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The Effect of Government Debt, External Debt and their Interaction on OECD Interest Rates

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By David Turner and Francesca Spinelli

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ABSTRACT/RESUME

The effect of government debt, external debt and their interaction on OECD interest rates

In the wake of the financial crisis there has been renewed focus on the importance of a country's net external debt position in determining domestic interest rates and, relatedly, its vulnerability to a crisis. This paper extends the panel estimation of OECD countries described in Turner and Spinelli (2012) to investigate the effect of external debt and its interaction with government debt on the interest-rate-growth differential. The inclusion of net external debt is found to be significant in both economic and statistical terms, and of particular importance for euro area countries in the post-crisis period. The results imply that the interest-rate effect of marginal increases in external debt or government debt is non-linear and dependent on the initial levels of debt, with the interest rate effect rising sharply in the post-crisis period for euro area countries which have a combination of both high external debt and high government debt. The policy implications for those countries under financial market pressure, especially within the euro area, are that reducing external deficits and debt are at least as important as reducing government deficits and debt. In any case, the effect of higher net external debt on interest rates provides a feedback effect which may prevent countries running sustained large current account imbalances over a long period. However, evidence of an asymmetry in the effect (between the effect of net external debt and net external assets) suggests that the pressure for adjustment will apply more strongly to deficit countries. It also implies that increased polarisation of external debt positions will raise the overall level of global interest rates.

JEL classification: E43; E62; H63; H68
Keywords: fiscal sustainability, government debt, external debt, interest rates, interest-rate-growth differential

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L'effet de la dette publique, de la dette extérieure et de leur interaction sur les taux d'intérêt dans la zone OCDE

À la suite de la crise financière, il y a eu un nouvel intérêt porté à l'importance de la position nette extérieure d'un pays dans la détermination des taux d'intérêt domestique, et par conséquent, sa vulnérabilité à une crise. Ce papier étend l'estimation de panel des pays de l'OCDE décrit dans Turner et Spinelli (2012) afin d'étudier l'effet de la dette extérieure et de son interaction avec la dette publique sur l'écart entre le taux d'intérêt et le taux de croissance. La prise en compte de la position nette extérieure apparait significative à la fois en termes économiques et statistiques, et notamment pour les pays de la zone euro dans la période postérieure à la crise. Les résultats soulignent que l'effet de la dette extérieure ou publique sur le taux d'intérêt est non linéaire et dépend des niveaux initiaux de dette ; en particulier l'effet sur le taux d'intérêt augmente beaucoup après la crise pour les pays de la zone euro du fait de la présence simultanée d'une dette extérieure et publique élevée. La conséquence en terme de politique économique pour ces pays sous pression des marchés financiers, spécialement dans la zone euro, est que la réduction des déficits et dettes extérieurs est au moins aussi importante que la réduction des déficits et dettes publics. Dans tous les cas, l'effet d'une dette extérieure nette élevée sur les taux d'intérêt se conjugue à un effet rétroactif qui peut empêcher un pays d'avoir des déséquilibres récurrents de balance courante sur une longue période. Cependant, l'existence d'une asymétrie de l'effet (entre l'effet d'une dette ou d'un surplus extérieur) suggère que la pression à l'ajustement va s'exercer plus fortement sur des pays avec des déficits. Cela implique également que la polarisation accrue sur les positions nettes extérieures va augmenter le niveau global des taux d'intérêt.

Classification JEL : E43 ; E62 ; H63 ; H68
Mots clé : viabilité budgétaire, dette extérieure, taux d'intérêt, écart taux d'intérêt, taux de croissance

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THE EFFECT OF GOVERNMENT DEBT, EXTERNAL DEBT AND THEIR INTERACTION ON OECD INTEREST RATES

by

David Turner and Francesca Spinelli[1]

1. Introduction and summary

1. In the wake of the financial crisis there has been renewed focus on the importance of a country's net external debt position in determining domestic interest rates and, relatedly, its vulnerability to a crisis. Catao and Milesi-Ferretti (2012) find using an up-to-date sample of advanced and emerging economies that there is a strong effect of net external liabilities on external crisis risk. Within the European Monetary Union, Gros (2013) argues that the wide variation in interest rates on government bonds is better explained by external debt than government debt. The ability of Japan to accumulate ever higher government debt without escalating interest rates is often explained by its ability to finance government debt domestically and its high level of net external assets (for example: OECD, 2013; Kawai and Morgan, 2012).

2. The empirical framework employed in this paper extends Turner and Spinelli (2012) to investigate the effect of external debt and its interaction with government debt on the interest-rate-growth differential. The earlier work, using a panel estimation of OECD countries, found important effects on this differential from inflation volatility, the slope of the yield curve, a measure of the "global savings glut" and government debt. The main findings of the current paper relating to the effect of external debt and government debt are as follows:

- The inclusion of net external debt is significant in explaining the interest-rate-growth differential in both economic and statistical terms, although important differences are found for euro area countries when the estimation period is extended to include the post-crisis period. For a country with existing net external debt an increase in the ratio of net external debt to GDP by 1 percentage point is estimated to raise the interest-rate-growth differential by about 2½ basis points, which is similar to other estimates in the literature.

- An important difference with the existing literature is, however, that when tested separately, the effect of changes in net external debt on the interest-rate-differential is found to be weaker for a country which starts from a positive net external asset position compared to one which starts from a net external debt position. Hence, the interest-rate "penalty" for high external indebtedness is larger than the interest rate reduction for an equivalent net external asset position.

