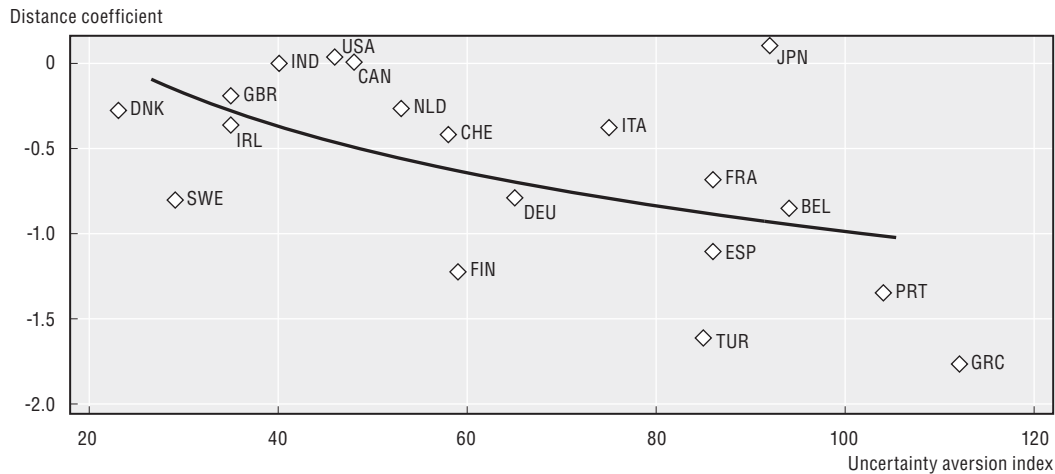
Generally, a higher degree of uncertainty aversion as measured by the UAI is associated with a larger distance effect (a more negative impact of distance on bilateral asset holdings).¹³ As the UAI enters the interaction with distance in logarithmic form, the coefficients can be interpreted as the increase in the absolute distance elasticity resulting from doubling the UAI in the investing country. For instance, the absolute distance elasticity of total portfolio investments would be increased by around 0.4 if the UAI in the investing country was doubled (Table 2, Column 1).¹⁴ However, given the negative correlation between the UAI and income per capita, an increase in the distance effect may not necessarily be attributable to higher uncertainty aversion but might instead reflect lower income per capita. To test this hypothesis, the analysis additionally controls for the interaction between distance and income per capita in the total portfolio equation (Column 6). While the size of the estimated coefficient on the interaction between the UAI and distance decreases, the coefficient remains negative and statistically significant at the 10% level, confirming the robustness of the result. Figure 1 provides a graphical illustration of the relationship between the UAI and the estimated distance coefficient for the countries in the sample.

3.2. Did the distance effect increase during the global financial crisis of 2008-09?

Asset liquidations by uncertainty-averse investors were at the heart of the financial crisis of 2008-09. Investors liquidated complex debt securities which had become difficult to value and moved into assets with less uncertain valuations, such as government bonds. Theoretical models by Caballero and Krishnamurty (2008), Krishnamurty (2010) and Uhlig (2010), among others, are based on such a “flight to quality”. If distance at least partly measures information frictions, as suggested by the empirical evidence on the performance of local investors (Hau, 2001; Malloy, 2005; Bae et al., 2008), in the gravity model estimated here asset liquidations by uncertainty-averse investors should be

Figure 1. **The distance effect increases with uncertainty aversion**

2005-06



Note: Estimated distance effect for total portfolio holdings.

Source: OECD calculations based on Hofstede (1970, 2001).

reflected in an increase in the distance effect. Investors would be expected to reduce their asset holdings in geographically more distant markets by more than in nearby locations when uncertainty suddenly rises. Table 3 reports the results from estimating equation (4) above, which is a formal test of whether, during the crisis, the distance effect differed significantly from that in the pre-crisis period.

Table 3. **The distance effect increased during the crisis**

Specification: Equation (4)

2005-06, 2008-09

Dependent variable	(1) Total portfolio	(2) Portfolio equity	(3) Portfolio debt	(4) Long portfolio debt	(5) Short portfolio debt	(6) FDI	(7) Loans and dep.
Distance * Crisis	-0.127*** (0.031)	0.008 (0.042)	-0.101*** (0.036)	-0.093** (0.038)	-0.239** (0.108)	0.049 (0.046)	-0.084** (0.042)
Observations	7 368	5 224	5 880	5 560	1 304	3 788	6 900
R-squared (within)	0.36	0.45	0.32	0.34	0.42	0.45	0.31

* Denotes statistically significant at 10%; ** significant at 5%, *** significant at 1%. The within R-squared denotes the variance within country pairs explained by the change in the distance effect over time and the investor-year and recipient-year fixed effects.

Notes: Includes investor-year and recipient-year fixed effects. Robust standard errors clustered at the country pair level in parentheses.

The distance effect indeed increased – the coefficient of distance became more negative – during the global financial crisis of 2008-09.¹⁵ There was a large and statistically significant increase for portfolio investments, which appears to be driven mainly by portfolio debt securities. Given that for total portfolio investments the estimated coefficient (i.e. the distance elasticity) was around -0.4 before the crisis (see Table 1, Column 1), a -0.13 change (Table 3, Column 1) corresponds approximately to a 30% increase in the distance effect. Put differently, the financial crisis of 2008-09 had similar effects on bilateral asset holdings as increasing the distance between countries by 30%. The increase in uncertainty aversion during the crisis also appears to have affected the geographical

pattern of international loans and deposits but not portfolio equity and FDI. This may reflect that portfolio equity and FDI are relatively illiquid investments in the sense that they cannot be rapidly withdrawn during a crisis without incurring large capital losses. Alternatively, equity investors, in particular those engaging in FDI, may have collected more accurate information about their investments than holders of portfolio debt securities or banks about their debtors. While the coefficients in Table 3 are not directly comparable across asset classes because of differing sample sizes, additional evidence presented in Section 4 supports the view that the increase in the distance effect was indeed particularly large for portfolio debt and for bank loans and deposits.

The collapse in global trade that coincided with the financial crisis of 2008-09 does not change the interpretation of the results in Table 3. The increase in the distance effect for international asset holdings may, to some extent, reflect the trade collapse of 2008-09 if the latter was disproportionately large for geographically-distant trading partners and if there are complementarities between goods and asset trade. However, this would not change the interpretation of the results in Table 3. Changes in transport costs cannot plausibly account for the possible increase in the distance effect in international trade. Instead, any increase in the distance effect in international trade would likely reflect a similar interaction between information frictions and higher uncertainty during the financial crisis of 2008-09 as described above.¹⁶

The increase in the distance effect during the financial crisis of 2008-09 was mainly driven by withdrawals of investors from particularly uncertainty-averse countries. Splitting the sample into reporting countries with below- and above-median indexes of uncertainty aversion shows that the increase in the distance effect for total portfolio holdings and loan and deposit holdings was large and statistically highly significant for investing countries with above-median indexes of uncertainty aversion (Table 4).¹⁷ By contrast, the increase in the distance effect was small and statistically less significant for countries with low indexes of uncertainty aversion. This suggests that the overall increase in the distance effect can, to a large extent, be attributed to investors from particularly uncertainty-averse countries.

Table 4. The increase in the distance effect during the crisis was mainly driven by countries with above-median uncertainty aversion

Specification: Equation (4)
2005-06, 2008-09

Dependent variable	(1) Total PF	(7) Loans and deposits
Distance * Crisis * (Below-median UAI)	-0.065* (0.038)	-0.050 (0.048)
Distance * Crisis * (Above-median UAI)	-0.126*** (0.039)	-0.115** (0.053)
Observations	7 368	6 900
R-squared (within)	0.36	0.31

* Denotes statistically significant at 10%; ** significant at 5%, *** significant at 1%. The within R-squared denotes the variance within country pairs explained by the change in the distance effect over time and the investor-year and recipient-year fixed effects.

