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ECO/WKP(2016)76

Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development

23-Nov-2016

English - Or. English

ECONOMICS DEPARTMENT

A RE-ASSESSMENT OF FISCAL SPACE IN OECD COUNTRIES

ECONOMICS DEPARTMENT WORKING PAPERS No. 1352

By Jarmila Botev, Jean-Marc Fournier and Annabelle Mourougane

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ABSTRACT/RÉSUMÉ**A re-assessment of fiscal space in OECD countries**

To what extent can public deficits increase without putting fiscal sustainability at risk, given the specific current macroeconomic situation of protracted low growth and low interest rates, combined with relatively high government debt levels? The answer depends on many factors, such as the state of the economy, the fiscal track record and projections of population ageing and their effect on government spending.

This paper makes use of three different approaches to better assess fiscal space, which can be defined in a broad manner as the extent to which public debt can increase. These approaches converge to a conclusion that there is fiscal space in most of the large advanced economies. There is also evidence that fiscal space may have risen in most OECD countries since 2014, mainly driven by the decrease in interest rates. Reforms to health and pension programmes would help to create additional fiscal space.

JEL Classification: H3, C3

Keywords: fiscal space, OECD, market access, fiscal sustainability

Une ré-évaluation des marges de manoeuvre budgétaires dans les pays de l'OCDE

Dans quelle mesure les déficits publics peuvent-ils augmenter sans compromettre la viabilité budgétaire? La situation macroéconomique actuelle, caractérisée par une faible croissance prolongée et de faibles taux d'intérêt, combinée à un niveau d'endettement public relativement élevé, justifie une réévaluation de cette question. Sa réponse dépend de nombreux facteurs, tels que l'état de l'économie, les antécédents budgétaires ou les projections du vieillissement de la population et leurs effets sur les dépenses gouvernementales.

Ce document utilise trois approches différentes pour mieux évaluer les marges de manoeuvre budgétaires, qui peuvent être définie de manière large comme la mesure dans laquelle la dette publique peut augmenter. Ces approches convergent vers la conclusion qu'il existe des marges de manoeuvre budgétaires dans la plupart des grandes économies avancées. Il est également prouvé que l'espace budgétaire peut avoir augmenté dans la plupart des pays de l'OCDE depuis 2014, principalement sous l'effet de la baisse des taux d'intérêt. Les réformes des programmes de santé et de retraite aideraient à créer des marges de manoeuvre budgétaires supplémentaires.

Classification JEL: H3, C3

Mots clés: marges budgétaires, OCDE, accès aux marchés, soutenabilité budgétaire

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A RE-ASSESSMENT OF FISCAL SPACE IN OECD COUNTRIES

Jarmila Botev, Jean-Marc Fournier and Annabelle Mourougane¹

1. Introduction and main messages

1. Almost a decade after the outbreak of the financial crisis, the global economy remains in a low-growth trap with weak investment, trade, productivity and wage growth and rising inequality in some countries. Monetary policy is overburdened, and its ultra-accommodative stance creates distortions and may fuel financial risks and distortions. Alongside structural reforms, a stronger fiscal policy response is needed to boost near-term growth and strengthen long-term prospects for inclusive growth.

2. However, in the context where public debt has risen to high levels in most OECD countries, it is important to assess the extent of countries' fiscal space. In the past few years, the assessment of fiscal policy has focused essentially on public budget balance positions rather than on the consequences for growth. This focus has resulted in a higher debt-to-GDP ratio in the short term, as shortfalls in investment, human capital and productivity have curbed GDP growth. A rethink is needed for how the fiscal policy stance should be evaluated, particularly in the context where low sovereign interest rates provide more fiscal space.

3. In recent years, a number of new methods have complemented the more traditional approaches to assess fiscal space (see Annex 1 for an overview of the different methods). This chapter relies essentially on three, with the objective of approaching the complex reality from different angles:

- Ghosh et al. (2013) and Fournier and Fall (2015) focus on *market access*. They calculate fiscal space as the distance between actual debt levels and their estimated limits. Debt limits measure the debt level at which a sovereign borrower loses market access and hence cannot service its debt in a normal way. Debt limits depend on assumptions made on risk-free interest rates and potential output growth, the size of shocks that hit economies, the country's fiscal track record and the fiscal reaction to increasing debt. The fiscal reaction relies on the assumption that governments cannot indefinitely sustain public primary surpluses and will experience fiscal fatigue at some point. The model includes a non-linear risk premium that rises sharply if debt becomes close to the debt limit.
- Bi (2011) and Bi and Leeper (2013) examine sovereign default risks but account for *long-term fiscal sustainability*. They rely on a DSGE approach, whereby the shape of the Laffer curve (which derives expected tax revenues from tax rates) depends on macroeconomic circumstances. Shocks to the economy and long-term projections of spending and transfers are accounted for. The approach does not provide a point estimate of the debt limit, but its

1. The authors are members of the Economics Department of the OECD. They would like to thank Mark Baker, Sebastian Barnes, Sven Blondal, Ane-Kathrine Christensen, Boris Cournède, Catherine Mann, Peter Hoeller and country Desks from the Economics Department for their comments and suggestions, as well as Sylvie Foucher-Hantala for statistical support and Veronica Humi (also from the Economics Department) for editorial assistance. They also thank Zuzana Mucka (CBR) for providing us her version of the MATAB codes.

distribution, i.e. the probability for a country to default at each value of the debt-to-GDP ratio. This distribution is derived using the expected present value of future maximum primary surpluses, which come from driving tax revenues to the peak of the Laffer curve and expenditure to its projected level.

- Blanchard et al. (1990) focus essentially on *long-term fiscal sustainability*. When the interest rate is persistently below the growth rate, governments are able to run permanent deficits of any size. When the interest rate to growth differential is positive, fiscal space is computed as the tax gap between the sustainable and the current tax-to-GDP rate, where the former is the constant tax rate that would achieve an unchanged debt-to-GDP ratio over the relevant horizon, for a given projection set of public spending and transfers. Contrary to the former two approaches, this framework does not account for macroeconomic shocks. In this paper, a variant of this methodology is used to compute sustainable tax rates with a small macroeconomic model.

4. The main messages are the following:

- Interest rates on government debt are very low in advanced economies, following exceptional monetary stimulus and have generated savings through lower interest payments.
- Measures of fiscal space -- those that focus on the gap between actual debt and estimated levels at which market access would be compromised -- appear to have risen in most OECD countries since 2014, as lower interest rates have more than offset headwinds from lower potential growth and higher debt.
- Measures that examine market access and account for projected long-term ageing-related spending pressures also point to some space in most of the larger advanced economies.
- The extent of fiscal space appears to be uncertain in Italy and depends to a large extent on whether the focus is on past developments of the primary balance ("market access" approach) or on the budgetary implications of population ageing ("long-term fiscal sustainability" approach).
- Structural reforms that effectively contain the cost of healthcare and pension spending, including by reforming entitlements, create additional space.
- The increase in fiscal space provides room for manoeuvre, provided that low interest rates are locked-in through long-term borrowing. In particular, countries could issue more long-dated bonds and take advantage of favourable financial conditions.
- Although policy requirements vary by country depending on their circumstances and positions in the cycle, most advanced countries have scope to use the expanded fiscal space in the context of a fiscal initiative which would comprise measures fostering productivity and long-term growth.

2. The current economic context calls for a reassessment of fiscal space

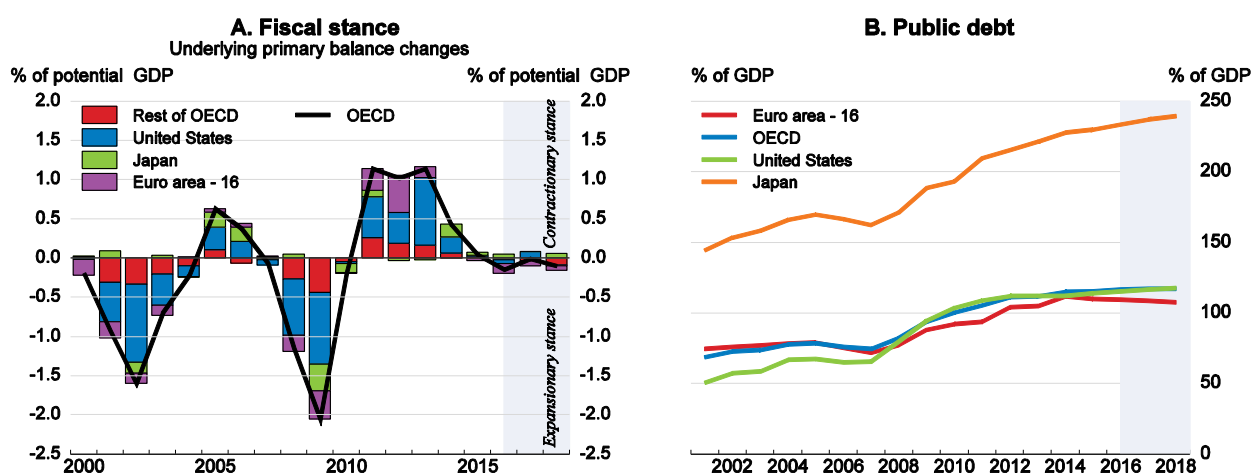
5. The very low level of interest rates on government debt in advanced economies raises important questions about the use of fiscal policy in the context of the low-growth trap and high debt levels. Other things being equal, low interest rates expand "fiscal space" - a measure of how much governments can borrow without losing market access or facing sustainability challenges. This shifts the perceived trade-off

between borrowing to support growth and consolidation, making it possible in some countries to borrow more without undermining sustainability. However, lower growth and higher debt, as well as risks and long-term challenges need to be taken into account when evaluating the size and desirability of using fiscal space.

Public debt has risen since the crisis...

6. The 2008 crisis, and the expansionary response it triggered, resulted in a surge in public debt. Fiscal policy was subsequently tightened in most OECD countries bringing the debt-to-GDP ratio onto a more sustainable path but depressing demand (Figure 1). Since 2015, the fiscal stance in the OECD has moved to being broadly neutral in many countries and financial turbulence in euro area markets has waned. Public debt has stabilised in the euro area and the United States. However, the recovery has been fragile, monetary policy is overburdened, and political uncertainties have risen. In this context, a number of OECD countries have announced in 2016 a reconsideration of fiscal policy initiatives to support near-term growth and increase long-term productive capacities.