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1. David Turner is Head of the Macroeconomic Analysis Division of the OECD Economics Department, Francesca Spinelli formerly worked in that Division, but now works for the Trade in Services Division of the Trade and Agriculture Directorate. They would like to thank Jean-Luc Schneider, Yvan Guillemette, Jan Strasky and participants at the 2013 Project Link meeting for helpful comments on the paper as well as Diane Scott for help in the final document preparation. The views expressed in this paper are those of the authors and do not necessarily represent those of the OECD or its member countries.

- Compared to the results in the earlier study, the effect of government debt on the interest-rate-differential is more heterogeneous, depending on the extent to which it is accompanied by an increase in external debt. Thus in the earlier paper the effect of an increase in general government debt by 1 percentage point of GDP (evaluated relative to a threshold of 75% of GDP) was found to increase interest rates by about 4 basis points. In the current study, the effects of an increase in government debt (in each case evaluated relative to an initial threshold of 75% of GDP) for non-euro-area countries is about 2½ basis points if financed entirely domestically and about 3½ to 5 basis points if it is financed externally (being higher if the country starts from a position of net external debt).

- In the post-crisis period, there is evidence of increased sensitivity of euro area interest rates to both government and external debt, which provides some quantification of the increased vulnerability of countries within a monetary union arising from the separation of decisions about debt issuance and monetary control (De Grauwe, 2011). The preferred specification includes a non-linear variable which is a combination of both government and external debt and helps to explain much of the recent extreme movements in euro area interest rates. It implies that the marginal effects of increases in government and external debt depend strongly on initial debt levels. For example, a 1 percentage point increase in the government-debt-to-GDP ratio above the 75% threshold varies as follows: for countries which start with positive net external assets the interest rate effect is the same as for non-euro-area countries (about 2½ basis points); for countries with net external debt of about 25% of GDP (similar to Italy) the increase in interest rates is more than double that (about 5½ basis points); but for a country with initial net external debt of 100% of GDP (similar to Greece, Portugal, Ireland and Spain) the corresponding increase in interest rates is nearly five times greater (about 12 basis points). While the magnitudes of these effects reflect particular financial market tensions over the estimation period, which have subsequently eased, they do suggest that those euro area countries with a combination of both high external and government debt may be most vulnerable during a period of heightened financial market tension.

3. The policy implications for countries under financial market pressure, especially those within the euro area, are that reducing external deficits and debt may be at least as important as reducing government deficits and debt. In any case, the effect of higher net external debt on interest rates provides a feedback effect which will likely prevent countries running sustained large current account imbalances over a long period.[2] However, evidence of an asymmetry in the effect (between the effect of net external debt and net external assets) suggests that the pressure for adjustment will apply more strongly to deficit countries. It also implies that increased polarisation of external debt positions will raise the overall level of global interest rates.

4. The remainder of the paper is organised as follows: the next section sets out the empirical framework for the analysis; section 3 reports estimation results; section 4 considers the policy implications of the results, focusing on the interest rate implications of government and external debt. The data used in the empirical work is described in more detail in Annex 1 and there is a brief selective review of some of the literature concerning the effect of external debt on interest rates in Annex 2. Lastly, Annex 3 reports the sensitivity of the results to relaxing the restriction on nominal potential growth.

2. Indeed, these results have been used to calibrate the OECD's long-term projection model (Johannson, *et a1,* 2012) so that increasing net external debt puts upwards pressure on domestic interest rates and this tends to lower investment and rein in the current account deficit.

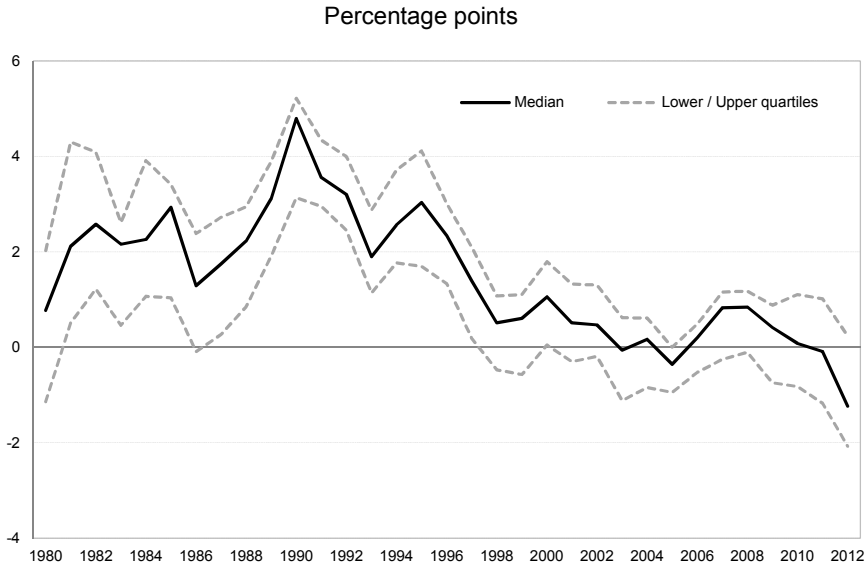
2. The framework for explaining the interest-rate-growth differential

5. For the purposes of the empirical estimation, the interest-rate-growth differential is measured as the difference between the interest rate on 10-year government bonds and a smoothed OECD estimate of nominal potential growth. This measurement of the differential differs in several important respects from that included in the familiar identity linking government debt and the primary balance, but is a more practical measure for the purpose of estimation, particularly because of greater cross-country comparability (see Turner and Spinelli, *op cit*., for further discussion).