Notes: Includes investor-year, recipient-year and pair-fixed effects. Robust standard errors clustered at the country pair level in parentheses.

Summing up, these results are consistent with the view that increases in perceived uncertainty were at the core of the 2008-09 crisis. Investors, especially those who were particularly uncertainty averse, disproportionately reduced the holdings of assets in geographically more distant locations, possibly because they had less information about them.

3.3. Which structural policy settings mitigated the crisis-related increase in the distance effect?

Some structural policies may mitigate the increase in the distance effect in times of crisis. For instance, financial market transparency may reassure investors as it facilitates the assessment of the health of the financial system. Regulations that increase financial market transparency could thereby limit the extent to which distant investors may wish to reduce their holdings in the event of global financial turmoil. Consistent with this hypothesis, Gelos and Wei (2005) find that mutual funds tend to disproportionately exit non-transparent countries during financial crises. Similarly, stricter prudential banking regulation may induce investors to retain a higher share of their holdings in a given country, in particular if they are located in geographically-distant countries with less information on the destination country. Finally, restrictions on capital outflows – which may limit the amount of capital investors can repatriate during financial crises – could primarily be a constraint on geographically-distant investors. This could arise, for example, when geographically more distant investors desire to reduce their holdings by more, in which case tighter capital account restrictions should limit the increase in the distance effect during crises.¹⁸ These hypotheses are tested by estimating several variations of equation (5).

Only structural policy variables relating to domestic banking regulation appear to have limited the increase in the distance effect during the global financial crisis of 2008-09 (Table 5). Neither the overall quality of institutions nor capital outflow restrictions were found to be effective, but the absence of statistically-significant results for the latter variables could also reflect inherent difficulties in measuring them.¹⁹ By contrast, stricter capital adequacy requirements were found to have limited the increase in the distance effect both for total portfolio investments and bank loans. Resilience and reduced leverage of the banking system may also have raised foreign investors' confidence in its stability, possibly resulting in a particularly large stabilising effect on capital flows from more distant investors during the crisis. Similarly, more extensive external auditing and disclosure requirements for banks appear to have limited the increase in the distance effect for loans and deposits during the crisis, presumably as better access to information helped reassure investors about the safety of their investments.

4. Robustness checks

This section assesses the robustness of the previous analysis, with a particular focus on the central result that the effect of distance increased during the financial crisis of 2008-09.²⁰ It is found that this result is robust to changes in the sample, alternative estimation methods or using a different proxy for bilateral frictions. Moreover, the robustness checks presented below strengthen the view that there was a clear ranking of the increase in the distance effect across asset classes, with debt securities as well as bank loans and deposits more affected than portfolio equity and FDI.

Table 5. Some structural policy setting were associated with smaller increases in the distance effect during the global financial crisis of 2008-09

Equation (5): Coefficients of interaction terms between distance, crisis and structural policies
2005-06, 2008-09

Dependent variable	Total portfolio investment				
Institutional quality	-0.009				
	(0.031)				
Liquid liabilities to GDP		0.021			
		(0.079)			
Bank capital adequacy rules			0.071**		
			(0.030)		
Bank information disclosure rules				0.048	
				(0.043)	
Capital outflow restrictions					0.142
					(0.100)
Observations	7 232	6 564	6 884	6 884	6 180
R-squared (within)	0.36	0.35	0.35	0.35	0.37
Dependent variable	Total loans and deposits				
Institutional quality	0.049				
	(0.040)				
Liquid liabilities to GDP		-0.006			
		(0.129)			
Bank capital adequacy rules			0.082*		
			(0.046)		
Bank information disclosure rules				0.148**	
				(0.070)	
Capital outflow restrictions					-0.139
					(0.104)
Observations	6 836	5 952	5 756	5 756	4 820
R-squared (within)	0.31	0.30	0.30	0.30	0.30

* Denotes statistically significant at 10%; ** significant at 5%, *** significant at 1%. Reported coefficients denote the triple interactions between distance, the crisis dummy and the structural policy in the first column. The interactions between distance and the crisis dummy are included but not reported. The capital outflow restrictions relate to the recipient country and the specific type of flow. Source: Schindler (2009). The within R-squared denotes the variance within country pairs explained by the change in the distance effect over time and the investor-year and recipient-year fixed effects.

Notes: Includes investor-year, recipient-year and pair-fixed effects. Robust standard errors clustered at the country pair level in parentheses.

4.1. Sample period

The estimations in the main text use, respectively, end-of-year data from the 2005-06 and 2008-09 periods to estimate the distance effects prior to and during the crisis. Using two years in each period improves estimation efficiency by reducing the impact of measurement error on the precision of the estimated coefficients. Strictly speaking, however, the geographical pattern of asset withdrawals during the crisis should be inferred from comparing capital stocks at the end of the pre-crisis period with those at the end of the crisis. Arguably, end-of-2006 data should be used for the end of the boom period, as capital flows started to reverse during 2007. Similarly, end-of-2009 data can be seen as marking the end of the most acute phase of the global financial crisis, as capital flows to emerging countries recovered in 2010. Table 6 therefore reports the results from estimating equation (3) for the years 2006 and 2009. The estimated coefficients are almost identical to those in Table 3. Unsurprisingly, the standard errors are somewhat higher than in the

Table 6. **The distance effect increased during the crisis**

Specification: Equation (4)

2006, 2009

Dependent variable	(1) Total portfolio	(2) Portfolio	(3) Portfolio debt	(4) Long portfolio debt	(5) Short portfolio debt	(6) FDI	(7) Loans and dep.
Distance * Crisis	-0.153*** (0.035)	0.051 (0.040)	-0.157*** (0.043)	-0.120*** (0.046)	-0.202* (0.120)	-0.031 (0.047)	-0.077* (0.047)
Observations	4 342	3 146	3 510	3 374	892	2 374	3 704
R-squared (within)	0.29	0.35	0.28	0.30	0.43	0.39	0.24

* Denotes statistically significant at 10%; ** significant at 5%, *** significant at 1%. The within R-squared denotes the variance within country pairs explained by the change in the distance effect over time and the investor-year and recipient-year fixed effects.

Notes: Includes investor-year, recipient-year and pair-fixed effects. Robust standard errors clustered at the country pair level in parentheses.

baseline estimations, reflecting the loss in estimation efficiency when using two years instead of four.

4.2. Reported zero positions

Both in the CPIS and BIS data there is a substantial number of reported zero positions, which reflect either small holdings or “true” zero positions. It has been argued in the international trade literature that the logarithmic transformation of the gravity equation may bias the estimated coefficients, including because zero reported trade flows are dropped (Santos and Tenreyro, 2006). However, non-linear estimators addressing this issue may fail to converge in models with large numbers of fixed effects (Santos and Tenreyro, 2011). Studies on the determinants of foreign asset positions generally exclude zero positions from the analysis or transform the dependent variable before taking logarithms (Lane and Milesi-Ferretti, 2008).²¹ In the current context, asset positions with a reported value of zero both at the end of the boom period and the end of the crisis period do not contribute to the understanding of the geographical pattern of asset reallocations during the crisis. Therefore, it makes economic sense to exclude them from the sample. By contrast, assets positions with positive reported values in one period and zero values in the other may be relevant. For instance, if investors fully unwind positions (i.e. bring asset holdings to zero) mainly in geographically distant countries, this would contribute to an increase in the distance effect.²² Hence, these observations should be included in the estimation sample. Table 7 reports the results from estimating equation (3) when observations with zero reported values in either the pre-crisis or crisis periods are retained. This is achieved by adding $\varepsilon=1$ (equal to USD 1 000) to the dependent variable before taking logarithms.²³

Sample size increases by around 50% for total portfolio holdings and aggregate equity and debt portfolio holdings, and by around 20% for loans and deposits. These sample changes notwithstanding, the estimated coefficients are similar to those in the baseline estimates in Table 3. A noticeable difference is that in Table 6 the largest increase in the distance effect is for loans and deposits, while the increase for short-term portfolio debt becomes statistically insignificant.

