EXECUTIVE BOARD MEETING

EBS/20/16

March 11, 2020

To: Members of the Executive Board

From: The Secretary

Subject: **April 2020 World Economic Outlook—Analytical Chapter 2**

Board Action:	Executive Directors' **consideration** (Formal)
Tentative Board Date:	**Wednesday, April 1, 2020**
Publication:	Yes, it is intended that the full set of the World Economic Outlook documents will be released to the public at the time of the World Economic Outlook press conference, tentatively scheduled for **Tuesday, April 14, 2020**. The analytical chapters will be made available to the public on the IMF website in advance of the publication of the full document.
Questions:	Mr. Bluedorn, RES (ext. 35392) Ms. Chen, RES (ext. 38586)
Additional Information:	The paper will be revised for publication in light of the Executive Board discussion. If Executive Directors have additional comments, they should notify Mr. Bluedorn and Ms. Chen by **5:30 p.m. on Friday, March 24, 2020**.

CHAPTER 2

COUNTERING FUTURE RECESSIONS IN ADVANCED ECONOMIES: CYCLICAL POLICIES IN AN ERA OF LOW RATES AND HIGH DEBT

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CHAPTER 2

COUNTERING FUTURE RECESSIONS IN ADVANCED ECONOMIES: CYCLICAL POLICIES IN AN ERA OF LOW RATES AND HIGH DEBT

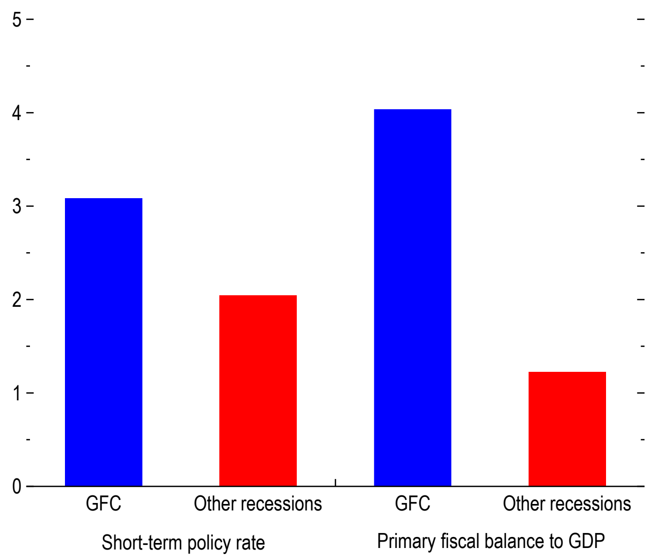
More than a decade after the global financial crisis, interest rates are at historical lows in many advanced economies and public debts on average higher than they have been over the past 60 years. This chapter examines policymakers' options to respond to downturns and build resilience in this context. Even amid low rates, central banks still have scope to use unconventional monetary policy tools to support the economy, although questions remain about side effects on financial stability and threats to central bank independence with their use. When monetary policy is constrained, countercyclical fiscal policy needs to play a larger role. New analysis shows that, over the past few years, declining interest rates relative to growth have modestly reduced the average rise in debt ratios in advanced economies compared with earlier projections. Evidence suggests that fiscal stimulus using public spending is particularly potent when there is economic slack and rates are low while monetary policy is accommodative. Analysis shows that newly proposed measures for rules-based fiscal stimulus—stimulus automatically triggered by deteriorating macroeconomic indicators—can be highly effective in countering a downturn in such an environment. To ensure a prompt and effective response to adverse shocks in such conditions, policymakers should consider increasing the sensitivity of traditional automatic stabilizers and adopting rules-based fiscal stimulus measures.

Introduction

Policymakers in advanced economies took strong and coordinated actions in reaction to the global financial crisis in 2008. Central banks reduced policy rates by an average 3 percentage points, somewhat greater than the cuts made in earlier recessions (Figure 2.1). The average government provided expansionary fiscal stimulus with primary balances to GDP declining by about 4 percentage points, markedly more than in previous recessions.[1] In parallel, central banks

Figure 2.1. Monetary and Fiscal Responses to Crises and Recessions in Advanced Economies since 1960
(Percentage point decline in indicated policy variable)

In response to the global financial crisis, central banks reduced policy rates by about a third more, and the primary fiscal balance declined by about three times more than during other recessions.



Sources: Bank for International Settlements; Haver Analytics; IMF, *International Financial Statistics*; Mauro and others (2015); national sources; World Bank; and IMF staff calculations.
Note: The change in the indicated policy variable is dated to the year before a recession starts to the year after it ends. Recessions are defined to be years of negative output growth. All estimates are statistically significantly different from zero and estimates for the GFC and other recessions are statistically significantly different from each other at the 10 percent level. GFC = global financial crisis associated recession (start in 2007–09).