6. A positive link between long-term interest rates and potential growth can be derived from microeconomic foundations (Laubach, 2009), although such a derivation does not necessarily imply a unit coefficient on growth. Such a restriction is imposed here so that the results are more readily comparable with Turner and Spinelli (2012). If this restriction is relaxed, the coefficient on nominal potential growth is estimated to be about 0.7, although the coefficients on the government and external debt only change marginally (as discussed in Annex 3 which examines the sensitivity of the results to the relaxation of this restriction).

7. Based on this definition, the interest-rate-growth differential for 22 OECD countries shows 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 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. Following the financial crisis, there has been much greater dispersion in the differential; the differential for the median country fell below -1 percentage point in 2012 (its lowest level since 1980), while for some of the euro area countries under financial market pressure the differential soared, notably exceeding 20 percentage points for Greece in 2012.

Figure 1. **The interest-rate-growth differential for 22 OECD countries**



Source: OECD *Economic Outlook* November 2013 and OECD calculations, for further details on the data see Annex 1.

8. The basic empirical framework for explaining the interest-rate-growth differential is similar to that employed by Turner and Spinelli (2012) with explanatory variables as follows:

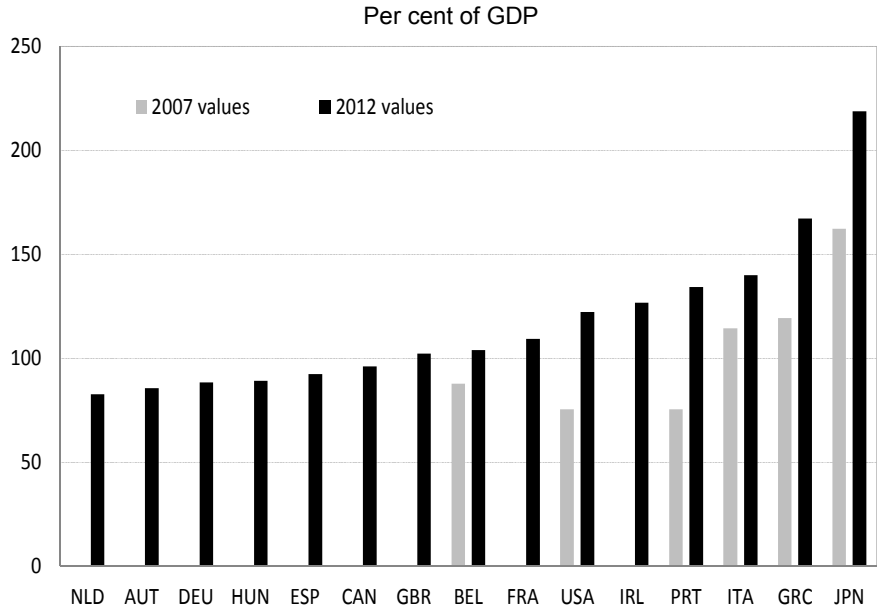
- A measure of the volatility of inflation, here taken to be the 10-year standard deviation of CPI inflation, which is considered as a proxy for uncertainty surrounding inflation, with a prior being that reduced uncertainty/volatility will imply a lower interest-rate-differential.

- A measure of the slope of the yield curve, here taken to be the difference between lagged short-term interest rates and a four-year lagged average of long-term interest rates, which is included to allow for the influence of policy interest rates. Thus, low policy rates, by creating expectations of future low short-term interest rates, are likely to drag down current long-term interest rates.

- A proxy for the "global savings glut" originating from Asian emerging markets and oil exporters, taken to be an *ex-post* measure of these countries' current account balances, with a prior being that this variable will tend to reduce the interest-rate-differential for all OECD countries, as argued by Bernanke (2005, 2007) in relation to the United States.

- A measure of government indebtedness, taken to be the excess of the gross government debt-to-GDP ratio above 75%, where this threshold is the one that is used in modelling long-term interest rates for the OECD *Economic Outlook* projections.[3] The number of countries for which government debt has risen above this threshold has increased substantially in the aftermath of the crisis (Figure 2).

Figure 2**. OECD countries for which gross government debt exceeds 75% of GDP**



Note: Although reported in the chart, Hungary (HUN) has not been included in the empirical analysis.