4.3. Inclusion of financial centres

International financial centres (IFCs) cannot be viewed as the true source or destination of investment flows, as they frequently act as pure intermediaries. In the

Table 7. **The distance effect increased during the crisis (2005-06, 2008-09)**

Specification: Equation (4)

Including zero values

Dependent variable	(1) Total portfolio	(2) Portfolio equity	(3) Portfolio debt	(4) Long portfolio debt	(5) Short portfolio debt	(6) FDI	(7) Loans and dep.
Distance * Crisis	-0.133*** (0.033)	0.014 (0.037)	-0.084** (0.035)	-0.092*** (0.035)	-0.112 (0.107)	-0.037 (0.044)	-0.214*** (0.053)
Observations	10 852	6 968	8 120	7 496	2 636	4 248	8 312
R-squared (within)	0.34	0.39	0.27	0.30	0.29	0.42	0.26

* Denotes statistically significant at 10%; ** significant at 5%, *** significant at 1%. The within R-squared denotes the variance within country pairs explained by the change in the distance effect over time and the investor-year and recipient-year fixed effects.

Notes: Includes investor-year, recipient-year and pair-fixed effects. Robust standard errors clustered at the country pair level in parentheses.

baseline estimation IFCs are therefore excluded from the sample. The results from estimating the baseline model including IFCs are reported in Table 8. While the sample size increases by up to 50% with respect to the baseline specification excluding IFCs, the results remain qualitatively the same. The distance effect increased during the crisis for portfolio holdings and loans and deposits, with the increase for portfolio holdings being driven by debt holdings.

Table 8. **Including IFCs does not alter the results**

2005-06, 2008-09

Dependent variable	(1) Total portfolio	(2) Portfolio equity	(3) Portfolio debt	(4) Long portfolio debt	(5) Short portfolio debt	(6) FDI	(7) Loans and dep.
Distance * Crisis	-0.078*** (0.026)	0.007 (0.033)	-0.120*** (0.028)	-0.132*** (0.028)	-0.220*** (0.072)	0.055 (0.043)	-0.067* (0.039)
Observations	11 308	7 900	8 976	8 472	2 276	4 252	8 572
R-squared (within)	0.30	0.37	0.27	0.29	0.38	0.46	0.29

* Denotes statistically significant at 10%; ** significant at 5%, *** significant at 1%. The within R-squared denotes the variance within country pairs explained by the change in the distance effect over time and the investor-year and recipient-year fixed effects.

Notes: Includes investor-year, recipient-year and pair-fixed effects. Robust standard errors clustered at the country pair level in parentheses.

4.4. “Closeness” instead of geographical distance

Besides geographical distance, some of the bilateral explanatory variables included in the baseline gravity equation in Table 2 may also measure information frictions. A common language, for instance, facilitates communication and reduces the cost of information acquisition. Similarly, it may be less costly to obtain information about neighbouring countries or former colonies. To test whether asset reallocations during the financial crisis of 2008-09 were indeed related to this broader set of potential proxies for information frictions, the first standardised principal component of common language, common border, former colonial relationship, bilateral newspaper trade and inverse distance is interacted with the crisis dummy in equation (4). The estimation results, reported in Table 9, are qualitatively similar to those in the baseline specification which focuses on geographical distance alone. During the financial crisis of 2008-09 investors

Table 9. **Fund withdrawals were smaller in geographically and culturally “close” countries**

(2005-06, 2008-09)

Dependent variable	(1) Total portfolio	(2) Portfolio equity	(3) Portfolio debt	(4) Long portfolio debt	(5) Short portfolio debt	(6) FDI	(7) Loans and dep.
Closeness * Crisis	0.050*** (0.013)	0.003 (0.017)	0.041** (0.016)	0.039** (0.017)	0.077** (0.037)	-0.023 (0.018)	0.024* (0.014)
Observations	7 368	5 224	5 880	5 560	1 304	3 788	6 900
R-squared (within)	0.36	0.45	0.32	0.34	0.42	0.45	0.31

* Denotes statistically significant at 10%; ** significant at 5%, *** significant at 1%. The within R-squared denotes the variance within country pairs explained by the change in the distance effect over time and the investor-year and recipient-year fixed effects.

Notes: Includes investor-year, recipient-year and pair-fixed effects. Robust standard errors clustered at the country pair level in parentheses.

reallocated their asset holdings toward countries that were geographically and culturally “closer” to their home country. This effect appears to be largest for portfolio debt holdings and in particular for short-term debt holdings.

4.5. Sample balanced both within and across asset classes

As already mentioned in Section 3, the estimated increase in the distance effect during the crisis is not directly comparable across asset classes because of differing sample sizes. While balancing the sample both within asset classes over time and across asset classes is impossible due to the sharp reduction in sample size this would entail, it is possible to balance the sample pair-wise across the relevant asset classes.²⁴ Table 10 reports the results from the following pair-wise balanced panels: Total portfolio securities and FDI; bank loans and deposits and FDI; and equity portfolio and debt portfolio securities. The results are similar to those in the unbalanced panel. There is a statistically-significant increase in the distance effect for portfolio debt and bank loans and deposits, whereas the increase in the distance effect is statistically insignificant for FDI and portfolio equity.

Table 10. **The distance effect increased during the crisis**

Balanced panel within and across asset classes (2005-06, 2008-09)

Dependent variable	(1) Total portfolio	(2) FDI	(3) Loans and dep.	(4) FDI	(5) Portfolio equity	(6) Portfolio debt
Distance * Crisis	-0.076* (0.041)	0.027 (0.039)	-0.219*** (0.064)	-0.035 (0.039)	0.035 (0.042)	-0.267*** (0.074)
Observations	5 560	5 560	2 928	2 928	3 768	3 768
R-squared (within)	0.29	0.41	0.43	0.53	0.42	0.35

* Denotes statistically significant at 10%; ** significant at 5%, *** significant at 1%. The within R-squared denotes the variance within country pairs explained by the change in the distance effect over time and the investor-year and recipient-year fixed effects.

Notes: Includes investor-year, recipient-year and pair-fixed effects. Robust standard errors clustered at the country pair level in parentheses.

4.6. Further recipient-country characteristics

Country characteristics other than the specific regulatory setups identified in Section 3 do not appear to be associated with the increase in the distance effect during the global financial crisis of 2008-09. Columns (1) and (2) of Table 11 show that when the Brune

Table 11. **Other recipient-country characteristics were not related to the increase in the distance effect during the crisis**Equation (5): Coefficients of interaction terms between distance, crisis and structural policies
2005-06, 2008-09

Dependent variable	Total portfolio investment				
Capital outflow restrictions (Brune, 2006)	-0.018				
	(0.059)				
Capital outflow restrictions (Quinn and Toyoda, 2008)	-0.002				
	(0.002)				
GDP per capita	-0.014				
	(0.028)				
Product market regulation (OECD)				0.034	
				(0.066)	
Quality of regulation (World Bank WGI)				-0.059	
				(0.040)	
Observations	7 104	5 496	7 087	4 736	7 222
R-squared (within)	0.36	0.36	0.36	0.35	0.36
Dependent variable	Total loans and deposits				
Capital outflow restrictions (Brune, 2006)	0.046				
	(0.080)				
Capital outflow restrictions (Quinn and Toyoda, 2008)	0.000				
	(0.003)				
GDP per capita	0.003				
	(0.033)				
Product market regulation (OECD)				-0.097	
				(0.102)	
Quality of regulation (World Bank WGI)				0.038	
				(0.051)	
Observations	6 732	3 908	6 663	2 692	6 808
R-squared (within)	0.31	0.26	0.30	0.30	0.31

* Denotes statistically significant at 10%; ** significant at 5%, *** significant at 1%. Reported coefficients denote the triple interactions between distance, the crisis dummy and the structural policy in the first column. The interactions between distance and the crisis dummy are included but not reported. The capital outflow restrictions relate to the recipient country and the specific type of flow. The within R-squared denotes the variance within country pairs explained by the change in the distance effect over time and the investor-year and recipient-year fixed effects.