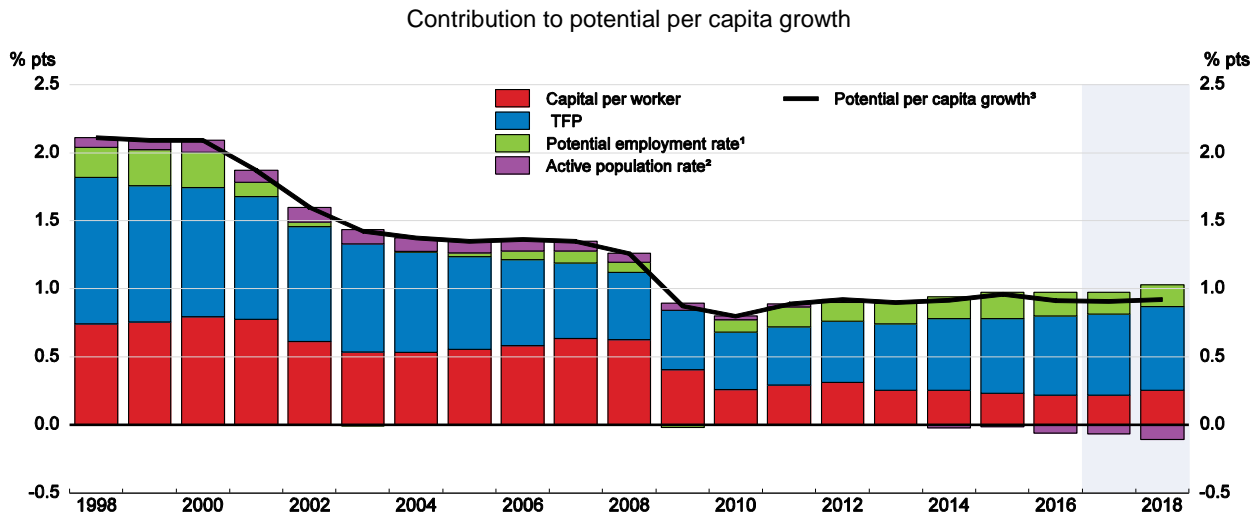
Figure 1. Fiscal stance and public debt levels in OECD countries



Source: OECD Economic Outlook database.

... and potential output has been hit hard...

7. Estimates of potential output per capita growth in the major OECD economies have declined in the aftermath of the crisis. They are estimated on average at around 1% in 2016, almost 1 percentage point below the average in the two decades preceding the crisis (Figure 2). Weak capital stock growth and declining factor productivity were the two main factors contributing to the decline.

Figure 2. OECD Potential output growth has slowed markedly

Note: Assuming potential output (Y^*) can be represented by a Cobb-Douglas production function in terms of potential employment (N^*), the capital stock (K) and total factor productivity (E^*) then $y^* = a * (n^* + e^*) + (1 - a) * k$, where lower case letters denote logs and a is the wage share. If P is the total population and PWA the population of working age (here taken to be aged 15-74), then the growth rate of potential GDP per capita (where growth rates are denoted by the first difference, $d(\cdot)$, of logged variables) can be decomposed into the four components depicted in the figure: $d(y^* - p) = a * d(e^*) + (1-a) * d(k - n^*) + d(n^* - pwa) + d(pwa - p)$.

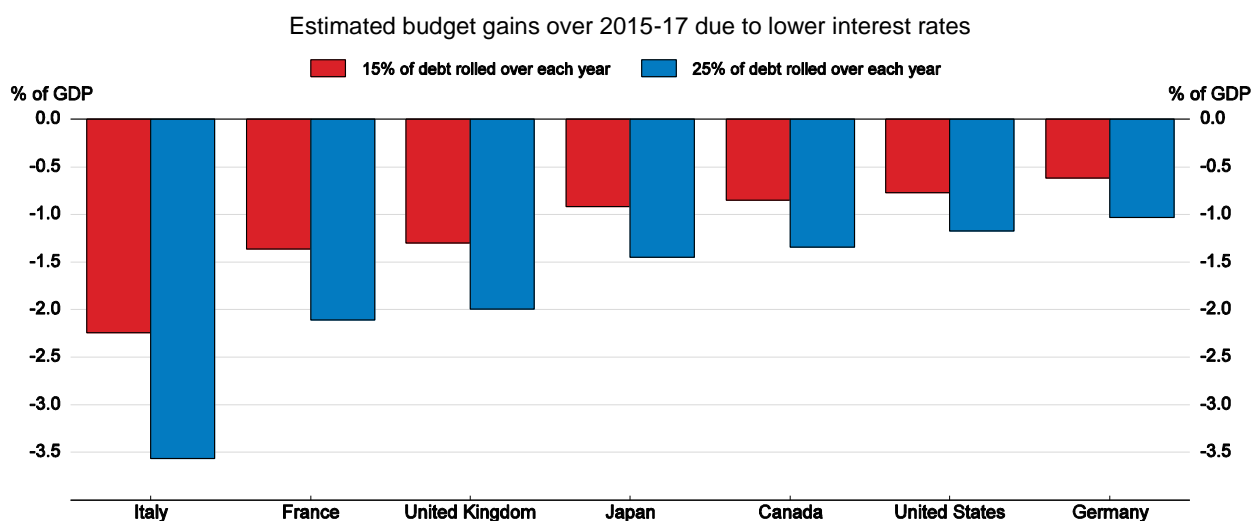
1. Potential employment rate refers to potential employment as a share of the working-age population (aged 15-74).
2. Active population rate refers to the share of the population of working age in the total population.
3. Percentage changes. With growth in Ireland in 2015 computed using gross value added at constant prices excluding foreign-owned multinational enterprise dominated sectors.

Source: Economic Outlook database.

... but lower interest rates provide savings

8. The fall in interest rates on government debt in advanced economies has in part reflected exceptional monetary policy stimulus, with just over 30% of OECD government debt currently trading at negative yields. This continues a long trend of declining nominal and real yields over past decades, which has been compounded by very low or even negative policy rates and large-scale central bank purchases at long maturities, as well as the reduction in the term premium following changes in banking regulations. In the euro area, declining risk spreads since the 2011-12 crisis have contributed to lower borrowing costs. At the same time, many governments have used the opportunity to extend the maturity of outstanding debt, locking in low rates (OECD, 2016).

9. Declining interest rates have resulted in savings on interest costs for governments. Looking forward, and partially accounting for the maturity structure of public debt, further reduction in interest costs are likely if yields remain around the current level as old debt at higher yields matures. This would generate significant additional savings, notably in Italy and to a lesser extent in France and the United Kingdom over 2015-17, under the assumption that 15% of the initial stock of debt is rolled over each year and the rest is valued at an implicit rate that captures the maturity structure of the debt (Figure 3). Assuming an alternative scenario of 25% of debt maturing each year would lead to even stronger gains.

Figure 3. Fall in government interest payments

Note: Based on general government debt at the end of 2014, assuming that 15% or 25% of this initial debt stock matures each year, comparing the interest rate on 10-year government bonds in 2014 with the interest rate for 2015 and the 2016 average until August for 2016 and 2017. The remaining stock of debt is valued at the implicit interest rate, which depends on the maturity structure. The computation does not incorporate the most recent increase in sovereign bond yields, as the latter do not markedly change the results.

Source: OECD Economic Outlook database and OECD analytical database.

3. Several approaches can be used to measure fiscal space

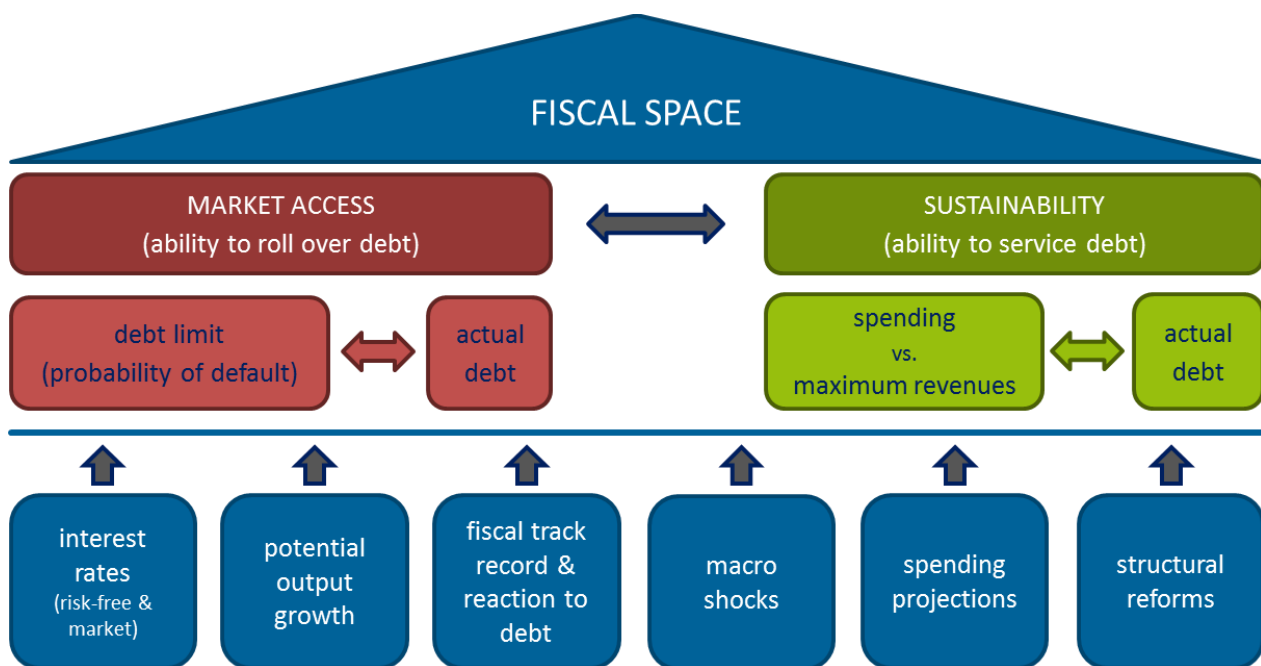
10. With conventional monetary policy facing constraints and evidence pointing to a greater effectiveness of fiscal policy to stabilise the economy than in the past, fiscal space needs to be reassessed (Furman, 2016). At first glance, fiscal space appears to be a relatively intuitive concept and can be defined as the "room in a government's budget that allows it to provide resources for a desired purpose without jeopardizing the sustainability of its financial position or the stability of the economy" (Heller, 2005).

11. A simple way to measure fiscal space is to use synthetic indicators such as the interest rate to growth differential or *de facto* fiscal space (Aizenman and Jinjark, 2010; see Annex 1 for a review of such indicators). Such indicators send clear signals and are easy to communicate. However, their simplicity also means that they fail to capture important factors determining fiscal space.