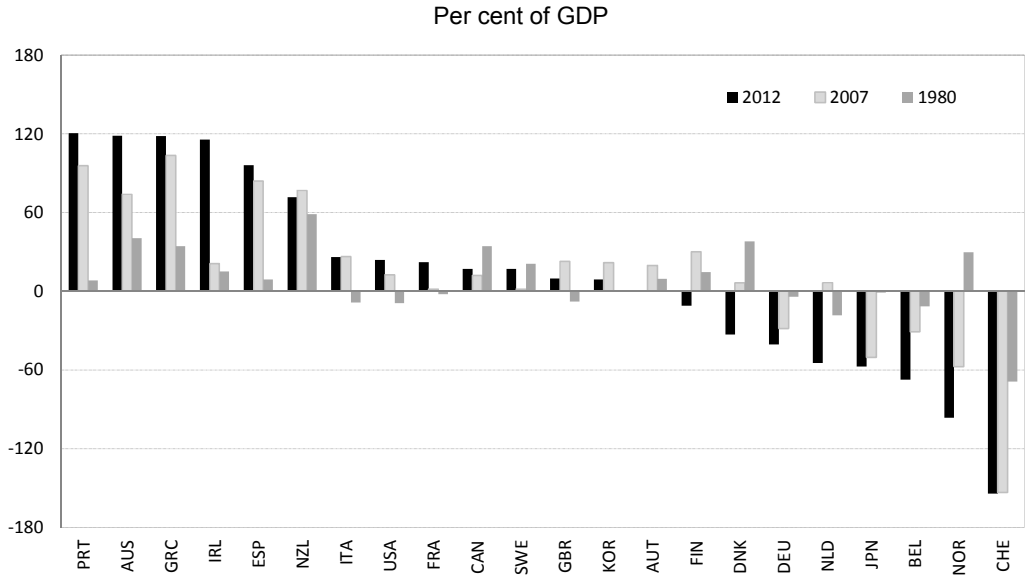
Source: OECD *Economic Outlook* November 2013 and OECD calculations.

9. These explanatory variables are supplemented with a measure of the net external indebtedness of a country, given a number of empirical multi-country studies find an effect on interest rates (see Annex 2). The net external debt positions among OECD countries have tended to become more polarised over the

3. No particular precision should be attached to the 75% debt threshold, rather there are a range of studies (including Egert, 2010, Laubach, 2009 and Sutherland *et al.*, 2012) that suggest that government debt ratios in excess of levels of between 60% and 90% have an effect on interest rates.

sample period (Figure 3): Greece, Portugal, Ireland and Spain have all substantially increased their net external debt positions with the net external debt ratios exceeding or approaching 100% of GDP; whereas Germany, Japan, Belgium, Norway and Switzerland have all built up net external asset positions.

Figure 3. **Net external-debt-to-GDP ratio of selected OECD countries**



Note: The first ratio refers to 1980 or the earliest year available. See Table A1 in Annex 1 for details on the time period covered for each country's net external position.

Source: IMF International Financial Statistics, November 2013, see Annex 1 for further details on the data.

3. Estimation results

10. The estimation is run for 22 OECD countries (chosen for reasons of data availability) on a sample period which extends from 1980 to 2012 (Table 1).[4] The interpretations of the coefficients on variables which are common across a range of specifications are as follows:

- Inflation variability is consistently significant and positive and implies that the median reduction in inflation variability of 3½ percentage points between the 1980s and the 2000s would have reduced the interest-growth-differential by about ¾ percentage point, although by much more in some countries.

- The measure of the yield curve slope is positive and significant implying that for every percentage point difference between current short-term interest rates and lagged long-term rates, current long-term interest rates will be pulled about 20 to 25 basis points in the same direction.

- The "global savings glut" variable is strongly significant and implies that over the pre-crisis 2000s the interest-rate-growth differential for all OECD countries was reduced by just over 1 percentage point compared to the 1980s and 1990s.

4. The panel is unbalanced, because there are some countries for which data is not complete over the full sample period. Further details are given in Annex 1.

Table 1. **Panel regression results explaining the interest-rate-growth differential for 22 OECD countries**

Sample 1980-2012, Dependent variable: interest-rate-growth differential

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Var(π)	0.177 **	0.192 **	0.215 ***	0.241 ***	0.199 ***	0.148 **	0.169 ***	0.180 ***
Ycurve	0.180 ***	0.189 ***	0.202 ***	0.168 ***	0.233 ***	0.246 ***	0.238 ***	0.241 ***
S Glut	-1.715 ***	-1.595 ***	-1.784 ***	-1.638 ***	-1.742 ***	-1.763 ***	-1.651 ***	-1.637 ***
GDebt	0.050 ***	0.048 ***	0.043 ***	0.046 ***	0.029 ***	0.026 ***	0.023 ***	0.025 ***
NXD		0.031 ***						
NXD>0			0.045 ***	0.045 ***	0.030 ***	0.020 ***	0.024 ***	0.025 ***
NXD<0			0.012 *	0.015 **	0.015 **	0.014 **	0.011 **	0.011 **
D_USA				-4.040 ***	-2.953 **	-2.675 **	-2.652 **	-2.746 **
D_GRC								8.338 ***
D_EMU*GDebt					0.102 ***	0.064 ***		
D_EMU*NXD>0						0.039 ***		
D_EMU*NXD>0*Gdebt							0.148 ***	0.123 ***
Number of observations	640	609	609	609	609	609	609	609
Adj R-squared	0.31	0.38	0.39	0.42	0.53	0.55	0.60	0.61
S.E. of regression	1.99	1.81	1.79	1.75	1.56	1.53	1.45	1.43
Country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Country dummies	no	no	no	yes	yes	yes	yes	yes