Notes: Includes investor-year, recipient-year and pair-fixed effects. Robust standard errors clustered at the country pair level in parentheses.

(2006) or Quinn and Toyoda (2008) measures of capital outflow restrictions are used instead of Schindler (2009), the coefficient on the interaction of these indicators with distance and the crisis dummy remains statistically non-significant. Moreover, GDP per capita in the recipient country appears to be unrelated to the increase in the distance effect (Column 3), providing further evidence that the structural policy indicators relating to banking sector regulation identified in Section 3 do not merely pick up broad economic development. Finally, the overall regulatory setup as measured by the OECD Product Market Regulation (PMR) indicator or the World Bank Quality of Regulation indicator do not display a robust relationship with the increase in the distance effect during the global financial crisis of 2008-09.

5. Conclusion

This paper uses a large dataset of bilateral investment positions covering portfolio assets, FDI, as well as loans and deposits, to assess the role of uncertainty aversion in

international asset allocation. One view of the global financial and economic crisis of 2008-09 attributes the associated sharp fluctuations in capital flows to indiscriminate selling by uncertainty-averse investors (Caballero and Krishnamurty, 2008; Krishnamurty, 2010; Uhlig, 2011). According to this view, the financial dislocations of 2008-09 increased uncertainty, inducing investors to consider worst-case scenarios and replace risky financial claims with better-known and safer assets. This paper provides empirical support for this view. Using a survey-based measure of country-level uncertainty aversion, this paper first shows that uncertainty-averse investors have a stronger preference for geographically-proximate locations than investors who are less uncertainty averse. It further shows that the preference for geographically-proximate locations generally went up during the 2008-09 global crisis as investors shed disproportionately the assets of geographically-distant countries, possibly because information frictions for these countries were larger. The results of this paper also suggest that structural policies can alleviate the destabilising effects of increases in global uncertainty. Regulatory policies enhancing information disclosure and capital buffers in the banking system are found to mitigate particularly strong capital withdrawals from more distant investors in times of global financial-market stress.

Notes

1. See Anderson (2011) and Bergstrand and Egger (2011) for recent reviews of the gravity model in international trade and, *inter alia*, Baldwin and Taglioni (2007), Bussière et al. (2008), and Bussière and Schnatz (2009) for recent empirical applications.
2. This said, distance may to some extent also capture trade linkages or familiarity effects unrelated to information frictions. In particular, the behavioural finance literature has documented that, even in the absence of superior information, employees tend to overinvest in own-company stock or investors tend to be overconfident in forecasting domestic as opposed to foreign asset returns, which suggests behavioural biases toward familiar assets (Foad, 2010).
3. The absence of statistically-significant results for the latter variables could also reflect difficulties in measuring them.
4. A pilot survey was conducted for 29 reporting countries in 1997. However, some major investing countries, including Germany, did not participate.
5. Both small international financial centres (as defined by Lane and Milesi-Ferretti, 2010) and the more important international financial centres Cyprus, Hong Kong S.A.R. of China, Luxembourg and Singapore are excluded from the analysis.
6. Observations with a value of zero in the database relate either to “true” 0 bilateral asset positions or to bilateral asset positions below a given threshold (USD 0.5 million in the IMF CPIS data).
7. Although the survey was carried out around 1970 and the foreign investment positions used in this paper span the period 2001-09, the measurement error in this variable is unlikely to be high. Uncertainty aversion can be considered as an element of a country’s culture which only changes very slowly over time (Williamson, 2000). For instance, Huang (2007) finds that the UAI is highly correlated with religion: the share of the population that is protestant displays a correlation of -0.5 with the UAI, while the population share of Catholics displays a positive correlation of 0.5.
8. To ensure comparability of coefficients the sample has been balanced across asset classes. The results for the unbalanced sample are qualitatively and quantitatively similar (available upon request).
9. Note that the coefficients for the total portfolio equation are not necessarily within the interval given by the portfolio equity and portfolio debt equations. The reason is that in the CPIS data for some country pairs, reported total portfolio assets differ from the sum of reported portfolio equity and reported portfolio debt.

10. The estimated coefficient of the euro area dummy is highly significant with the expected positive sign for all types of flows under consideration. Common language, common border and colonial relationship also come out broadly as expected, although not always statistically significant.
11. Huang (2007) analyses whether the distance effect in international trade varies with the UAI in the exporting country. He finds that the distance effect (the negative impact of distance on exports) increases significantly with the UAI.
12. To ensure comparability of coefficients the sample has been balanced across asset classes. The results for the unbalanced sample are qualitatively and quantitatively similar (available upon request).
13. The coefficient for the total portfolio equation is not within the interval given by the portfolio equity and portfolio debt equations, because in the CPIS data for some country pairs, reported total portfolio assets differ from the sum of reported portfolio equity and reported portfolio debt. The estimation results for FDI are not reported as one motive for choosing FDI over the other investment modes is precisely to reduce monitoring costs and thus limit uncertainty. As expected, in unreported regressions, the coefficient on the interaction between the UAI and distance turns out statistically insignificant (available upon request).
14. As the average distance elasticity for the countries in the sample is negative, a negative estimated coefficient on the interaction between distance and the UAI implies a larger distance elasticity in absolute terms.
15. Note that the sample is balanced within asset classes over time to ensure the estimated distance coefficient is not contaminated by composition effects. Further note that the simultaneous inclusion of investor-year, recipient-year and pair-fixed effects increases the overall fit of the empirical model. In contrast to the preceding section which attempted to explain the geographical pattern of portfolio holdings, this section attempts to explain the *change* in portfolio holdings over time. Instead of the overall R-squared this section therefore reports the within R-squared, which measures the proportion of the variance within country pairs that is explained by the time-varying distance effect and the investor-year and recipient-year fixed effects.
16. Moreover, depending on the direction of causality between asset and goods trade, the possible increase in the distance effect for international goods trade may itself reflect developments in international asset holdings. For instance, restrictions in the availability of trade credit were a major factor behind the trade collapse of 2008-09 (Amiti and Weinstein, 2009).
17. Samples that are balanced within asset classes over time for disaggregated portfolio and FDI holdings include an insufficient number of investing countries to allow splitting the change in the distance effect across investing countries with below- and above-median indexes of uncertainty aversion.
18. By contrast, there may be no such relation if distant investors anticipate the effect of capital outflow restrictions during crises and therefore do not invest in countries with restrictions on capital outflows in the first place.
19. Overall institutional quality is measured as the first standardised principal component of the following World Bank Governance indicators: Government effectiveness, political stability, voice, rule of law, control of corruption and regulatory quality.
20. The results on the correlation between the structural policy settings in the recipient country and the increase in the distance effect are generally robust to the changes in sample and definitions discussed below. For presentational ease, these tables are not reported but are available from the authors upon request.
21. A common transformation of the dependent variable is $\ln(y+\varepsilon)$, where y denotes the dependent variable and ε an arbitrary small number.
22. Similarly, if investors mainly build up new positions in geographically proximate countries during the crisis, this would also contribute to an increase in the distance effect.
23. Additionally retaining observations with zero reported holdings in both the boom and crisis periods gives qualitatively and quantitatively similar results.
24. As a large part of the reduction in sample size when balancing the sample across asset classes reflects country pairs with zero holdings for one or both asset classes, observations with zero reported values in either the pre-crisis or crisis periods, but not both, are retained for this robustness check.