12. This paper focuses on three approaches that are described in more detail in the following sections, as fiscal space can be measured in terms of either losing market access or achieving long-term sustainability. In practice, these two aspects of fiscal space are interrelated, as long-term sustainability considerations often affect market access through risk premia. However, it is difficult to comprehensively capture all the factors affecting fiscal space with a single method, and therefore studies usually either focus on market access (Ghosh et al. 2013 and Fournier and Fall, 2015) or long-term sustainability (Blanchard et al., 1990); one method that comes closest to marrying these two aspects is Bi (2011) and Bi and Leeper (2013). Figure 4 illustrates these two fiscal space dimensions. On one side, there is uncertainty about the extent to which the government is facing the risk to be unable to roll over debt. Fiscal space can be thought of as the difference between the current debt level and the debt limit at which the government would lose *market access*. On the other side, fiscal space can be defined in terms of long-term *fiscal sustainability*. In practice, the conclusions from these two approaches can differ. For instance, a country with an expected marked rise in ageing and health public spending can have fiscal space according to the market access approach, but none according to the fiscal sustainability approach.

13. In addition, the scarcity of sovereign credit events in advanced economies in recent history renders the estimation of fiscal space -- especially by the market access definition -- challenging. Quantitative analysis can only build on assumptions on how households and businesses would react in the future should higher debt levels be reached. As a result, debt limits and resulting fiscal space estimates should be used with care and uncertainties surrounding those estimated underlined. In real life, debt limits have to account for many factors, including the level and trajectory of public debt, financing needs, fiscal track record, economic development, market sentiment and macroeconomic shocks. As analytical methods by nature have to be parsimonious, the best option is to rely on a range of methods, complemented with the consideration of country specificities, to get a full assessment.

Figure 4. Different approaches to measuring fiscal space



14. All the methods covered in this paper face common limitations. In particular, they all boil down to a stylised representation of a very complex problem and consider a closed economy. They also do not account for a number of country-specific factors, for instance the maturity structure of the public debt. Still these complementary analyses help to understand the key mechanisms at work.

Fiscal space as a measure of distance to loss in market access

15. Following Ghosh et al. (2013), Fournier and Fall (2015) investigate the limits to public debt sustainability with a theoretical model that embeds both the fiscal reaction of government to rising debt and the market reaction. For those countries that have never experienced particularly high debt level, a model-based approach makes it possible to investigate their theoretical debt limit. Such a model-based approach also provides insights on the mechanisms at work when government debt is becoming large.

16. The model builds on the assumption that market participants expect that governments will behave in the future as they did in the past. The balance reaction function estimation differs from Ghosh et al. (2013): it uses a piece-wise linear functional form. More specifically, fiscal authorities are assumed to follow a fiscal reaction function, whereby the primary budget balance reacts to the public debt level and control variables:

$$PB_{it} = \beta_1 GAP_{it} + \beta_2 OT_{it} + \beta_3 (D_{it-1} 1_{D_{it-1} < d_1} + d_1 1_{d_1 \leq D_{it-1}}) + \beta_4 (D_{it-1} 1_{d_1 \leq D_{it-1} < d_2} (d_2 - d_1) 1_{d_2 \leq D_{it-1}}) + \beta_5 D_{it-1} 1_{d_2 \leq D_{it-1}} + \beta_6 OO_{it} + u_i + v_{it} \quad (1)$$

where PB_{it} denotes the primary budget balance of country i at time t , GAP_{it} denotes the output gap, OT_{it} denotes the openness ratio scaled by the terms of trade, OO_{it} denotes fiscal one-offs, D_{it} denotes the public debt level and d_1 and d_2 are estimated thresholds beyond which the fiscal reaction to debt changes. The regression includes country fixed effects u_i and an autoregressive error term of order 1, v_{it} .

17. Using annual panel data for 31 OECD countries over the period 1985–2013, estimations in Fournier and Fall (2015) reveal different government behaviours at different debt levels. Estimates confirm that governments react weakly by increasing their primary balance when debt increases but remains below about 120% of GDP (d_1 in Figure 5). However, from about 120% to about 170% (d_2 in Figure 5), governments react strongly to rising debt. Beyond this threshold, governments may abandon fiscal discipline and reduce the primary balance. Alternative estimates also capture the effect of the business cycle on the primary balance, and include additional control variables, such as asset prices, inflation, IMF programmes, old age dependency ratio, euro area membership or government size.

18. The interest rate includes a risk premium reflecting the probability of default in the next period p_{t+1} , which is the probability that debt d_{t+1} goes beyond its maximum level \bar{d} :

$$p_{t+1} = P(d_{t+1} > \bar{d}) \quad (2)$$

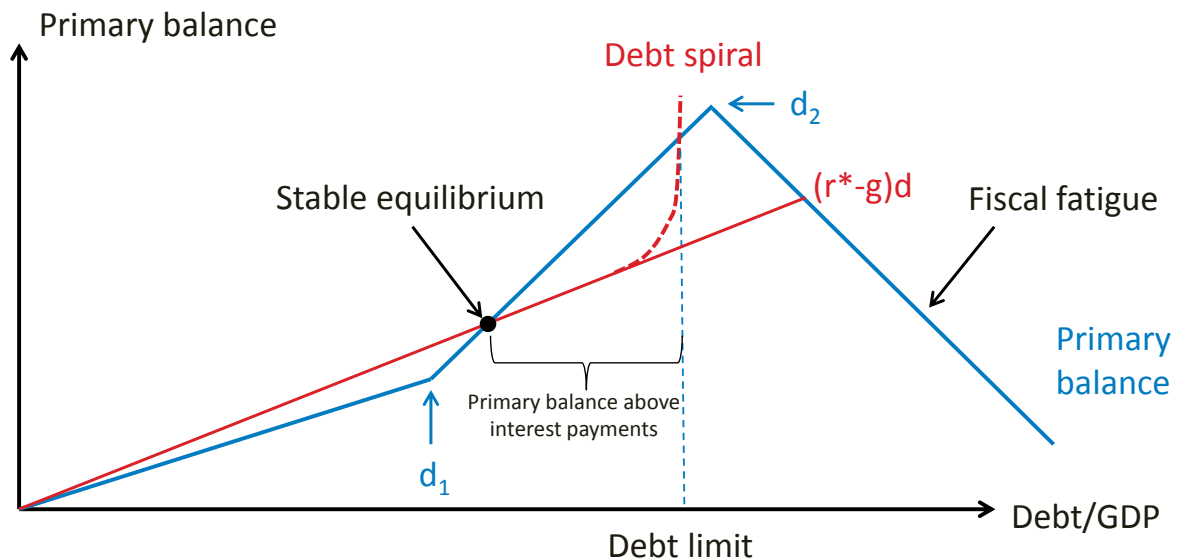
with the following debt accumulation dynamic:

$$d_{t+1} = (1 + r(p_{t+1}) - g)d_t + \mu + f(d) + \varepsilon_t \quad (3)$$

where g denotes the potential growth rate, μ denotes an average stance of fiscal policy, $f(d)$ the estimated reaction of the primary balance to debt and ε_t captures macroeconomic shocks to the primary balance.

19. The debt limit is a function of the exogenous variables of the model, including the risk-free interest rate-growth rate differential $r_i - g_i$, the size of the macroeconomic shocks $V(\varepsilon_i)$, and the average past primary surplus μ_i . Debt stabilises when the effect of past debt accumulation is exactly offset by the primary balance. There is a stable equilibrium, at which the government would generate a higher surplus if a shock increases the debt ratio (Figure 5). By contrast, when the debt level approaches the debt limit, the government faces an interest rate spiral, and at the debt limit, the interest rate goes towards infinity, which means that the government loses market access (dashed red curve in Figure 5).

Figure 5. Determination of the debt limit



Note: g is the growth rate, r^* is the risk-free interest rate, d is the debt-to-GDP ratio, d_1 and d_2 are two estimated thresholds signalling changes in the reaction function to increasing debt.

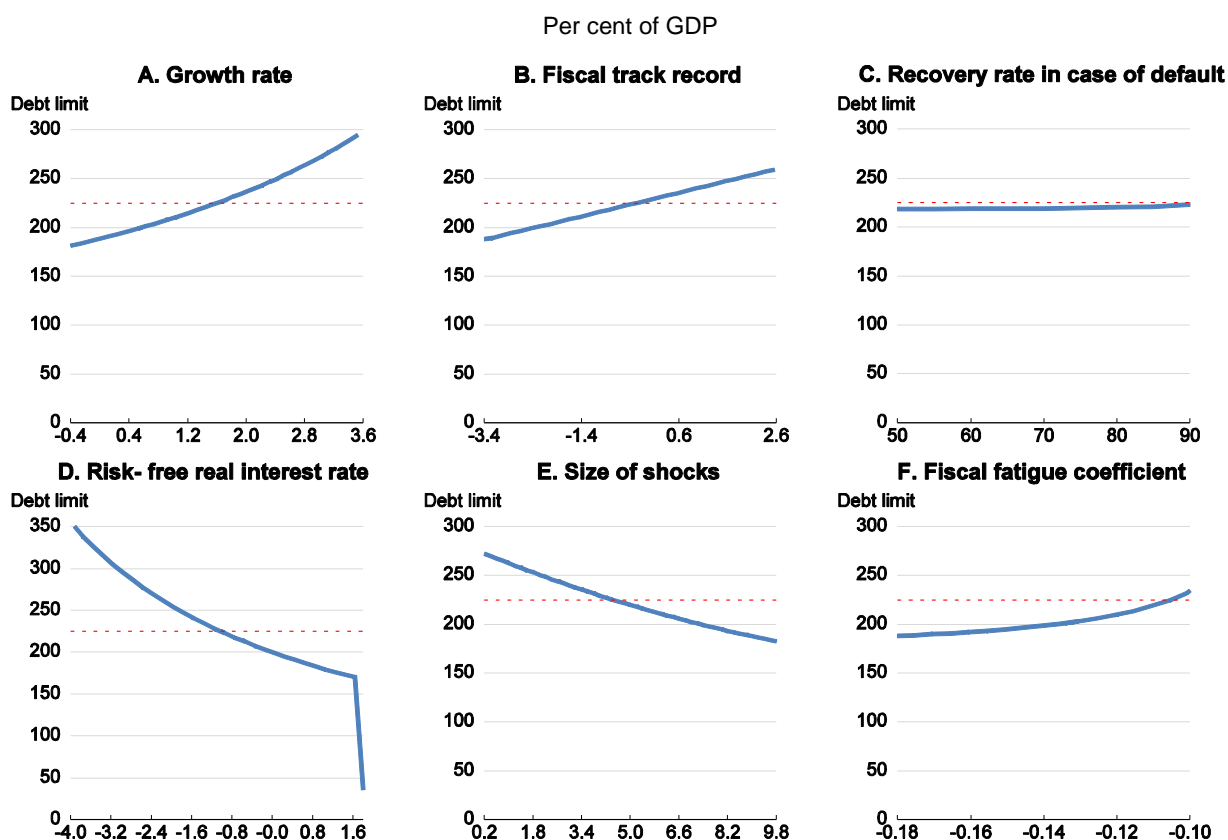
Source: Fournier and Fall (2015).