Notes: Variable definitions as follows (see Annex 1 for further details): Var(π) = measure of the variability of inflation taken as the 10-year standard deviation of CPI inflation; Ycurve = Measure of the slope of the yield curve, taken as the difference between lagged short-term interest rates and a lagged moving average of long-term interest rates; GDebt = Ratio of gross-government-debt-to-GDP in excess of 75%; NXD<0 net external-debt-to-GDP ratio when the country holds net external assets (taking the value zero for net external debt positions); NXD>0 net external-debt-to-GDP ratio (taking the value zero for net external asset positions); D_USA = Dummy variable to capture the possible effects of quantitative easing, taking values of unity for the USA in 2011 and 2012; D_GRC = Dummy variable taking the value unity for Greece in 2012; D_EMU = Dummy variable taking the value of unity for euro area countries over the period 2010-12 to distinguish the post-crisis period for euro area countries. Country dummies (coefficients not reported here, except to note their presence in the final row of the table) take values of unity in 1998 for Korea (the Asia crisis) in 1990 for Spain and Sweden, and 1990-91 for Finland, coinciding with banking crises."***", "**" and "*"denote statistical significance at the 1%, 5% and 10% levels, respectively.

Source: OECD calculations based on OECD *Economic Outlook* November 2013, IMF *World Economic Outlook* database, October 2013 data and IMF International Financial Statistics, November 2013.

11. The effect of changes in government debt varies with the equation specification, with the simplest specification, [equation (1) in Table 1] which is also closest to the preferred equation of Turner and Spinelli (2012) implying each percentage point increase in government debt raises the interest-rate differential by about 5 basis points, which is similar to the effect estimated in Turner and Spinelli (2012). However, as net external debt is included and the post-crisis period is differentiated for euro area countries (as discussed below) this effect falls to 2-4 basis points.

12. The inclusion of an additional variable for the ratio of net-external-debt-to-GDP ("NXD", taking negative values when gross external assets exceed gross external liabilities) is statistically significant [equation (2) in Table 1] and implies that an increase in the net external debt-to-GDP ratio of 1 percentage point will raise interest rates by about 3 basis points. Further estimations consider whether the effect of changes in net external assets and net external debt are symmetric, by distinguishing whether a country has net external debt ("NXD>0", taking positive values when a country has net external debt but is zero when a country has net external assets) or net external assets ("NXD<0", taking negative values when a country has net external assets, but is zero when a country has net external debt). When both variables are included in the specification [equation (3)], the coefficient on the former is greater (as well as statistically more significant), implying that the effect on interest rates of a unit increase in the net external debt-to-GDP ratio is larger starting from a position of net external debt than net external assets. The coefficient estimates on net external debt vary when the post-crisis period is differentiated for euro area countries, although the distinction of a larger marginal effect when starting from a position of net external debt than net external assets remains.

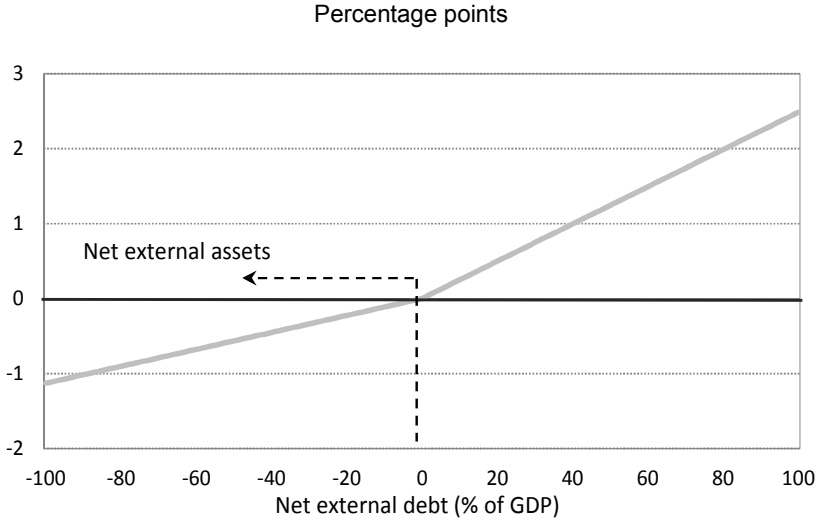
13. Examination of the residuals of equations (1) to (4) showed that they were particularly large for euro area countries which had come under financial market pressure in the post-crisis period, so that introducing a post-crisis dummy for euro-area countries considerably improved the fit for these countries. This dummy (taking the value of unity for years after 2009, but only for euro area countries) was significant when multiplied by the government debt or net external debt variables, implying that increased sensitivity of euro area countries to these variables in the post-crisis sample [equations (5) and (6)]. However, the preferred specification improves in terms of fit and parsimony with the introduction of a non-linear variable which was the product of the dummy variable, government debt and net external debt [equation (7)]. With the exception of Greece in 2012, equation (7) including the non-linear debt variable, tracks the dispersion of interest rates within the euro area reasonably well in the post-crisis period and seemingly much better than some recent studies which have systematically under-predicted the increase in interest rates in euro area periphery countries (Di Cesare, 2012; De Grauwe and Ji, 2012; and Proghosyan, 2012). For this reason, a dummy variable is included for Greece in 2012 in the final preferred equation (8).