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ICT investments and productivity: Measuring the contribution of ICTs to growth

by

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This study uses an econometric approach to estimate the contribution of three types of ICT investments (computer, software and communication) in 26 industries (the whole business sector) in 18 OECD countries over 1995-2007, based on the EU KLEMS Database. The estimated contribution of ICT investments to value added growth in the business sector varies from 1.0% a year in Australia to 0.4% a year in Japan. In one-third of the countries considered, the contribution of ICT investment was bigger or equal to the contribution of non-ICT investments. In most countries, computing equipment provided the largest contribution and accounted for over 50% of the overall ICT contribution. The only exceptions are Finland, where investments in communication equipment exceeded those in computing equipment, and Japan, where software was the most dynamic component of ICT investments. ICT producing industries account for no less than two-thirds of total factor productivity (TFP) growth in Germany, Slovenia and the United Kingdom, about 60% in the United States and just below 50% in France and the Netherlands. In Denmark, the Czech Republic and Italy, TFP increased in the ICT producing industries whereas it decreased for the total business sector.

JEL classification: O47, E23, E22.

Keywords: Growth accounting, ICT, GMM, EU KLEMS.

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Growth accounting is the most widely used approach to measure the contribution of ICT investment to economic growth. It consists in decomposing the growth of value added into the growth of production inputs, namely labour, ICT investments and non-ICT investments.

This decomposition requires some measure of the elasticity of value added to each input, i.e. the increase in value added associated with a 1% increase in a given input. However, inputs' elasticities are not observable and researchers have to rely on some method to estimate them. Economic studies have adopted two different approaches.

In the first approach (non-parametric), the elasticity of each input is assumed to be equal to its share in the value added. The assumption, however, is valid on a set of strong hypotheses about the technology of production (constant returns to scale), the behaviour of firms (profit maximisation) and the characteristics of technological progress (Hicksian neutrality). Furthermore, this approach assumes that every increase in value added which is not explained by growth in production inputs is due to an increase in total factor productivity (TFP). As a result, all deviations from the above hypotheses and all measurement errors in the statistical data are misinterpreted as differences in TFP across countries and over time.

The second approach (parametric) consists in estimating the inputs' elasticity through econometric techniques. This approach has two advantages. First, it does not impose any *a priori* hypotheses on the technology of production, the behaviour of firms or the degree of competition in the markets. Second, it permits a direct estimation of the inputs' productivity, in a way that measurement errors are not incorrectly accounted as total factor productivity. The drawback of the econometric approach is that it is less flexible – as coefficients are fixed across at least one dimension of the data – and requires a larger set of observations.

This study adopts the econometric approach to estimate the contribution of three types of ICT investments (computer, software and communication) in 26 industries (the whole business sector) in 18 OECD countries over the period 1995-2007.

The study is organised as follows. Sections 1 and 2 discuss the non-parametric and the parametric approach, respectively, and review the main studies on ICT investments based on these approaches. Section 3 describes the EU KLEMS dataset which is used in the present analysis. Section 4 introduces the econometric model and reports its estimates. The results for the total business sector are discussed in Section 5 while Section 6 summarises the main findings and indicates the direction for further research.

1. The non-parametric approach to growth accounting

The characteristic feature of the non-parametric approach to growth accounting is to assume the elasticity of each input to be equal to its share in the value added. Input shares are measured either in relation to total income, if the product market is regarded as perfectly competitive, or in relation to total costs, if the product market is believed to operate under monopolistic competition.

The above assumption relies on three main hypotheses, which are generally un-tested.

First, the technology of production is characterised by constant returns to scale. Based on this hypothesis, any increase in value added which is not accounted for by an increase in the production inputs is interpreted as technical progress. However, if returns to scale are increasing rather than constant, technical progress is over-estimated and the contribution of the inputs is under-estimated (and vice versa). Although some progress has been made recently to loosen this hypothesis (see Diewert and Nakamura, 2007 for a survey), it still remains crucial for this approach.

Second, firms can change the level of production inputs at any time without incurring any adjustment costs. The hypothesis of instantaneous profit maximisation permits the measurement of the elasticity of each input as its (cost or income) share. However, if the hypothesis fails to hold, observed input shares deviate from the production elasticities and some of the contribution of production inputs are erroneously accounted as TFP (or vice versa).

Finally, the rate of technical progress is assumed to be equal for all factors (Hicksian neutrality). This hypothesis permits the separation of changes in the production technique along a given isoquant – due to changes in the relative cost of production inputs – from upward shifts of the isoquant – due to technical progress. In particular, under the hypothesis of Hicksian neutrality, input shares are independent from technical progress and provide the correct measure of input elasticity. However, if technical progress is capital (labour) augmenting and the production function is not a Cobb-Douglas, the input share of capital (labour) would increase as a result of technical progress itself (Antràs, 2004). Therefore, the hypothesis of Hicksian neutrality would lead to overestimating the contribution of capital (labour) to growth and underestimating TFP. This bias is likely to be significant for ICT capital, where the rate of technical progress over the last few decades has been faster than for labour and other types of capital.

1.1. Previous findings

Early studies on the impact of ICTs on productivity yielded largely inconclusive results. The well-known Solow paradox for which “computers are visible everywhere except in productivity statistics” summarises the state of art in the early 1990s. The lack of correlation between ICT investment and productivity growth was mostly due to incorrect measurement of ICT capital prices and quality.

Significant improvements in the measurement of ICT capital (OECD, 2001 and 2009) have opened the way to a new stream of analysis on the growth effects of ICTs, while, the work carried out by the OECD to internationally harmonise ICT prices (Wyckoff, 1995; Schreyer, 2000; and Colecchia and Schreyer, 2002) allowed controlling for differences in methodologies among countries.

Jorgenson and Stiroh (2000) apply Jorgenson's *production possibility frontier* (1967) to explain the increase in productivity growth in the United States after 1995. They find that computer hardware played an increasing role as a source of economic growth and that average labour productivity grew much faster between 1995-99 due to capital deepening as a direct consequence of the fall in ICT prices and the increase in TFP.

Oliner and Sichel (2000, 2002) reach similar results, based on a Solow-like growth accounting model. They find that the contribution of ICT capital increased between the periods 1974-95 and 1996-99 and that TFP growth also increased by 40% in the period 1996-99.

Colecchia and Schreyer (2002) extend the approach followed by Jorgenson and Stiroh (2000) and Oliner and Sichel (2000) to nine OECD countries up to the year 2000. They found that in the preceding two decades ICT contributed between 0.2 and 0.5 percentage points per year to economic growth, depending on the country. During the second half of the 1990s, this contribution rose to 0.3 to 0.9 percentage points per year. They showed that the United States had not been alone in benefiting from the positive effects of ICT capital investment on economic growth and in experiencing an acceleration of these effects. However, effects have clearly been largest in the United States followed by Australia, Finland and Canada. Of the nine countries considered Germany, Italy, France and Japan registered the lowest contribution of ICT to economic growth.