20. This model takes the macroeconomic environment as given. It is therefore useful to examine the sensitivity of the results to the macroeconomic assumptions and identify the main determinants of estimated debt limits. Assumptions on potential growth, inflation, risk-free interest rate and size of shocks appear to be those that matter the most (Figure 6).

21. The model is non-linear and can have two types of solutions. In most cases, a debt limit can be found, suggesting that past behaviour is sustainable. In some other cases, no solution can be found, suggesting that under the assumption of unchanged behaviour, the public debt dynamic is not sustainable. One important feature of the approach to underline is that if the public debt dynamic of a country is quite close to a limit case, a change in the macroeconomic environment can induce a shift into an unsustainable dynamic. Conversely, a change in government behaviour or an improvement in macroeconomic conditions can bring a country out of a sovereign stress situation.

22. One limitation of this approach is that a lender of last resort is assumed to prevent any self-fulfilling crisis. In practice, institutions do not always guarantee this, and a self-fulfilling crisis can crucially depend on other parameters, such as the debt maturity structure and the share of debt issued in foreign currency.

Figure 6. Debt limit sensitivity analysis



Note: For each panel, the title refers to the parameter that is varied, all other parameters being set equal to the OECD average. Parameter values are reported on the horizontal axis, and the corresponding debt limit is reported on the vertical axis. The fiscal track record is the average primary deficit in GDP point that would prevail if the debt level is zero. Below a growth threshold, or above a risk-free real interest rate threshold, there is no solution. Horizontal lines denote the debt limit that would prevail in a virtual country, parametrised using OECD average parameters.

Source: Calculations based on Fournier and Fall (2015).

Tax gaps and sustainable tax rates

23. Rather than losing access to markets, a number of alternative approaches focus on measures that are consistent with ensuring fiscal sustainability. The rationale behind them is that policymakers need to account for long-term spending projections when they decide about today's fiscal stance.

24. Blanchard et al. (1990) assess fiscal space by examining the tax gap, which is the difference between the sustainable and the actual tax-to-GDP ratio ("tax rate"). This gap can be computed at different horizons. A positive indicator points to the need for either increasing taxes and/or decreasing spending in the future. The indicator also measures the size of the required adjustment, under the assumption the adjustment is undertaken without delay.

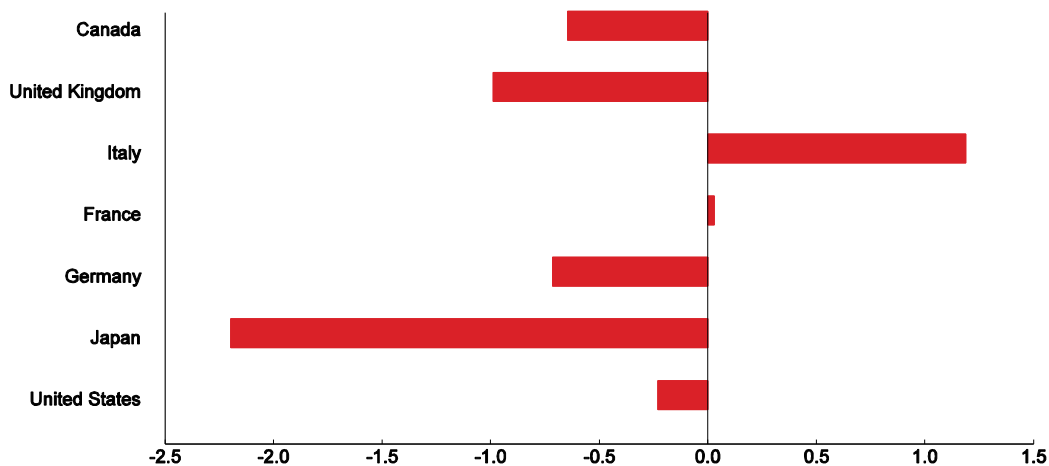
25. The sustainable tax rate is the rate which, if constant, would achieve an unchanged debt-to-GDP ratio at the end of the relevant horizon, for a given forecast of spending and transfers. The assumption that the debt-to-GDP ratio converges to its initial level is less stringent than it could seem, as discounting means too different levels of the ratio far in the future imply nearly the same sustainable tax rate today.

26. This approach is valid in a context where the interest rate is above the economic growth rate. When the interest rate is persistently below the growth rate, governments are able to run permanent deficits of any size under this approach.

27. Over the medium term, a simplified indicator can be computed without having to project spending. Using the methodology described in Blanchard et al. (1990) and data from the latest Economic Outlook, two-year-ahead gaps appear to be negative in all the most advanced economies but Italy (Figure 7). This result points to some fiscal space over the period of 2016-17 reflecting essentially the negative interest rate to growth differential that is expected during that period. In such a situation, governments would no longer need to generate primary surpluses to achieve sustainability. Such a measure, however, faces similar limits as synthetic indicators, in that it does not account for long-term developments in public spending.

Figure 7. Medium term gap

2-years ahead 2016-17, per cent



Source: OECD calculations.

28. Over the long term, the computation of tax gaps requires to project the main categories of public spending, such as those on social spending from population ageing, as governments' commitments to specific programmes have implications far into the future. For this purpose, projections of pensions were taken from Pensions at a Glance (2015) up to 2060 and healthcare spending from the long-term health spending scenario derived in de la Maisonneuve and Oliveira Martins (2015). One caveat of using these two sets of projections is that they may rely, at least over the medium term, on different growth and price projections. Other spending was assumed to remain constant at 2015 levels.

29. In this paper, we enrich the original method proposed by Blanchard et al. (1990) by deriving tax gaps using the Fiscal Maquette (FM), a small macroeconomic model (see Annex 2 for a description). Part of health spending is treated as an investment and fosters output growth.

30. The sign of the tax gaps depends to a very large extent on the assumptions used to project health care spending, which are traditionally surrounded by large uncertainties, given the difficulty to estimate the price of technology in this sector. Measures to contain costs in the health sector are found to increase fiscal

limits in all the countries. In the same vein, reforms that will restrain increase in pension spending will also increase fiscal space.

31. This method presents several advantages: it takes into account future developments of the economy and long-term spending projections. It is also tractable and relatively easy to communicate. Gaps can also be computed under a range of policy assumptions. However, in the current context of persistent low and negative interest rates, this approach loses some of its relevance. Finally, a major drawback is its reliance on specific assumptions, such as long-term spending on health care, which are surrounded by major uncertainties.

Making use of the Laffer curve and defining forward-looking debt limits

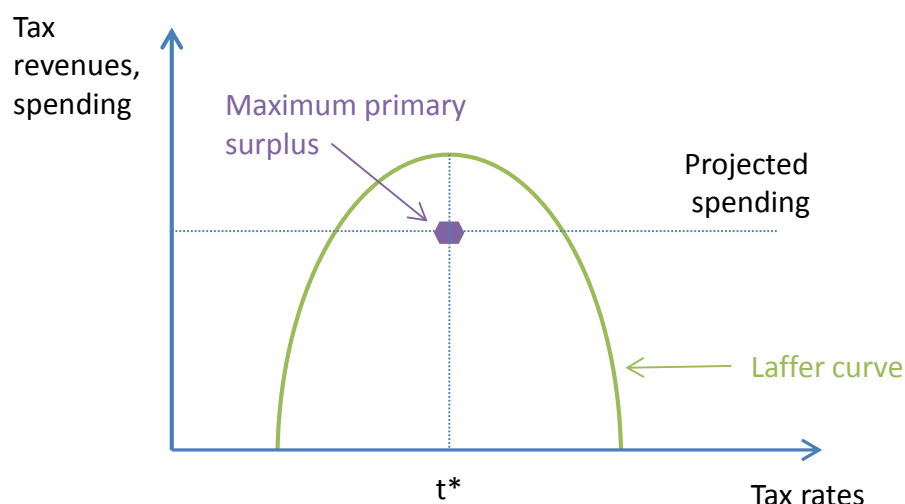
32. Bi (2011) and Bi and Leeper (2013) also emphasise long-term sustainability in their assessment of fiscal limits, a measurement of the government's ability to service its debt. Empirically those limits are derived from a DSGE framework. The fiscal limit is forward-looking and depends on expected future policies and how credible those policies are, on private behaviour (consumption-saving and labour-leisure choices) and on the fundamental shocks to the economy.

33. In this approach, the fiscal limit arises endogenously from the economy's dynamic Laffer curve, whose shape depends on the state of the economy. The maximum level that the government is able to pay back depends on the expected present value of future maximum primary surpluses, where maximum surpluses come from driving tax revenues to the peak of the Laffer curve and driving expenditure and transfers to some expected levels.

34. More specifically, a closed economy with linear production technology is considered. Output depends on the level of productivity and the labour supply. Household consumption and government purchases satisfy the aggregate resource constraint. The gap between productivity and its steady state follows an autoregressive process of order 1.

35. At time t , the government may partially default on its liabilities. The government finances lump-sum transfers to households and unproductive purchase by collecting tax revenue through a tax on labour income and issuing one-period bonds. Lump-sum transfers are countercyclical and government purchases follow an autoregressive process of order 1. Following Schmitt-Grohe and Uribe (2007), the government increases tax rates when public debt rises. An increase in the tax rate may or may not increase the tax revenue, depending on where that actual tax rate is in the Laffer curve, whose shape depends on the state of the economy (productivity and government purchase). For a given state, the government can reach the maximum fiscal surplus at the peak of the Laffer curve. At each point in time and for each state of the economy, the maximum primary balance will be derived from the difference between these maximum revenues and projected spending (Figure 8). The resulting fiscal space will be computed as the sum of all these maximum primary surpluses, expressed in present value terms. More details in the specifications are reported in Annex 3.

36. Uncertainty in the economy means, however, that there is no single threshold for debt that, when crossed, triggers sovereign default. Rather, the outcome is a probability distribution of the fiscal limit, i.e. the probability for a country to default for each value of the debt-to-GDP ratio. Markov Chain Monte Carlo simulations are used to produce the distribution of the fiscal limit, which is approximated as a normal distribution.