14. One weakness of the estimated equations is a tendency for them to systematically over-predict the interest-growth differential in recent years, but especially in 2012 and especially for the larger countries. The inclusion of a dummy for the United States in 2011 and 2012 to capture the effects of quantitative easing is highly significant, but the size of the coefficient suggests a larger effect than found by studies which have specifically focused on trying to identify the magnitude of this effect. The large under-prediction in 2012 for Japan, France, Germany, United Kingdom and the United States as well as smaller countries such as Australia, Norway and Sweden might have alternative explanations: direct effects from quantitative easing measures (in the United States, United Kingdom and Japan) or international spillovers from such measures in other countries; and/or the possibility that in current circumstances the proxy for the slope of the yield curve does not adequately capture the duration over which policy rates are expected to be maintained at low levels.

4. Effects of government debt and external debt on interest rates

15. This section considers the implications of the final preferred specification (equation 8) for the effect of changes in government and external debt. For non-euro area countries, the effect of a 1 percentage point increase in net external debt is to raise interest rates by just about 2½ basis points (Figure 4), which is similar to other estimates in the literature (see Annex 2). However, the effect is not symmetrical, so that an increase in net external assets by 1 percentage point will only lower interest rates by about 1 basis point.

Figure 4. **The effect of external debt on the interest-rate-growth-differential**



Note: The chart shows the estimated effect of changes in external debt on the interest-growth differential.

Source: OECD calculations made using the coefficients of equation (8) in Table 1.

16. The combined effect of external and government debt on the interest-growth differential for non-EMU countries is additive, as illustrated by the parallel interest-rate schedules for external debt at different levels of government debt shown in Figure 5a. The inclusion of net external debt in the specification implies that the increase in interest rates from an increase in government debt depends on whether it is domestically or externally financed, as shown in Figure 6; precisely, for non-euro area countries, an increase in the government debt ratio (above the 75% threshold) raises interest rates by 2½ basis points if domestically financed and 3½ to 5 basis points if entirely externally financed (the larger effect being for countries starting from an initial position of net external debt).

17. The inclusion of the non-linear debt term has major implications for euro area countries in the post-crisis period, because it suggests that there is an important interaction between government debt and net external debt. The marginal effect of an increase in either government debt or net external debt (or both) on interest rates is very dependent on the initial levels of these variables with a sharply escalating increase in the cost of debt at higher levels of external debt as illustrated by the increasing slope of the interest-rate schedules for external debt as the level of government debt increases in Figure 5b. Thus, the effect of a marginal increase in government debt (above the threshold of 75% of GDP) on interest rates differs across euro area countries as follows (Figure 6):

- For a euro area country which has no net external debt (like Germany) the effect of an increase in government debt is the same as for non-euro area countries, namely 2½ basis points if financed entirely domestically and 3½ basis points if financed entirely externally.

- For a country with net external debt of about 25% of GDP (similar to Italy) the increase in interest rates for a marginal increase in government debt is between 5½ and 8 basis points (depending on whether it is domestically or externally financed, respectively).

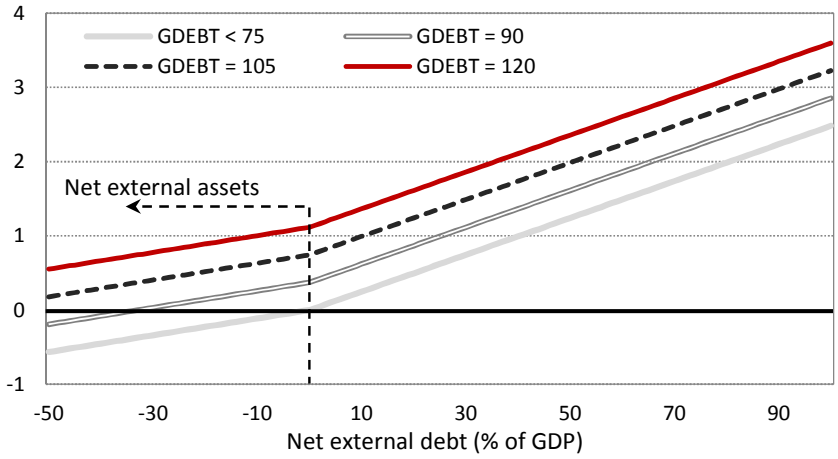
- For a country with initial net external debt of 100% of GDP (similar to Greece, Portugal and Spain) the corresponding increase in interest rates is between 12 and 15 basis points.

The annual specification considered here cannot capture the higher frequency variation which has been apparent in euro area interest differentials and appears to be driven by financial market sentiment reacting to policy announcements and political events which are not modelled within this framework. Nevertheless, the estimation results do suggest that when financial market tensions are heightened, those countries with a combination of high external debt and government debt are most exposed, as suggested by Gros (2012).

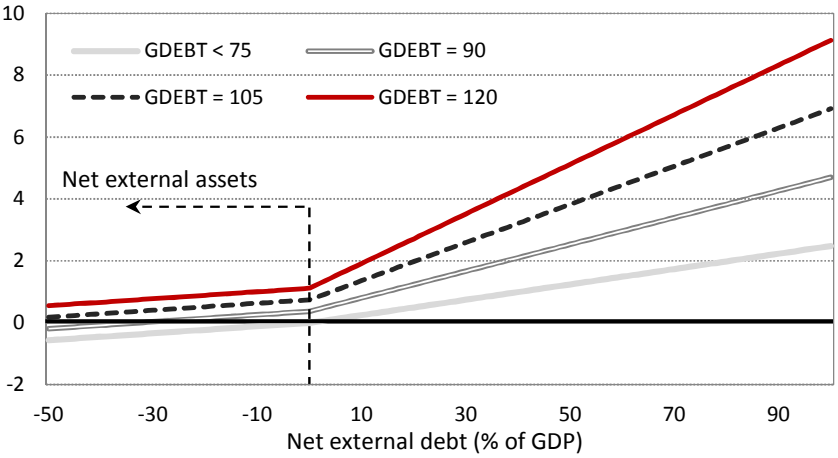
Figure 5. **Risk premia effects of different combinations of external and government debt**