Oulton (2002) applies a modified growth accounting approach to the United Kingdom, using US producer price indices adjusted for exchange rates to deflate the value of ICT investment. He finds that the ICT contribution to GDP growth increased from 13.5% in 1979-89 to 20.7% in 1989-98. ICTs contributed 55% of capital deepening during the period 1989-98 and 90% in the period 1994-98.

Using data on ICT investments from the tax declarations of 300 000 French firms, Crepon and Heckel (2002) evaluate the contribution of ICTs to the growth of value added via two channels: the accumulation of IT capital across all industries and the TFP gains in ICT-producing industries. They find that, over the period 1987-98, ICTs accounted for 0.7 percentage points of the yearly value added growth, 0.3 points from capital deepening and 0.4 points from TFP growth in ICT-producing industries. This amounts to over one-quarter of the yearly value added growth (2.6%).

Improving the measurement of ICT capital is also at the core of the work of Van Ark *et al.* (2002) to explain the different impact of ICTs on productivity between the United States and Europe over the period 1980-2000. They find that the pattern of ICT diffusion in Europe has not been much different from that in the United States, beginning with a rapid increase in office and computing equipment, followed by a surge in communication equipment, and backed up by increased investment in software. However, EU countries started from much lower stocks of ICT capital so that both the intensity of ICT and its contribution to productivity growth have been lagging behind the United States.

This perspective is further developed by Timmer *et al.* (2010), who provide a detailed analysis of the sources of growth from a comparative industry perspective. The authors argue that Europe's slow growth is the combined result of a severe productivity slowdown in traditional manufacturing and other goods production, and a concomitant failure to invest in and reap the benefits from ICT, in particular in market services.

If ICT capital deepening and TFP growth in ICT-producing sectors measure the direct growth contribution of the use and the production of ICTs, microeconomic studies emphasise the complexity of the link from technology to productivity. To leverage ICT investment successfully, firms must typically make large complementary investments and innovate in areas such as business organisation, workplace practices, human capital and intangible capital.

Important progress has been made in incorporating intangible assets into a macro growth accounting framework by Corrado *et al.* (2006). They find that the role of multifactor productivity is significantly diminished, the growth rates of output and output per worker increases at a noticeably faster rate and capital deepening becomes the unambiguously dominant source of labour productivity growth. More broadly, the factors typically associated with the growth of the knowledge economy take up a greater importance when intangibles are included.

2. The parametric approach to growth accounting

The parametric approach to growth accounting provides an alternative method to measure the contribution of ICT investment to growth. It avoids postulating a relationship between production elasticities and income shares, which may or may not correspond to reality, and indeed puts researchers in a position of testing these relationships.

Further possibilities arise with econometric techniques: allowance can be made for adjustment cost (the possibility that changes in factor inputs are increasingly costly the faster they are implemented) and variations in capacity utilisation (*e.g.* Basu, Fernald and Shapiro, 2001). In addition, it is possible to investigate forms of technical change other than the Hicks-neutral formulation implied by the conventional growth accounting approach; and there is no *a priori* requirement to assume constant returns to scale of production functions. The literature on the econometric approach is large, and examples of integrated, general models can be found in Morrison (1986), Boskin and Lau (1990) and Nadiri and Prucha (2001).

All these possibilities come at a cost, however. The econometric approach allows for less flexibility, as coefficients are fixed across at least one dimension of the data. Fully-fledged models raise complex econometric issues and sometimes put a question mark on the robustness of results. Often, researchers are constrained by the sample size of observations, and have again to revert to *a priori* restrictions (for example constant returns to scale) to increase the degrees of freedom for estimation.

More fundamentally, the output and input data used in the econometric analysis have been estimated based on the non-parametric approach itself. “Thus, the question of whether or when to use econometrics to measure productivity change is really a question of the stage of the analysis” at which the non-parametric approach should be abandoned (Hulten, 2001). The two approaches, therefore, should be regarded as complementary, in that the non-parametric estimates provide a benchmark for interpreting the more complicated results of the parametric approach.

2.1. Previous findings

In an interesting meta-study, Stiroh (2002) compares the methods, data and results of a set of 20 studies. He finds that the estimated ICT elasticity to output differs among studies due to the econometric method, the sample period or the level of aggregation. Studies reporting excess returns to ICT investments are characterised by the omission of important variables – such as improved workplace practices and firm re-engineering – related to ICT deployment. When controlling for unobserved heterogeneity via fixed effects, the ICT coefficient falls substantially. The General Method of Moments (GMM) estimation, which accounts for unobserved heterogeneity and simultaneity, suggests that ICT matters but excess returns are replaced by normal returns. Overall, most results show a productivity effect from IT-use, but the point estimate of the elasticity is fragile and depends on the details of the estimation.

O'Mahony and Vecchi (2005) use a dataset of US and UK non-agricultural market industries to estimate the impact of ICT capital on output growth. As traditional industry panel data analysis fails to find a positive contribution, they employ a dynamic panel data approach in order to account for heterogeneity across industries. Pooled estimates show a positive and significant return of ICT capital on output growth. ICT investment produces excess returns as compared with the prediction from growth accounting. Individual countries' estimates imply a larger long-run impact in the United States than in the United Kingdom.

Some macroeconomic studies focus on specific ICT infrastructures such as telecommunication or broadband infrastructure and find positive and significant impacts on growth. Roller and Waverman (2001) investigate the relationship between investment in telecommunication infrastructure and economic performance in 21 OECD countries over the period 1971-90. Controlling for simultaneity and country-specific fixed effects, they find a causal relationship between telecommunication infrastructure and aggregate output. Their results suggest that a 1 percentage point increase in the telecommunication penetration rate (main telephone lines per capita) increases aggregate output growth by an average 0.045 percentage points.

Czernich *et al.* (2009) test the effect of broadband infrastructure on economic growth using an annual panel of 25 OECD countries over 1996-2007. In order to control for the endogeneity of the broadband penetration, they specify a technology diffusion model in which the ceilings of the broadband diffusion curve across countries are determined by the size of the pre-existing traditional networks. The results show a positive effect of broadband diffusion on economic growth, suggesting that a 1 percentage point increase in the broadband penetration rate results in a 0.09-0.15 percentage point increase in annual per capita growth.

Koutroumpis (2009) analyses the effect of broadband infrastructure on GDP growth in OECD countries between 2002 and 2007. To control for the bidirectional relationship between infrastructure and growth, he uses a simultaneous equation model that endogenises supply, demand and output. His results suggest that a 1 percentage point increase in the penetration rate increases GDP growth by an average of 0.025 percentage points. In addition, there is evidence of increasing returns to broadband telecommunication investment, consistent with the persistence of network effects. The critical mass in broadband infrastructure investment is estimated to be at 30% of broadband penetration, which effectively translates into half of the population having access to broadband connection.

3. Data source

The data source for the present analysis is the EU KLEMS Growth and Productivity Accounts (www.euklems.net). This database includes measures of output and input growth at the industry level. The input measures include various categories of capital (K), labour (L), energy (E), material (M) and service inputs (S). The measures are developed for 25 individual EU member states, Australia, the United States and Japan and cover the period from 1970 to 2007. However, industry data on ICT capital are available in only 18 of these countries.

Labour input service is estimated so as to reflect the actual changes in the amount and quality of labour input over time. Total employment is divided into types based on various characteristics: age, gender and educational attainment. Aggregate labour services are assumed to be a translog function of the services of individual types. In addition, it is

assumed that the flow of labour services for each labour type is proportional to hours worked, and workers are paid their marginal productivities. In this way, changes in the composition of total employment, e.g. an increase in the proportion of skilled workers, would lead into an increase in labour input service.