Figure 8. Maximum primary balance at a given period and state of the economy**Table 1. Calibration of the Bi-Leeper model**

	United States	Japan	Germany	France	Italy	United Kingdom	Canada
Steady state productivity	1	1	1	1	1	1	1
Standard deviation shock productivity	0.008	0.015	0.011	0.011	0.012	0.012	0.011
Persistence productivity (AR(1))	0.749	0.507	0.383	0.736	0.611	0.731	0.600
Steady state government purchase	0.05	0.051	0.066	0.079	0.062	0.063	0.066
Standard deviation shock government purchase	0.003	0.007	0.0037	0.004	0.003	0.006	0.005
Persistence government purchase	0.98	0.92	0.96	0.98	0.96	0.98	0.99
Steady state transfers	0.038	0.036	0.046	0.062	0.058	0.062	0.042
Standard deviation shock transfers	0.1	0.1	0.1	0.0	0.1	0.1	0.1
Persistence transfers	-2.9	-0.8	-1.4	-1.8	-1.5	-1.2	-0.8
Calibration							
Steady state productivity	Normalised						
Standard deviation shock productivity	Stdev of detrended GDP per worker normalised by mean						
Persistence productivity (AR(1))	Estimated						
Steady state government purchase	Mean of govt purchases 1980-2015, or first-last available date						
Standard deviation shock government purchase	Stdev of govt purchases as above						
Persistence government purchase	Estimated from govt purchases per worker						
Steady state transfers	De la Maisonneuve and Oliveira Martin (2015)						
Standard deviation shock transfers	Stdev of transfers above						
Persistence transfers	Estimated						

37. In this paper, the model has been calibrated for the most advanced economies. The most important parameters are reported in Table 1.

38. This approach faces several limitations. First, a country may not be able, for political reasons, to raise tax to reach the peak of the Laffer curve. Second, some tax rates such as consumption tax rates do not necessarily yield a Laffer curve. Third, the ability to reduce spending is also important in determining the

maximum surplus and the Laffer curve has no information about the potential for government spending reduction.

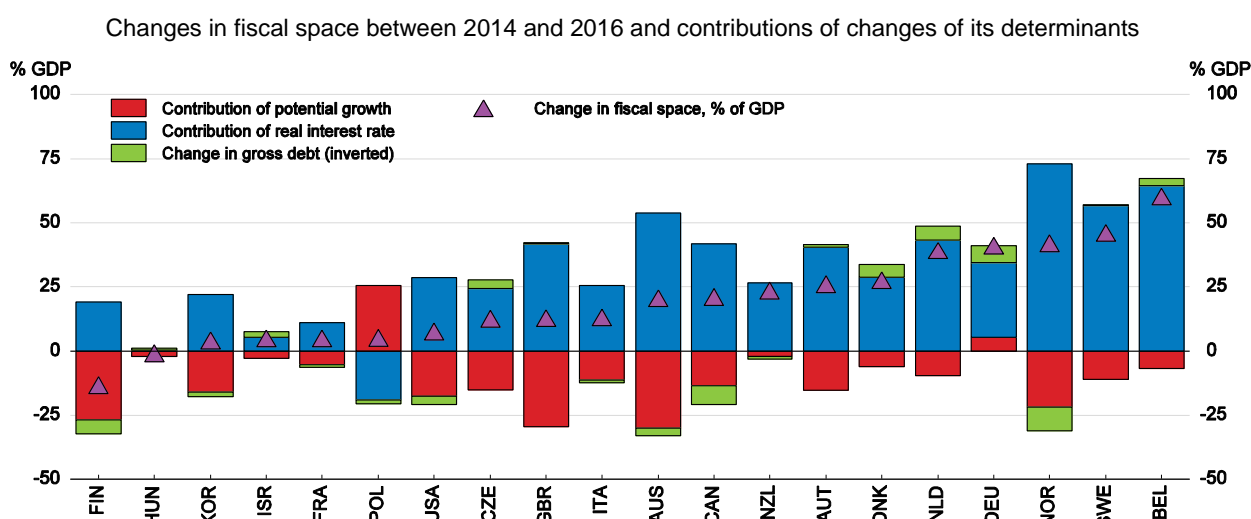
4. Fiscal space has risen in most OECD countries

39. The three methods presented in the previous section have been used to assess the extent of fiscal space in the current environment of low growth-low interest rates.

Very low interest rates have increased fiscal space

40. Focusing on market access, fiscal space is assessed to have increased significantly in many advanced economies from 2014 to 2016. The impact of the reduction in interest rates outweighs the estimated fall in potential output growth, while the increase in debt limits is larger than the changes in the debt-to-GDP ratio (Figure 9). The magnitude of the estimated increase in fiscal space varies widely across countries. It was above 20% of GDP in seven OECD countries, including Germany and the United Kingdom. However, it is estimated to have visibly narrowed in Finland and Korea, due to the large fall in potential output and the relatively small decline in real interest rates, but significant space remains.

Figure 9. Lower interest rates increase fiscal space



Note: Fiscal space is the difference between debt limits and current debt. Debt limits are computed with a stylised model in which the estimated fiscal reaction function of governments has the "fiscal fatigue" property and the modelled interest rate takes into account market reactions. The potential growth and the real risk-free interest rate are exogenous. The debt limits are computed with the information available up until 16 November 2016 and with the information available when the Economic Outlook No. 95 (May 2014) was published. The size of shocks and the fiscal track records are assumed unchanged between 2014 and 2016. 15 OECD countries are not shown in this chart in most cases because of data limitations and in some cases as reported in Fournier and Fall (2015), because of the absence of solution in the model as the past behaviour did not suffice to keep debt sustainable.

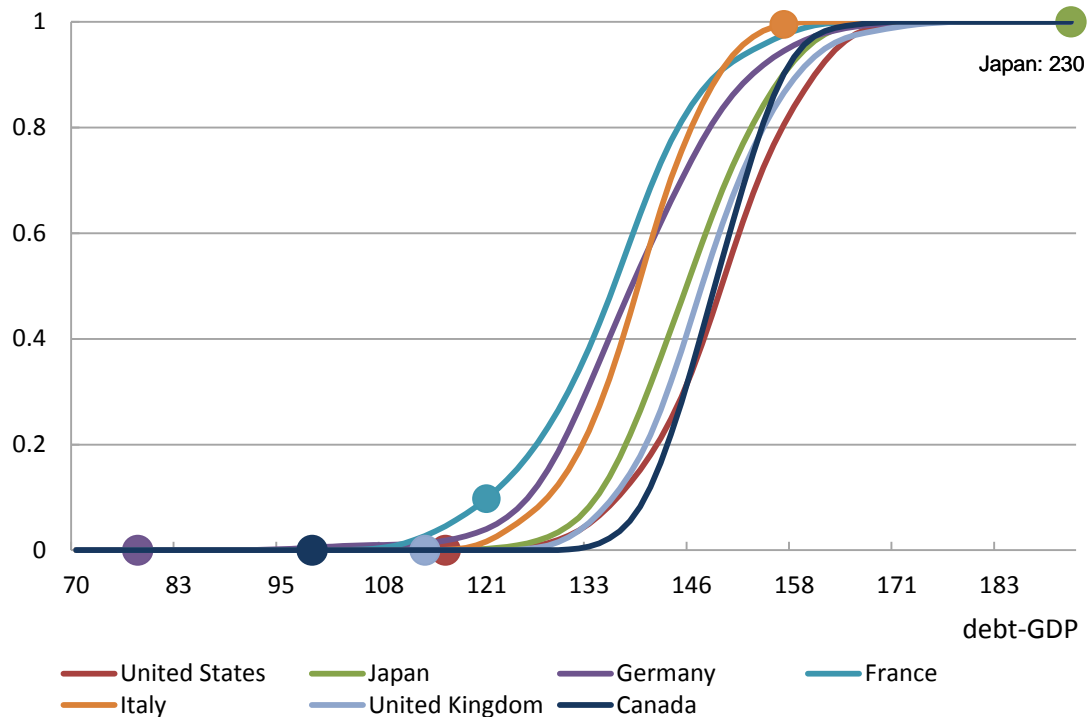
Source: OECD calculations based on Fournier and Fall (2015) and OECD Economic Outlook database.

41. Looking at fiscal space from the perspective of debt-limit distribution probability functions indicates that most large advanced economies have fiscal space, Japan being a notable exception (Figure 10). The "market access" approach also suggests that Japan lacks fiscal space.

42. The long-term fiscal sustainability approach also points to uncertainties regarding the extent of fiscal space in France and Italy. In France, the market access measure of fiscal space points to small gains of fiscal space, within the margin of uncertainty. The fiscal sustainability measure does not send a clear signal either. In Italy, fiscal space appears to be limited when focusing on long-term fiscal sustainability,

taking into account the budgetary implications of population ageing. This differs from the results derived from the market access approach that reflects past developments of the primary balance.

Figure 10. Fiscal limit cumulative distribution function



Note: For each country the curve depicts the probability of default at each given public debt-to GDP level. For instance, the probability of default is zero in all G7 countries when the actual debt-to-GDP ratio is below 113%. Circles correspond to the 2015 level of the debt-to-GDP ratio. Public debt refers to general government gross financial liabilities according to the SNA definition.

Source: OECD calculations using Bi (2011) and Bi and Leeper (2013).

Fiscal space depends on the pace at which real interest rates and potential output growth become aligned...