Percentage points

(a) Non-euro area countries



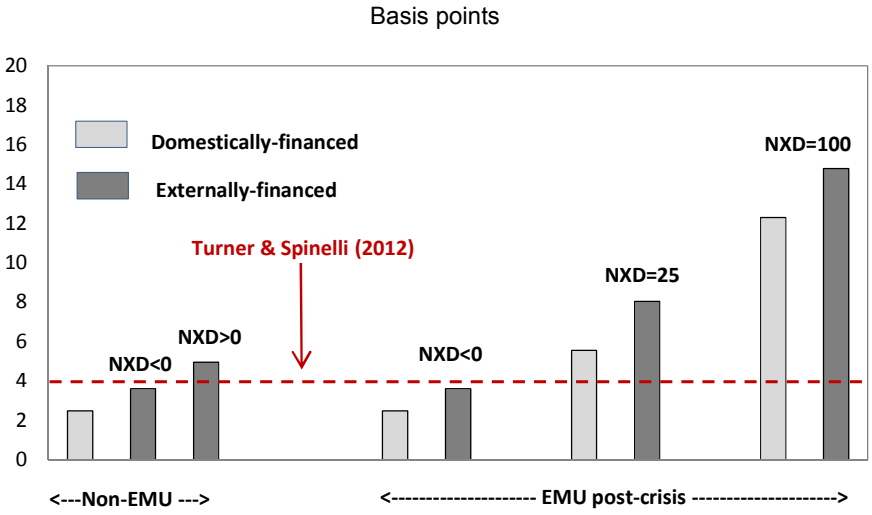
(b) Euro area countries



Note: The charts show the estimated effect of different combinations of external and government debt on the interest-growth differential.

Source: OECD calculations based on the coefficients of equation (8) in Table 1.

Figure 6. **Risk premia effects of an increase in the government-debt-to-GDP ratio by 1 percentage point**



Note: The chart show the effect on long-term interest rates of an increase in the government debt-to-GDP ratio by one percentage point when the initial ratio exceeds a threshold of 75%. It distinguishes whether the extra government debt is financed domestically (lighter bars) or externally so leading to an equivalent increase in net external debt (NXD) (the darker bars). Following the estimation results, the effects are also distinguished between EMU and non-EMU countries, and for the former countries the effects depends on the initial level of net external debt, the three cases considered to be net external assets and net external debt of 25% and 100% of GDP..

Source: OECD calculations made using the estimated coefficients of equation (8) in Table 1.

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ANNEX 1. DATA DESCRIPTION

The data used in this paper cover 22 OECD member countries over the period 1980-2012. These countries were selected to maximise the time span of the panel dataset so that the maximum number of observations per variable would be 636. However, due to the gaps in the data for some countries, particularly Greece, the effective number of observations used in each regression is slightly lower. The exact country coverage of the variables is presented in Table A1.

Most of the data used in this paper are taken from the recently published OECD *Economic Outlook* No. 94 database, released in November 2013. Data used to construct the measure of the "global savings glut" are extracted from the IMF *World Economic Outlook* (WEO) database, released in October 2013, while data used for net external debt are sourced from the International Investment Position Statistics of the IMF, using BPM5 data as far as possible and complementing them with BPM6 figures when required.

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 1, 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 the OECD measure of nominal potential GDP growth smoothed with an HP-filter;
- *Inflation volatility* is measured as a ten-year standard deviation of CPI inflation;
- The *slope of the yield curve* is calculated as the difference between lagged short-term interest rates (generally three-month Treasury bill rate) and a four-year lagged average of long-term interest rates on 10-year Treasury bonds;
- A proxy measure of the *global savings glut*, 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 A2);
- A variable measuring high government indebtedness is included, 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;

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

- A dummy variable taking value unity for Euro area countries over the period 2009 to 2012 and zero elsewhere, designed to exclude the influence of the debt variable and/or the net external debt variable for EMU countries over that specific period, included from equation (5) onwards;

- Finally, a variable (NXD) measuring the ratio of net external debt to GDP, taking negative values when gross external assets exceed gross external liabilities, is included for equation (2). From equation (3) on two separate variables are included to distinguish whether a country has net external debt (NXD>0, which takes positive values when a country has net external liabilities and is zero (rather than negative) when a country has net external assets) or net external assets (NXD<0, taking negative values when a country has net external assets and being zero in case the country has net external debt). Both variables are adjusted in the case of Finland in 1999 to smooth the effect of the high-tech bubble, during which an excessive number of shares in Nokia were predominantly held abroad, *i.e.* by foreign residents.