According to the recommendations of the *OECD Productivity Manual* (OECD, 2001), capital input is measured as capital services, rather than stocks. Capital is divided into different asset types and it is assumed that the flow of capital services for each asset type is proportional to its stock, independent of time. For each individual asset, stocks have been estimated on the basis of investment series using the perpetual inventory method (PIM) with geometric depreciation profiles. Depreciation rates differ by asset and industry but have been assumed identical across countries. O'Mahony and Timmer (2009) provide more details on capital service calculations.

For the aggregation of capital services over the different asset types it is assumed that aggregate services are a translog function of the services of individual assets, where the weights are given by the average shares of each component in the value of capital compensation. As observed in Section 2, this aggregation method is a direct application of the non-parametric approach.

The basic investment series by industry and asset have been derived from capital flow matrices and benchmarked to the aggregate investment series from the National Accounts. Although the ESA provides a classification of capital assets, it is not always detailed enough to back out investment in information and communication equipment. Additional information has been collected to obtain investment series for these assets, or assumptions concerning hardware-software ratios have been employed. When the deflator for computers did not contain an adjustment for quality change, a harmonised deflator based on the US deflator has been used as suggested by Schreyer (2002).

While the *EU KLEMS Database* provides information on capital services for nine types of assets, this article focuses on the distinction between ICT and non-ICT capital services and, within the first asset type, among Information Technology, Communication Technology and Software services.

The *EU KLEMS Database* provides data at a detailed industry level. This article examines the business sector (26 industries)¹ in 18 OECD countries over the period 1995-2007.

4. Econometric model and estimates

This study uses an econometric approach to estimate the contribution of ICT investments to the growth of value added. Following a well-established approach (Boskin and Lau, 1990), it is assumed that all economies and industries have potential access to the same technology but each may operate on a different part of it depending on specific individual circumstances. More formally, the production function has the same functional form across all countries and industries but that inputs differ in efficiency unit.

The advantage of this approach is that it reduces the number of elasticities to be estimated (one for each input) while it permits the estimation of different TFP trends for each industry within each country. Its shortcoming is that the measure of the contribution of production inputs may be inaccurate in industries and countries that operate on a technology very different from the average.

The production function is approximated by the following functional form:²

$$\ln Y_{ijt}^* = a_L \ln L_{ijt}^* + a_{ICT} \ln ICT_{ijt}^* + a_{NICT} \ln NICT_{ijt}^* \quad (1)$$

where Y denotes value added, L labour services, ICT and $NICT$ the respective capital services; $i = 1, \dots, 18$ indicates the country, $j = 1, \dots, 26$ the industry and $t = 1996-2007$ time. All variables are expressed in “efficiency unit” and denoted by an asterisk.

The measured quantities of outputs and inputs of the different economies may be converted into the unobservable standardised, or “efficiency-equivalent”, units of outputs and inputs by multiplicative industry-, economy-, output- and input-specific time-varying augmentation factors, $A_{ij}(t)$ ’s.

In this study, the commodity-augmentation factors are assumed to have a constant geometric form with respect to time:

$$L_{ijt}^* = \exp(c_{Lij}t) L_{ijt} \quad (2)$$

$$ICT_{ijt}^* = \exp(c_{ICTij}t) ICT_{ijt} \quad (3)$$

$$NICT_{ijt}^* = \exp(c_{NICTij}t) NICT_{ijt}, \quad i = 1, \dots, 18; j = 1, \dots, 26; t = 1996-2007. \quad (4)$$

where c_{ij} ’s are constants measuring cross-country and cross-industry differences in the growth rate of inputs’ productivity.³

By replacing 2, 3 and 4 into 1, the production function is expressed in terms of observable variables and can be estimated as:

$$\ln Y_{ijt} = a_L \ln L_{ijt} + a_{ICT} \ln ICT_{ijt} + a_{NICT} \ln NICT_{ijt} + p_{ij} t + \varepsilon_{ijt} \quad (5)$$

where $p_{ij} = (a_L c_{ij}^{ICT} + a_{ICT} c_{ij}^{NICT} + a_{NICT} c_{ij}^L)$ is the annual rate of increase of total factor productivity (TFP) and $\varepsilon_{ijt} \sim N(0, \sigma_{ijt}^2)$ is an error term. As no constraint is imposed on the input elasticities (a_L , a_{ICT} and a_{NICT}) nor on the technical progress rates (c_{ij} ’s), the production function under (5) make no assumption about economies of scale, instantaneous profit maximisation or technical progress neutrality.

In order to estimate the production function under 5, the researcher has to deal with two main issues. First, changes in inputs are not independent from changes in output as both outputs and inputs are determined simultaneously by firms. Under such conditions, standard econometric techniques like Ordinary Least Squares (OLS) generate biased estimates, i.e. underestimate or overestimate the contribution of different inputs.

A common approach to solve the problem of simultaneity is the use of instrumental variables (IV). These are variables that are correlated to the inputs but not to the output and, therefore, allow controlling for variations in inputs that are simultaneous to variations in the output.

One problem with this approach is that finding suitable IV is not easy. The common solution is to use lagged values of the inputs. For instance, last year’s employment is likely to be correlated with current employment (because firms cannot fire or hire workers immediately) but the output produced this year only depends on this year’s employment. One concern with lagged values is that they may result in weak instruments, and this is an issue that estimation has to check for. An additional concern is that the number of lags will significantly change the results. Therefore, researchers need to test the appropriate number of lags.

The second issue for the econometric approach is that, under certain circumstances, it may erroneously suggest that some inputs, *e.g.* ICT investments, made no contribution to growth. For example, this might be the case when the ICT investments are better measured in an industry, *e.g.* manufacturing, than in another, *e.g.* services, so that the estimates will be more accurate in the former than in the latter industry. This is a specific example of the broader econometric issue of heteroskedasticity: econometric estimates provide better predictions for some units (*e.g.* some industries or some countries) than for others.

When heteroskedasticity is present, the most efficient approach is not the IV but the General Method of Moments (GMM). However, as GMM produces inaccurate estimates in small samples, one has to test for the presence of heteroskedasticity before dismissing the IV approach.

The econometric analysis of this study, therefore, went through the following steps. First, the contribution of labour, ICT and non-ICT capital to value added was estimated though standard OLS. Second, the IV approach was used to control for the simultaneity between output and inputs. Third, the IV estimates were found to be heteroskedastic and the production function was finally estimated by GMM with cluster-robust variance.

Regressions were run in STATA by the *ivreg2* command developed by Bau *et al.* (2007). Lags 1 to 4 of labour, ICT and non-ICT capital were used as IV, based on the results of an LM test which rejected the significance of longer lags. Standards tests on endogeneity of the regressors, over identification of the instruments and the weak identification supported the selected specification. The regression explains over 92% of the observed differences in value added across countries and industries. The regression output is summarised in Table 1 below.

Table 1. **GMM estimates and tests**

	Coefficient	T	[95% confidence interval]	
Labour	0.635	13.58	0.544	0.727
ICT capital	0.056	3.27	0.022	0.090
Non ICT capital	0.307	7.55	0.227	0.387

Notes: Industry * country * time dummies omitted. Number of observations: 5 278. Number of clusters: 468. Centered $R^2 = 0.965$. Hansen J statistic: 4.716. IV redundancy test: 30.373.

5. Main findings

This section discusses the results of the analysis for the total business sector.⁴ Column 1 in Table 2 reports the estimated value added elasticity of labour, ICT and non-ICT capital. A 1% increase in labour, ICT capital or non-ICT capital services leads to an increase in value added of, respectively, 0.635%, 0.056% and 0.307%. Although no assumption was made on the returns to scale, the data support the hypothesis of constant returns, *i.e.* the sum of elasticities equal to 1.