The authors of this chapter are Michal Andrle, Philip Barrett, John Bluedorn (co-lead), Francesca Caselli, and Wenjie Chen (co-lead), with support from Christopher Johns, Adrian Robles Villamil, and Shan Wang. The chapter also benefited from discussions with Jay Shambaugh and from comments from internal seminar participants and reviewers.

[1]Unlike the change in short-term policy rates, the change in the ratio of the primary fiscal balance to GDP is a mix of deliberate policy responses (whether discretionary or automatic) and the GDP decline from the recession. Alternative indicators that attempt to isolate the fiscal policy response are available, but do not cover as wide a sample of countries nor go back as far in time.

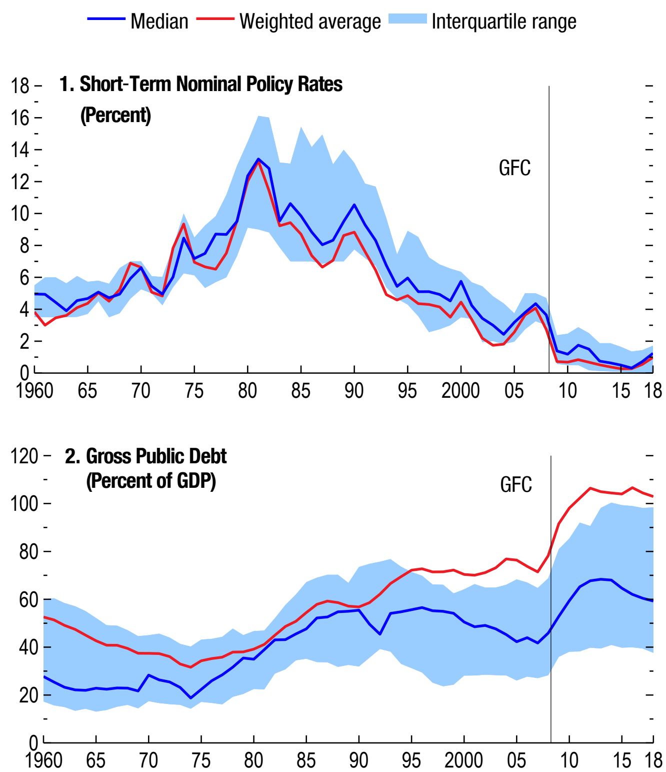
deployed more unconventional monetary policy tools, including forward guidance (public communication by the central bank about the likely future path of monetary policy and its objectives and intentions), large-scale financial asset purchases (quantitative and credit easing), and negative interest rates. These monetary and fiscal efforts are widely acknowledged to have averted a deeper slump.[2]

More than 10 years after the global financial crisis, advanced economy policy rates are considerably lower and public debt levels higher than over the previous 60 years, reflecting the consequences of the crisis as well as longer term trends (Figure 2.2, panels 1 and 2). Given the typical size of monetary and fiscal policy actions after a recession starts, some observers are raising questions about monetary and fiscal policymakers' scope to stimulate their economies in the event of a new downturn.[3]

Against this backdrop, this chapter examines countercyclical measures policymakers can deploy to counter future recessions and build resilience in an era of low rates and high public debt. Drawing upon the literature and new analysis, it addresses the following questions:

Figure 2.2. Policy Rates and Public Debt in Advanced Economies

Reflecting long-term trends and the aftermath of the global financial crisis, the average advanced economy policy rate is near its lowest level since 1960 while average public debt to GDP is near its historical highs.



Sources: Bank for International Settlements; Haver Analytics; IMF Historical Public Debt Database; IMF, *International Financial Statistics*; Mauro and others (2015); national sources; and IMF staff calculations.
Note: The sample includes 35 advanced economies. For panel 1, when a country joins the euro area, it drops out. The euro area policy rate (set by the European Central Bank) enters in 1999, replacing the policy rates for euro area member states as they join. The weighted average uses nominal US dollar GDP weights. Time coverage across countries is unbalanced. GFC = global financial crisis (2008).

- *Monetary policy:* Given low rates in many advanced economies, how can monetary policy best respond to adverse shocks?
- *Fiscal policy*: In view of historically high levels of debt in many advanced economies, to what extent have interest rate declines in recent years affected governments' capacities to borrow and provide fiscal support—their fiscal space as captured by public debt to GDP? What

[2]See Chapter 2 of the October 2018 *World Economic Outlook* (WEO).