Table A1. **Details on data availability**

Variable	Starting date	Ending date	Exceptions to the starting date
Interest rate – growth differential $(irl - g)_t$ ***dependent variable***	1980	2012	Portugal and New Zealand (1981), Switzerland (1982), Korea (1983), Greece (1994)
Short-term interest rate minus Long-term interest rate $(irs - irl)_t$	1980	2012	Denmark (1981), Sweden (1983), Ireland (1985), Greece (1994), Korea (1992)
Standard deviation of inflation $SD_5(\pi)_t$	1980	2012	Greece (1997)
Global savings glut	1980	2012	-
Debt 75	1980	2012	Australia (1988), New Zealand (1993), Greece and Portugal (1995), Ireland
Net external assets as a percentage of GDP	1980	2012	Australia (1986), Belgium (1981), Denmark (1991), France (1989), Greece (1999), Ireland (2001), New Zealand (1989), Portugal (1996), Spain (1981), Switzerland (1983), Sweden (1982)

Table A2. **List of countries composing the different aggregates considered in the empirical analysis**

Country aggregate	Countries
OECD 22	Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.
G 7	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.

ANNEX 2. A BRIEF SELECTIVE SUMMARY OF THE LITERATURE RELATING EXTERNAL DEBT TO INTEREST RATES

There are a number of empirical studies which find a link between a country's external asset/debt position and its domestic interest rates, although exact comparisons are difficult because of the precise set-up of the empirical estimation:

- Lane and Milesi-Ferreti (2001) find evidence of an inverse relationship between interest rates on government bonds and net foreign asset positions such that a 20 percentage point increase in the ratio of net foreign liabilities to *exports* position is associated with a 50 basis point increase in real interest rates. To put this result on a more comparable basis to other results discussed below, this would imply that, for an OECD country with a typical export-to-GDP ratio of about 40%,[5] an increase in net external debt of 1 percentage point of GDP would raise domestic interest rates by about 6 basis points. The same analysis suggests a marginally significant positive impact on interest rates from government debt.

- Rose (2010) employs a panel data set of 20 advanced economies over the period 1980-2004 and concludes that interest rates are sensitive to net international investment positions and that a 1 percentage point increase in the ratio of net external debt to GDP will typically be associated with an increase of 2 basis points in real interest rates.

- Cheung (2013) using a panel regression on 25 OECD countries over the period 1970-2007, finds that a 1 percentage point increase in net foreign debt as a share of GDP is associated with an increase in real long-term interest rates of 1.3 basis points. The estimation period is not extended to include more recent observations to "exclude the extraordinary effect of the financial crisis". No statistically significant effect on interest rates from government debt was found.

In summary, the three studies considered above find that an effect of an increase in the net external debt to GDP ratio of about 1 percentage point raises interest rates by between 1.3 and 6 basis points. All of these studies are based on a pre-crisis estimation period.

5. The inter-quartile range of export-to-GDP ratios among OECD countries is about 30% to 65% implying an increase of between 4 and 8 basis points for a 1 percentage point increase in net external debt.

ANNEX 3. SENSITIVITY OF THE RESULTS TO RELAXING THE RESTRICTION ON NOMINAL POTENTIAL GROWTH

The dependent variable in the estimations reported in the main paper, following Turner and Spinelli (2012), is always the differential between nominal long-term interest rates and nominal potential growth. To the extent that the equation is considered to provide an explanation for long-term interest rates, this effectively imposes a unit coefficient on nominal potential growth. If this restriction is relaxed so that the coefficient on potential growth is estimated, the freely estimated coefficient is estimated to be about 0.7 and is significantly very different from both zero and unity (see table below). There is a relatively small reduction in the estimated coefficients on government debt and external debt, although the coefficient on the yield curve increases by a factor of a half and on inflation variability more than doubles.

Table A3. **Panel regression results from relaxing the restriction on nominal potential growth**

Sample 1980-2012, 22 OECD countries

Dependent variable	IRL - G	IRL
G	1.00 [Implicit]	0.702 ***
var(π)	0.215 ***	0.485 ***
Ycurve	0.202 ***	0.300 ***
S Glut	-1.784 ***	-1.964 ***
GDebt	0.043 ***	0.033 ***
NXD>0	0.045 ***	0.035 ***
NXD<0	0.012 **	0.013 **
Number of observations	609	609
Adj R-squared	0.39	0.74
S.E. of regression	1.79	1.74
Country fixed effects	yes	yes
Country dummies	yes	yes

Note: Variable definitions as follows: IRL = Nominal long-term interest rates (percentage points); g = nominal potential growth (% per annum); Var(π) = measure of the variability of inflation taken as the 10-year standard deviation of CPI inflation; Ycurve = Measure of the slope of the yield curve, taken as the difference between lagged short-term interest rates and a lagged moving average of long-term interest rates; GDebt = Ratio of gross-government-debt-to-GDP in excess of 75%; NXD<0 net external-debt-to-GDP ratio when the country holds net external assets (taking the value zero for net external debt positions); NXD>0 net external-debt-to-GDP ratio (taking the value zero for net external asset positions). Statistical significance at the 1%, 5% and 10% levels is denoted by "***", "**" and "*", respectively.

Source: The equation in the first column is equation (3) from Table 1 in the main paper, whereas the equation in the second column is a re-estimate of this same equation but with the unit restriction on nominal potential growth relaxed.

The finding of a coefficient on potential growth of less than unity implies that higher potential growth will improve (*i.e.* reduce) the interest-rate-growth differential and so improve the prospects for fiscal sustainability of indebted countries. This is turn suggests that structural reforms which boost potential growth can also contribute to improving fiscal sustainability.

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