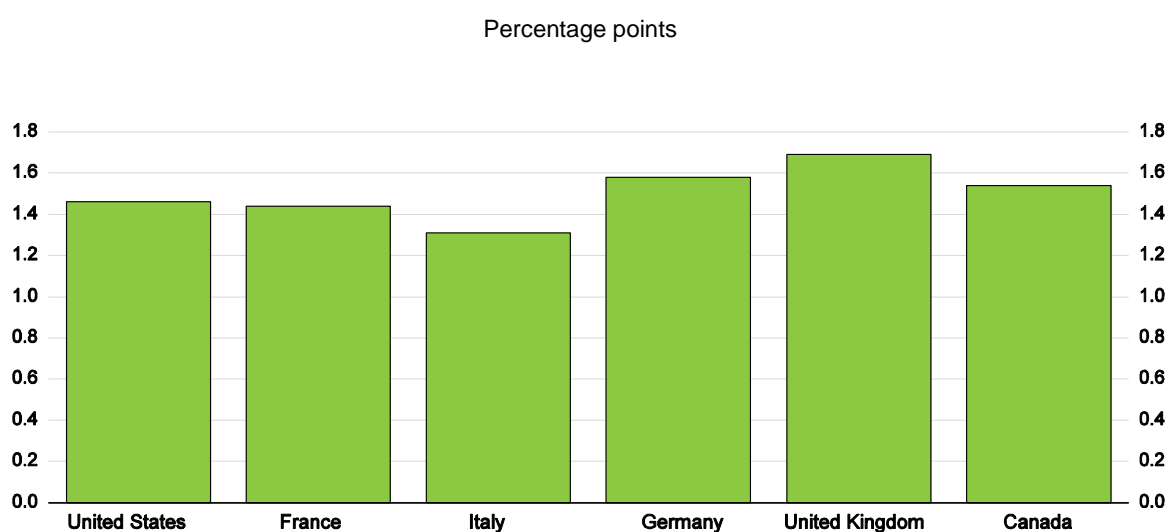
43. Low interest rates provide policy makers with room for manoeuvre but are also associated with fiscal risks. Assuming the differentials between growth and interest rates gradually converge to their long-term average, the long-term measure of fiscal space, based on Blanchard et al. (1990) and OECD pension spending projections, point to limited sustainability risks over the long term in the three main euro area economies (OECD, 2015a). However, health spending is expected to rise markedly over the next decades as the population ages (de la Maisonneuve and Oliveira Martins, 2015). Accounting for these projected increases in health costs, large advanced economies will have to adjust their tax ratios and/or spending by several percentage points of GDP to stabilise debt at current levels by 2060. The pace of this adjustment will depend to a large extent on the speed at which real interest rates become aligned to output growth. The pace of adjustment will depend to a large extent on the speed at which real interest rates become aligned to output growth. Accordingly, the “market approach” modelling illustrates that a substantial rise in the risk-free interest rate can dramatically reduce fiscal space. Locking in the unprecedented low levels of interest rates by issuing more long-dated bonds would help manage the interest-rate risk.

... but structural reforms to key spending programmes can help increase fiscal space

44. Structural fiscal reforms to contain health spending would ease long-term spending pressures, and many countries have room to reduce those costs (Joumard et al., 2010). Total health and long-term care expenditure could increase by 3.3 percentage points of GDP between 2010 and 2060 on average across OECD countries in a cost-containment scenario, down from 7.7 percentage points in a cost-pressure scenario, under similar income and demographic assumptions (de la Maisonneuve and Oliveira Martins, 2015). This would help countries regain some fiscal room, even when taking into account that some of the health spending is investment that contributes to future output, as the effect on the budget balance would dominate the effect on potential output (Figure 11). Across the largest advanced economies, tax gaps, which quantify by how much actual tax rates would have to increase for the debt-to-GDP ratios to be stabilised at current levels over the long term, would be reduced by 1.5 points on average.

45. Thanks to a number of past pension reforms, long-run sustainability has improved in some countries. Further reforms in this direction will further expand fiscal space. Whereas low growth in aggregate productivity can add to pension sustainability pressures, reforms that increase the retirement age allow contribution rates and replacement rates to be maintained, while also contributing to sizeable output gains (Johansson and Fournier, 2016). Finally, by raising potential output, product and labour market reforms can also increase the fiscal space available to governments.

Figure 11. Fiscal space gains from healthcare reforms



Note: Fiscal space is measured here in terms of tax gaps. These are computed by the difference between the actual and the sustainable tax rate, the latter being the tax rate that should prevail for the debt-to-GDP ratio in 2060 to be equal to the current level, for a given path of public spending. The reform is a change in entitlement, moving from a 'cost-pressure' to cost-contained' scenario.

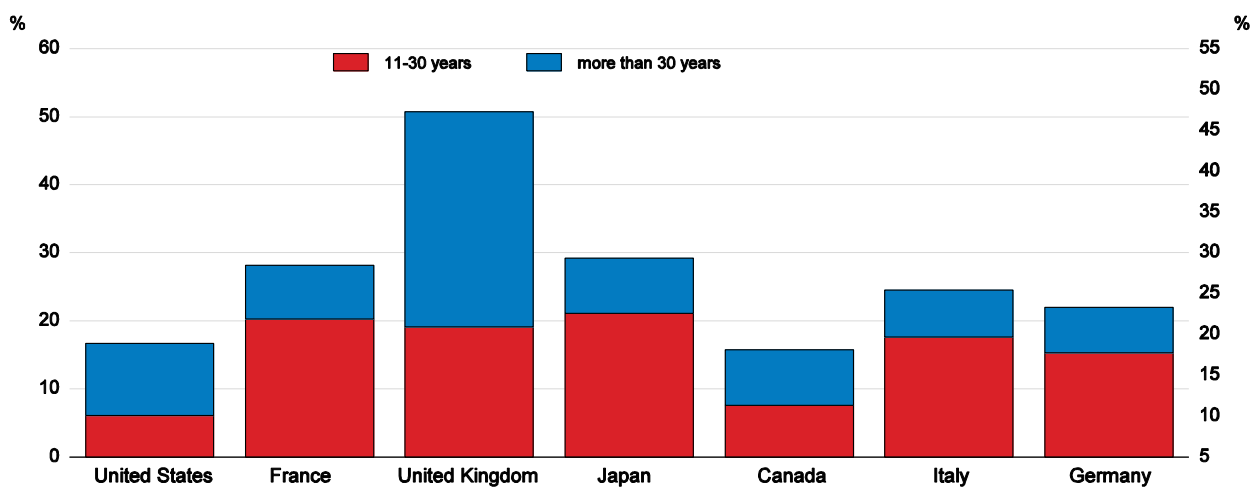
Source: Calculations based on using Blanchard et al. (1990) and data from de la Maisonneuve and Oliveira Martins (2015).

5. Policy implications

46. Overall, very low levels of interest rates give countries an opportunity to lock them in and benefit from low borrowing costs. Since the crisis, all the large advanced countries have issued long-dated bonds. Recently those yields have been close to 10-year bond yields. Still, long-dated bonds account for a small share of government debt at the moment, the United Kingdom being an exception (Figure 12). Countries could issue more long-dated bonds and take advantage of favourable financial conditions.

Figure 12. Share of long-dated bonds in public debt

3 November 2016



Source: Calculations based on using Factset and Bloomberg.

47. Although policy requirements vary by country depending on their circumstances and positions in the cycle, most advanced countries have scope to use the expanded fiscal space in the context of a fiscal package, where the composition of tax and spending choices is adjusted over time to make the mix more supportive of inclusive growth. Such a programme could include high-quality spending on education, health or research and development as well as green infrastructure that all bring significant output gains in the long run. In a few countries like Japan, however, a productivity-enhancing fiscal initiative should be budget-neutral.

REFERENCES

- Aizenman J. and Y. Jinjark (2011), "The Fiscal Stimulus of 2009-10: Trade Openness, Fiscal Space and Exchange Rate Adjustment", *NBER Working Paper* 17427.
- Bi, H. and E. M. Leeper (2013), "Analysing Fiscal Sustainability", *Bank of Canada Working Paper*, 2011-10, August, Ottawa.
- Bi, H. (2011), "Sovereign Default Risk Premia, Fiscal and Fiscal Policy", *Bank of Canada Working Paper*, 2013-27, August, Ottawa.
- Blanchard, O. et al. (1990), "The Sustainability of Fiscal Policy: New Answers to an Old Questions", *OECD Economic Studies*, No. 15, Autumn, Paris.
- Coenen, G., C. J. Erceg, C. Freedman, D. Furceri, M. Kumhof, R. Lalonde, D. Laxton, J. Lindé, A. Mourougane, D. Muir, S. Mursula, C. de Resende, J. Roberts, W. Roeger, S. Snudden, M. Trabandt and J. in't Veld (2012), "Effects of Fiscal Stimulus in Structural Models", *American Economic Journal: Macroeconomics*, Vol. 4(1).
- De La Maisonnette C. and J. Oliveira Martins (2015), "The future of Health and Long-Term Care Spending", *OECD Journal: Economic studies*, Volume 2014, OECD.
- Delong, J. and L. Summers (2012), "Fiscal Policy in a Depressed Economy", *Brookings Papers on Economic Activity*, Spring 2012.
- Fall, F. and J.M. Fournier (2015), "Macroeconomic Uncertainties, Prudent Debt Targets and Fiscal Rules", *OECD Economics Department Working Papers*, No. 1230, OECD Publishing, Paris. DOI: <http://dx.doi.org/10.1787/5jrxv0bf2vmx-en>
- Fournier, J.M. and F. Fall (2015), "Limits to Government Debt Sustainability", *OECD Economics Department Working Papers*, No. 1229, OECD Publishing, Paris. DOI: <http://dx.doi.org/10.1787/5jrxv0fctk7j-en>
- Furman, J. (2016), "The New View of Fiscal Policy and Its Application", Remarks at the Conference 'Global Implications of Europe's Redesign', New York, 5 October 2016, https://www.whitehouse.gov/sites/default/files/page/files/20161011_furman_suerf_fiscal_policy_cea.pdf
- Ghosh, A. R., et al. (2013), "Fiscal Fatigue, Fiscal Space and Debt Sustainability in Advanced Economies", *Economic Journal*, Vol. 123, pp. 4-30.
- Heller P. (2005), "Understanding Fiscal Space", IMF Working Paper 05/4.
- Jourard, I., C. André and C. Nicq (2010), "Health Care Systems: Efficiency and Institutions", *OECD Economics Department Working Papers*, No. 769, OECD Publishing, Paris. DOI: <http://dx.doi.org/10.1787/5kmfp51f5f9t-en>
- Kapadia, S. (2005), "Optimal Monetary Policy under Hysteresis", *Economics Series Working Papers* 205, University of Oxford, Department of Economics.
- Mourougane, A. (2016), "Crisis, Potential Output and Hysteresis", *International Economics*, DOI: <http://dx.doi.org/10.1016/j.inteco.2016.07.001>

Múčka, Z.(2015), “Is the Maastricht Debt Limit Safe Enough for Slovakia?”, *CBR Working Paper No. 2/2015*, Council for Budget Responsibility, Bratislava.

OECD (2016), *OECD Sovereign Borrowing Outlook 2016*, OECD Publishing, Paris.
DOI: http://dx.doi.org/10.1787/sov_b_outlk-2016-en

OECD, (2015), *Pensions at a Glance*, OECD Publishing, ParisDOI:
http://dx.doi.org/10.1787/pension_glance-2015-en

Price, R.W., T. Dang and J. Botev (2015), “Adjusting Fiscal Balances for the Business Cycle: New Tax and Expenditure Elasticity Estimates for OECD countries”, *OECD Economics Department Working Papers*, No. 1275, OECD Publishing, Paris. DOI: <http://dx.doi.org/10.1787/5jrp1g3282d7-en>

Rawdanowicz, Ł. (2012), “Choosing the Pace of Fiscal Consolidation”, *OECD Economics Department Working Papers*, No. 992, OECD Publishing, Paris. DOI: <http://dx.doi.org/10.1787/5k92n2xg106g-en>

Schmitt-Grohe S. and M. Uribe (2007), "Optimal Simple and Implementable Monetary and Fiscal Rules", *Journal of Monetary Economics*, 54, 1702-25.