Table 2. **Estimated value added elasticities to inputs**

Inputs	Elasticity	Cost share
Labour	0.635	0.639
ICT capital	0.056	0.039
Non-ICT capital	0.307	0.322

Column 2 reports the non-parametric values of the elasticities based on the average shares in total costs for the whole business sector over the period considered. On average, the estimated elasticities are not very different from the cost share of the respective inputs. However, the theoretic values tend to be higher for non-ICT capital (0.015) and lower for ICT capital (-0.017). As ICT capital services increased between 50% (in Japan) and 208% (in Australia) over the period considered, this implies that the contribution of ICT investment is between 0.84 and 3.5 percentage points lower according to the non-parametric rather than the econometric approach.

Table 3 reports the contribution of production inputs to the average yearly growth in value added in the business sector of the countries considered. The average contribution of ICT investments varies from 1.0% a year in Australia to 0.4% a year in Japan. In one-third of the countries considered, the contribution of ICT investment was bigger or equal to that of non-ICT investments.

Table 3. **Growth accounting of the business sector**

Per cent

	Period	Value added	Due to growth in:				Residual
			Employment	ICT capital	Non ICT capital	Productivity	
Australia ¹	1995-2007	3.5	1.4	1.0	1.0	0.0	0.0
Austria	1995-2007	2.4	0.7	0.7	0.4	0.6	0.0
Belgium	1995-2006	2.1	0.8	0.9	0.8	-0.4	0.0
Czech Republic	1995-2007	2.8	0.2	0.7	1.2	0.7	0.0
Denmark	1995-2007	1.9	0.9	1.0	0.4	-0.4	0.0
Spain	1995-2007	3.5	2.3	0.7	1.3	-0.8	0.0
Finland	1995-2007	3.6	1.1	0.6	0.5	1.4	0.0
France ¹	1995-2007	2.1	0.7	0.5	0.6	0.4	0.0
Germany	1995-2007	1.6	-0.1	0.6	0.7	0.4	0.0
Hungary	1995-2007	3.9	0.9	0.4	0.3	2.2	0.1
Ireland ¹	1995-2007	7.0	2.8	0.8	2.5	0.8	0.0
Italy ¹	1995-2007	1.4	0.8	0.5	0.7	-0.5	0.0
Japan	1995-2006	1.2	0.0	0.4	0.6	0.2	0.0
Netherlands ¹	1995-2007	2.7	1.0	0.7	0.5	0.4	0.0
Slovenia ¹	1995-2006	4.1	0.6	0.5	2.8	0.2	0.0
Sweden ¹	1995-2007	3.0	0.6	0.5	1.1	0.7	0.0
United Kingdom	1995-2007	2.7	0.9	0.7	0.8	0.3	0.0
United States	1995-2007	3.1	0.9	0.8	0.8	0.6	0.0

1. Does not add up to "value added" due to rounding.

Growth in total factor productivity accounted for a significant share of value added growth. The average yearly growth in TFP varied between 2.2% in Hungary and -0.8% in Spain. The proportion of value added growth not explained by the regression tends to be very small in all countries.

The contribution of different types of ICT capital goods (Communication equipment, Computing equipment and Software) is detailed in Table 4.⁵ In a large majority of countries, computing equipment provided the largest contribution and accounted for over 50% of the overall ICT contribution. The only exceptions are Finland, where investments in communication equipment exceeded those in computing equipment, and Japan, where software was the most dynamic component of ICT investments.

TFP estimates at the industry level permit the measurement of the contribution of the ICT-producing industries⁶ to total TFP growth in the business sector, as shown in Table 5. ICT-producing industries account for no less than two-thirds of total TFP in Germany, the United Kingdom and Slovenia, about 60% in the United States and just below 50% in France and the Netherlands. In Belgium, Denmark and Italy, TFP increased in the ICT-producing industries whereas it decreased for the total business sector.

Table 4. The contribution of ICT investment: communication equipment, computing equipment and software

Per cent

	ICT capital	Communication equipment	Computing equipment	Software
Australia	1.0	0.09	0.85	0.11
Austria	0.7	0.06	0.55	0.13
Belgium	0.9	n.a.	n.a.	n.a.
Czech Republic	0.7	0.05	0.58	0.04
Denmark	1.0	0.02	0.78	0.16
Spain	0.7	0.25	0.34	0.07
Finland	0.6	0.28	0.18	0.13
France	0.5	n.a.	n.a.	n.a.
Germany	0.6	0.12	0.38	0.12
Hungary	0.4	n.a.	n.a.	n.a.
Ireland	0.8	n.a.	n.a.	n.a.
Italy	0.5	0.08	0.36	0.07
Japan	0.4	0.11	0.14	0.14
Netherlands	0.7	0.09	0.51	0.13
Slovenia	0.5	0.07	0.32	0.08
Sweden	0.5	0.07	0.33	0.11
United Kingdom	0.7	0.06	0.53	0.16
United States	0.8	0.16	0.44	0.17

Table 5. Contribution of ICT-producing industries to TFP

Per cent

	Productivity growth in:		% due to ICT
	Business sector	ICT industries	
Australia	0.02	0.01	40
Austria	0.58	0.13	23
Belgium	-0.37	0.15	> 100
Czech Republic	0.71	0.19	27
Denmark	-0.39	0.15	> 100
Spain	-0.77	-0.00	0.4
Finland	1.44	0.50	35
France	0.43	0.21	49
Germany	0.41	0.29	69
Hungary	2.21	0.60	27
Ireland	0.78	0.25	32
Italy	-0.48	0.12	> 100
Japan	0.23	0.23	100
Netherlands	0.40	0.19	48
Slovenia	0.23	0.15	66
Sweden	0.66	0.71	> 100
United Kingdom	0.28	0.19	67
United States	0.59	0.35	59

6. Conclusions and further work

This study has used an econometric approach to estimate the contribution of three types of ICT investment (computer, software and communication) in 26 industries (the whole business sector) in 18 OECD countries over the period 1995-2007.

The values of the estimated input elasticities were found to be close to the values of corresponding cost shares used in non-parametric growth accounting, although the latter tend to be smaller for ICT investment. Over the period considered, this implies that the contribution of ICT investment is between 0.84 and 3.5 percentage points lower according to the non-parametric rather than to the parametric approach.

Although the regression explains a very large proportion of the observed differences in value added across countries and industries and over time, the assumption of constant elasticities may lead to underestimate the contribution of the production inputs and to overestimate TFP and vice versa. In addition, the hypothesis does not permit disentangling the productivity growth of each factor in TFP.

Further research should extend the present framework to a more flexible functional form, like a translog production function, in order to account for different elasticities across industries and countries and over time.

Notes

1. Are excluded: Public Admin. and Defence; Compulsory Social Security; Education, Health and Social Work; Other Community, Social and Personal Services; Private Households with Employed Persons; and Extra-Territorial Organisations and Bodies.
2. Attempts to estimate a translog production function were inconclusive due to high collinearity among the independent variables.
3. In EU KLEMS, real value added and the inputs' services are reported as a normalised index with 1995 = 100. Therefore, cross-industry and cross-country differences in the level of efficiency are wiped out by this normalisation.
4. Detailed results by industry are available from the author on request.
5. The contribution of each type of ICT capital is computed based on a common elasticity for ICT capital, as reported in Table 2.
6. ICT-producing industries are defined according to OECD, 2011. However, the level of industry breakdown at which data are available does not permit a precise delimitation of the ICT-producing industry. A common proxy is the sum of ISIC 30 to 33 Electrical and Optical Equipment and ISIC 64 Post and Telecommunications. This aggregate includes Post, which is not part of the ICT sector, and excludes ISIC 72, which is an ICT industry.

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