Sorbe, S. (2012), “Portugal - Assessing the Risks Around the Speed of Fiscal Consolidation in an Uncertain Environment”, *OECD Economics Department Working Papers*, No. 984, OECD Publishing, Paris. DOI: <http://dx.doi.org/10.1787/5k92smzp0b6h-en>

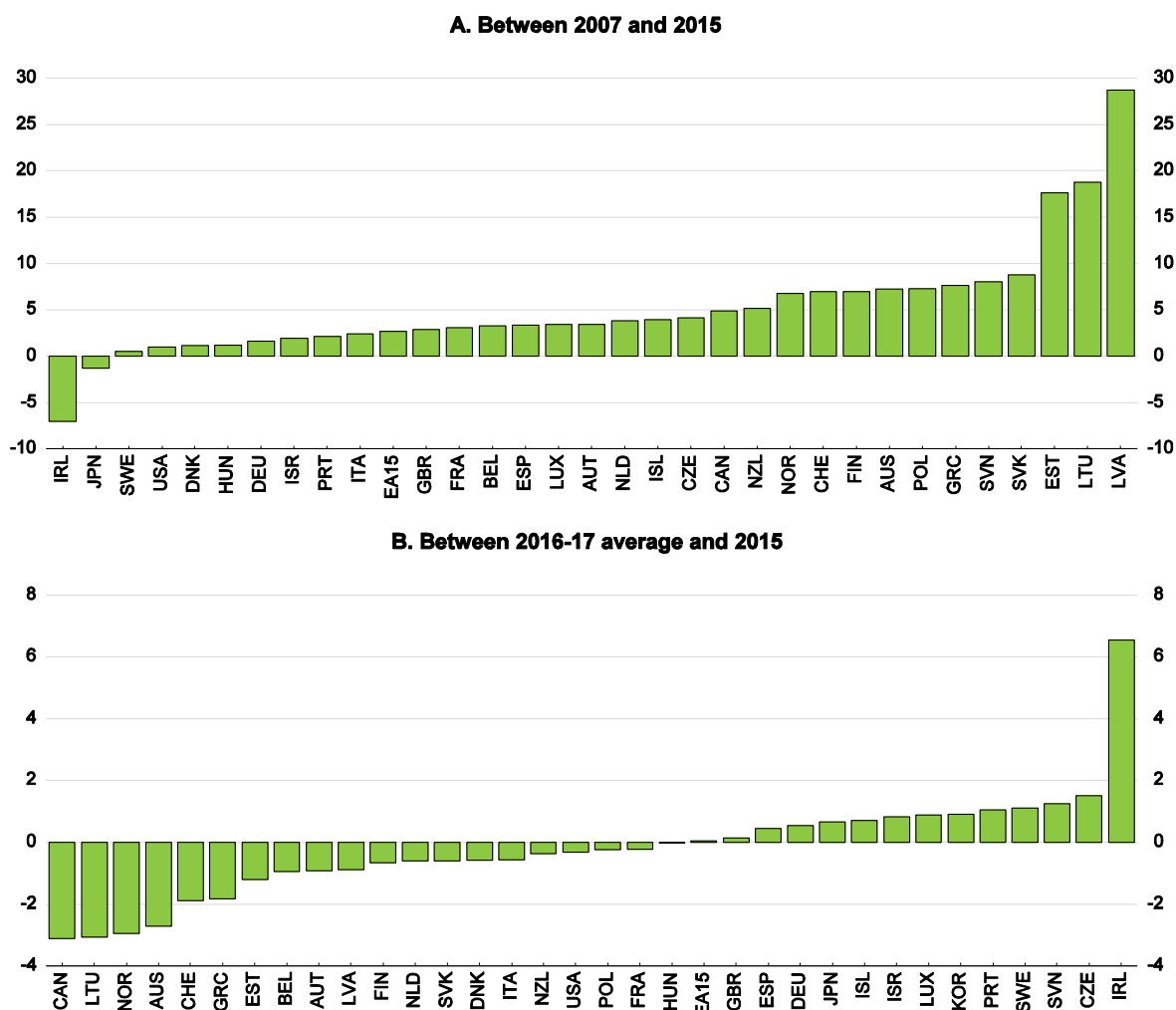
ANNEX 1. SYNTHETIC INDICATORS TO QUANTIFY FISCAL SPACE

Summarising a multidimensional and complex concept such as fiscal space which encompasses both market access and fiscal sustainability with one single synthetic indicator is necessarily a simplification. The advantage is that a single indicator sends clear signals and is easy to communicate. However, this simplicity also means that it fails to capture some possibly important factors determining fiscal space.

Interest rate – growth differential

The simplest way to grasp the evolution of fiscal space over time is to look at the interest rate-growth differential. The rationale behind is that the debt dynamics will be favourable and lead to an increase in fiscal space, when the nominal growth rate is sufficiently high to offset the impact of the nominal interest rates on the debt ratio, for a given primary balance. In addition, the market interest rate includes a risk premium, which should encompass the information the market can use to assess default probability.

Figure A1.1. Change in the interest rate growth differential



Source: OECD calculations.

Data from the latest Economic Outlook show that the interest rate-growth differential was negative in 2007 and 2015 in most countries. The difference has become less negative from 2007 to 2015 suggesting that the fiscal space decreased between the two periods. However the changes were relatively subdued in most G7 countries, and much less pronounced than in Southern or in eastern European countries (Figure 1). Looking forward, the differential is expected to get more negative in more than half of the OECD countries in 2016-17. This is the case for all the G7 economies, but Germany and Japan. The differential is also expected to rise dramatically in Ireland.

The main limitation of this approach is that it does not explicitly take into account the primary balance. If markets are short-sighted, it may also not take into account the effect of population ageing.

Years to repay the public debt

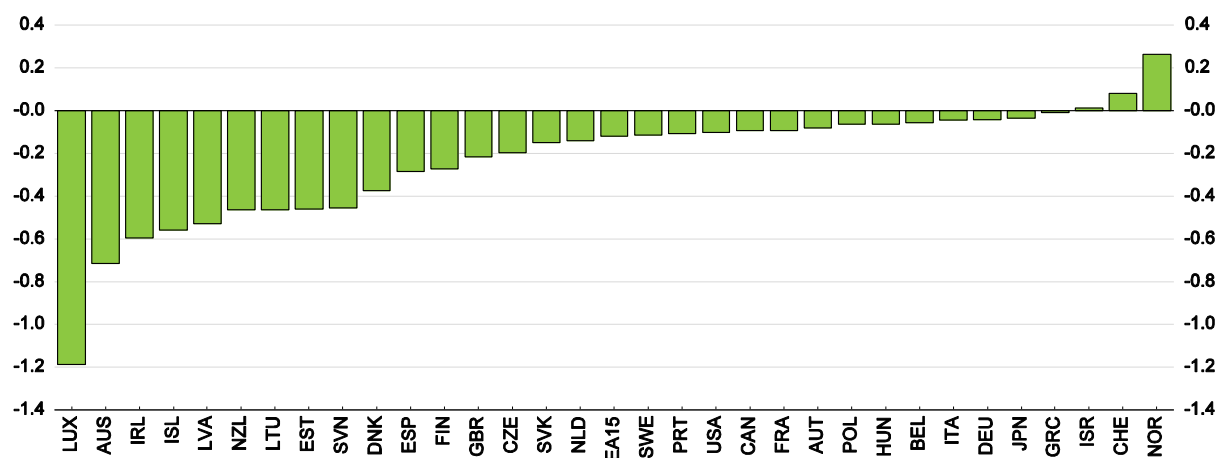
Aizenman and Jinjark (2011) define the concept of *de facto* fiscal space, computed as the inverse of the tax years it would take to repay public debt. Formally, the latter is the ratio of the outstanding public debt to the realised tax collection, averaged across several years to smooth for business cycle fluctuations. Low public debt relative to tax base implies greater fiscal capacity to fund stimuli using the existing tax capacity.

Empirically, it would have taken 3.1 years on average in OECD to fully repay the public debt in 2015. The number of years would be much higher for the G7 economies (6.3 years in 2015), reflecting mostly the very high outcome for Japan (15.1 years). The number of years is also higher for the euro area than the OECD average, but to a much lesser extent.

In most countries and regions, the *de facto* fiscal space, which is the inverse of the number of years needed to repay debt, is estimated to have been broadly stable since the 2007 in most countries (Figure). *De facto* fiscal space is estimated to have slightly decreased by 0.2 point in the OECD average and in the euro area, and by 0.1 point in the G7 countries. It increased in Switzerland, Norway and Israel. In most countries, the decrease is below 0.2 point. Amongst euro area countries, the decrease is much less marked in Germany and Italy. These results appear robust to alternative ways to smooth tax revenues to strip out the cyclical component.

This approach provides a very transparent framework to rank countries according to their available fiscal space. Its main limitation is that it does not account for a large number of factors that determine fiscal space, including the level of interest rates (which capture the cost of financing deficit through bond issuance) or the impact of population ageing on pension and healthcare spending over the medium to long term.

Figure A1.2. Difference in de facto fiscal space between 2015 and 2007



Source: OECD calculations.

Table 1. De facto fiscal space in selected OECD regions

	2007	2010	2015	Difference between 2015 and 2007
OECD	0.4	0.3	0.3	-0.2
G7	0.3	0.2	0.2	-0.1
EURO	0.6	0.4	0.4	-0.2

ANNEX 2. THE FISCAL MAQUETTE MODEL

The model draws on previous OECD work, especially Sorbe (2012), Rawdanowicz (2012) and Fall and Fournier (2015).

Specification of the main equations

Economic growth, which is modelled in reduced form, depends on potential growth, real interest rates and discretionary fiscal policy.

$$\Delta y_t = \Delta y_t^* + a_{y,gap} gap_{t-1} + a_{y,r} \Delta r_t + \lambda_1 \Delta ig_t + \lambda_2 \Delta cg_t - \lambda_3 \Delta tax_t + \varepsilon_{y,t} \quad (1)$$

With y_t the log of actual output, y_t^* the log of potential output, r_t the real long-term interest rate, ig , cg and tax are respectively public investment, public consumption and tax in percentage of potential GDP, and gap_t the output gap. λ s are fiscal multipliers. The gap term is necessary to make the model converge and captures the effect of other market mechanisms and stabilisation policies that are not explicitly modelled (*e.g.* unconventional monetary policy) and the impact of the external sector (which is exogenous in the model).

International trade spillovers are introduced in the growth equation when the model is simulated jointly for several countries (linked mode)

Potential output is affected by past developments in demand. Hysteresis has a permanent impact on the level of potential:

$$\Delta y_t^* = \Delta y_{t-1}^* + \mu * \text{Min}(gap_{t-1}, 0) + \frac{\epsilon}{deprec} ig_t + \delta * (\Delta y_{t-1}^* - \Delta y_{ss}^*) + \varepsilon_{y^*,t} \quad (2)$$

with $\mu > 0$ the degree of labour market hysteresis, ϵ is the elasticity of public capital in the production function, $deprec$ the depreciation rate, δ the speed of convergence of potential output to the steady state, y_{ss}^* and error term $\varepsilon_{y^*,t}$ is a supply shock.

Inflation is driven by an expectation-augmented Phillips curve where expectations are anchored to an inflation target.

$$\pi_t = a_{\pi,\pi} \pi_{t-1} + (1 - a_{\pi,\pi}) \pi_t^T + a_{\pi,gap} * gap_t + \varepsilon_{\pi,t} \quad (3)$$

With π_t inflation, π_t^T inflation target and $\varepsilon_{\pi,t}$ an inflation shock. The specification assumes dynamic homogeneity (*i.e.* that the coefficients on past and expected inflation sum to unity).

Monetary policy settings follow a Taylor rule

$$i_t = \text{Max}(\theta_1 i_{t-1} + (1 - \theta_1) * (i^* + \sigma_1 (\pi_t - \pi_t^T) + \sigma_2 * gap_t), \bar{i}) \quad (4)$$

With i_t nominal short-term interest rate, \bar{i} a lower threshold under which i_t cannot go and i^* the neutral rate which varies over time. The neutral rate is always consistent with targeted inflation and potential output developments. In euro area countries, monetary policy responds to euro area-wide inflation and output gap, so that country-specific inflation and output gap affect monetary policy to the extent of the weight of the respective country in euro area nominal GDP.

The long-term nominal interest rate on public debt is assumed to follow the short-term rate with a term premium and a fiscal risk. Fiscal risk increases by φ_1 basis points for each additional percentage point of gross debt. The implicit assumption here is that financial markets impose a risk premium on the interest rate applied to debt, that is function of the level of debt.

$$\text{irl}_t = i_t + \text{term}_t + \text{risk}_f + \varepsilon_{i,t} \quad (5)$$

$$\text{with} \quad \text{term}_t = \vartheta \text{term}_{t-1} + \text{term} \quad (6)$$

$$\text{and} \quad \text{risk}_f = \varphi d_{t-1} \quad (7)$$

where irl_t is the long-term nominal interest rate bearing on public debt, term the term premium, risk_f fiscal risk, d_t public debt-to GDP ratio, and $\varepsilon_{i,t}$ a shock. The term premium is time-varying, with an auto-regressive component, and in the medium term it converges to its historical average (term).

The real interest rate is computed as the difference between the nominal interest rate and inflation.

$$r_t = \text{irl}_t - \pi_t \quad (8)$$

Public balance is broken down into a structural component and a cyclical one, which moves with the output gap.

$$\text{pb}_t = \overline{\text{ig}}_t + \overline{\text{cg}}_t + \overline{\text{tax}}_t + (\alpha_{\text{cg}} + \alpha_{\text{tax}})\text{gap}_t + \varepsilon_{\text{pb},t} \quad (9)$$

where pb_t is the public balance, in percentage of GDP and α semi-elasticity of the respective fiscal variable to the output gap. $\overline{\text{pb}}_t$ is the cyclically-adjusted primary balance and comprises cyclically-adjusted public investment, public consumption and tax. One option in the model is to activate a fiscal reaction function whereby the primary balance is derived to stabilise the debt-to-GDP ratio over the long term.

Finally, the debt-to-GDP ratio is calculated using a standard debt accumulation formula.

$$\Delta d_t = \frac{(r_t - \Delta y_t)}{(1 + \Delta y_t)} d_{t-1} - \text{pb}_t \quad (10)$$

Parameters and calibration

The model has been constructed for large advanced economies. Parameters have been estimated, wherever possible. This is in particular the case for the growth and Phillips curve equations (Table 1). Those coefficients have been estimated using annual Economic Outlook data, released in November 2015.

Some parameters were calibrated using existing literature. Fiscal multipliers have been calibrated using Coenen et al. (2012).

The hysteresis parameter measures the effect of persistent weak demand on potential output. It is calibrated following Kapadia (2005) and Delong and Summers (2012) to 0.1 in English-speaking economies and 0.2 in continental European countries and in Japan. These values are consistent, though on the low side, with those estimated by Mourougane (2016) using a panel of OECD countries.

Although there is now a broad recognition that it is important to incorporate the feedback effect of financial markets, no consensus has emerged on the best way to model fiscal risks. The approach adopted

in this paper is to opt for simplicity and assume the premium depends on the level of the debt-to-GDP ratio.

The parameters entering the Taylor rule are standard. The inflation target is set at 2% for all countries. Central banks are assumed to avoid abrupt jumps in the policy rate by smoothing its adjustment. It is assumed the ECB reaction function is consistent with its de jure mandate and that the central bank targets only inflation.

The cyclical part of the budget is calculated using the elasticities of budget items to the output gap derived in Price et al. (2015). The resulting budget semi-elasticity ranges from 0.41 in Japan to 0.61 in France. It has been estimated with error-correction models using disaggregated spending and revenue data.

The steady-state term premium is computed using the average of the observed difference between short and long-term rates over the period 1999 to 2014 in the euro area countries and 1995 to 2014 in the other G7 economies.

Table A2.1. Calibration of the FM model

Parameter or variable		Value	Source
<i>Equation g*</i>			
μ	Degree of labour-market hysteresis	0.1 in the United States, the United Kingdom and Canada 0.2 in European countries and in Japan	Calibrated using Kapadia (2005); Delong Summer (2012)
ϵ	Elasticity of public capital in the production function	0.2	Bom and Ligthart (2014)
deprec	Depreciation rate	5%	Average general government capital in the United States using data from the Statistical office (4.6%)
δ	Potential output speed of convergence	-0.3	Calibrated
y_{ss}^*	Steady state rate of potential output growth	2% for the United States, 0.5% for Japan and 1% for the euro area countries	Calibrated
λ_1	Fiscal multiplier public investment	1.1 (0.7 for Japan)	Calibrated using Gechert et al. (2015) and Auerbach and Gorodnichenko (2014)
λ_2	Fiscal multiplier other public spending	1	
λ_3	Fiscal multiplier tax	0.3	
<i>Taylor rule and interest rates</i>			
θ_1	Inertia in interest premium in the Taylor rule	0.5	Calibrated
σ_1	Weight on inflation in the Taylor rule	1	Calibrated
σ_2	Weight on the gap in the Taylor rule	0.5	Calibrated
π_t^T	Inflation target	2%	Calibrated
\bar{i}	Lower limit on the interest rate	-5%	Calibrated
φ	Influence of debt on interest premium	0.5 basis point; 0.1 basis point for Japan	Calibrated
Term	Steady-state term premium	Average difference between long and short-term rates	
<i>Public deficit</i>			
$\alpha_{cg}, \alpha_{tax}$	Elasticity of fiscal variables to the output gap	Country-specific value, their sum is around 0.4-0.6 and takes into account changing share of each component in GDP and in total government spending/revenue	Calibrated using Price et al. (2015)
<i>Equation g</i>	Panel with same coefficient for all the countries, λ s are calibrated		SURE Estimation 1990-2014
<i>Equation Phillips</i>	Panel with same coefficient for all the countries		SURE Estimation 1990-2014

ANNEX 3. THE LONG-TERM SUSTAINABILITY MODEL BASED ON LAFFER CURVES

This annex reports the main equations of the model, for more details see Bi (2011), Bi and Leeper (2013) or Múčka (2015).

The deviation of productivity, a_t , from its steady-state a , follows an AR(1) process, with shock ε_t^a .

$$a_t = \rho_a a_{t-1} + (1 - \rho_a)a + \varepsilon_t^a \quad (1)$$

Government purchases, g_t , also follow an AR(1) process and react to the business cycle via their sensitivity to the cycle, ζ_g , g is the steady state of government purchases and ε_t^g is shock to government purchases :

$$g_t = \rho_g g_{t-1} + (1 - \rho_g)g + \zeta_g(a_t - a) + \varepsilon_t^g \quad (2)$$

Government transfers, z_t , are also sensitive to the business cycle, with sensitivity ζ_z , z the steady state of transfers and ε_t^z the transfer shock:

$$z_t = z + \zeta_z(a_t - a) + \varepsilon_t^z \quad (3)$$

The consumption, c_t , and labour supply, h_t , of a representative household ensues via utility maximisation subject to an intertemporal budget constraint, which is a function of government transfers z_t , tax rate τ_t , and debt default rate on government bonds, with a discount factor $\beta \in (0,1)$ and households' leisure preference parameter, ϕ . Household utility function is strictly concave and increasing in leisure and consumption. The resulting equations of household consumption and labour supply are the following:

$$c_t = \frac{(a_t - g_t)(1 - \tau_t)}{1 + \phi - \tau_t} \quad (4)$$

$$h_t = \frac{a_t(1 - \tau_t) + \phi g_t}{a_t(1 + \phi - \tau_t)} \quad (5)$$

The tax rate, τ_t^{max} is the peak of the Laffer curve. At this tax rate government tax revenues, Θ_t^{max} , are maximised, for a given state of the economy :

$$\tau_t^{max} = 1 + \phi - \sqrt{(1 + \phi)\phi(a_t - g_t)/a_t} \quad (6)$$

$$\Theta_t^{max} = (1 + 2\phi)a_t - \phi g_t - 2\sqrt{(1 + \phi)\phi a_t(a_t - g_t)} \quad (7)$$

At each period k , the combination of maximum tax revenues and government spending, gives the maximum primary surplus, ς^{max}

$$\varsigma_{(a_{t+k}, g_{t+k})}^{max} = \Theta_{(a_{t+k}, g_{t+k})}^{max} - g_{t+k} - z_{(a_{t+k})} \quad (8)$$

Finally, the fiscal limit, \mathfrak{B}_t^* , is obtained as the sum of the expected discounted maximum primary surpluses in all future periods:

$$\mathfrak{B}_t^* = \sum_{k=0}^{\infty} \beta^k \frac{u_{(a_{t+k}, g_{t+k})}^{max}}{u_{(a_t, g_t)}^{max}} \varsigma_{(a_{t+k}, g_{t+k})}^{max} \quad (9)$$