[3]See Carney (2020), Summers (2020), and Yellen (2020), among others.

fiscal stimulus measures appear to be most effective and how does their effectiveness differ with the degrees of economic slack and monetary accommodation? Could enhancements to existing automatic stabilizers and the adoption of rules-based fiscal stimulus—automatic fiscal stimulus triggered by the deterioration of macroeconomic indicators—help dampen economic fluctuations?

The main findings of the chapter are:

- Although the decline in rates in many economies has limited the scope for conventional interest rate cuts to counter a recession, further monetary accommodation is possible using unconventional tools. However, relying on monetary policy alone for additional countercyclical actions in this environment carries risks, with increasing concerns about possible side effects on financial stability and potential threats to central bank independence. Monetary policy can support fiscal stimulus in a recession by maintaining an accommodative stance.

- Recent unanticipated declines in interest rates relative to growth have modestly reduced the rise in the public debt-to-GDP ratio compared to what was expected in many economies. These unexpected changes in interest rate–growth differentials have played a roughly equal role as unexpected developments in primary fiscal balances in explaining unexpected changes in debt. Low interest rate–growth differentials are likely to persist on average, but there are still risks that the interest rate–growth differential can change quickly for a given country.

- The evidence suggests that public spending (investment and consumption) is the most potent fiscal instrument, generating large output effects with multipliers greater than one. Fiscal stimulus is especially powerful when the economy has slack and monetary policy is accommodative—circumstances that would characterize a downturn. Discretionary fiscal stimulus has helped in the past, but often comes with a delay.

- Analysis shows that newly proposed rules-based fiscal stimulus measures—stimulus automatically triggered by deteriorations in macroeconomic indicators—could be highly effective in countering a downturn when interest rates are at their effective lower bound and discretionary fiscal policy lags are long. Such measures implement a fiscal stimulus according to a predetermined rule in response to a downturn, as captured by the behavior of a macroeconomic outcome variable, such as the unemployment rate rising. Compared to a scenario without rules-based fiscal stimulus, the adverse output and debt-to-GDP effects are smaller. Model simulations suggest that the stabilization achieved by adopting rules-based fiscal stimulus comes close to that when monetary policy actions are unconstrained.

Taken together, the findings suggest that, to ensure a prompt and adequate response to a recession and improve the economy's resilience, policymakers should enhance fiscal policy's automatic response to adverse shocks.[4] Designing and adopting new fiscal tools—like rules-

[4]See Chapter 1 of the April 2020 *Fiscal Monitor* for a broader discussion of how economies can better prepare for future downturns by following an IDEAS strategy: (1) establishing a pipeline of appraised investment projects; (2) formulating in advance discretionary measures to deploy quickly; and (3) enhancing traditional automatic stabilizers.

based fiscal stimulus measures—and improving existing automatic stabilizers will take time and require political agreement. However, establishing sufficient automatic stabilizers and rules-based fiscal stimulus in advance of a downturn reduces the risks that contemporaneous political hurdles inhibit timely and effective fiscal stimulus.

There are some important caveats to this advice. The model simulations do not incorporate possible sovereign risk feedbacks. They assume that the economy is on sound fiscal footing, without any risk to the government's ability to borrow in financial markets. The analysis of how declines in the interest rate–growth differential impact fiscal constraints is conservative, only taking account of its consequences for borrowing costs relative to GDP, conditional on keeping the ratio of debt to GDP stable over the near term. It does not attempt to assess the implications of negative and persistent interest rate–growth differentials for long-term debt sustainability, which could suggest even greater scope for borrowing.[5] But countries that are facing high risks of a fiscal crisis may well encounter additional constraints on their actions.[6]

The chapter begins with a summary and discussion of the existing literature on monetary policy options when interest rates are close to the effective lower bound, noting their effectiveness but also some of their potential side effects and risks. The next section turns to fiscal policy, examining the potential implications of the recent evolution of $r - g$ for countries' fiscal borrowing constraints. Then, the chapter looks at the evidence on the potency of fiscal stimulus, examining how it varies by instrument, economic slack, and monetary policy's reaction. The penultimate section presents the findings from a model-based analysis of newly proposed rules-based fiscal stimulus to offset adverse shocks and stabilize the economy. Finally, the chapter concludes with a summary of the main takeaways and policy implications.

Monetary Policy Options When Interest Rates Are Low

As shown in Figure 2.2 (panel 1), apart from a few episodes, interest rates in advanced economies have been heading downward for many years, with this trend accelerating after the global financial crisis. This pattern accords with views that the natural rate of interest (the interest rate consistent with stable inflation and full employment) has declined.[7] Different perspectives on the underpinnings of this decline exist, ranging from structural deficiencies in aggregate demand (secular stagnation) to more supply-side factors, such as slowing long-term productivity growth or the long-lived effects of debt overhang following a deep recession.[8] Both perspectives suggest that low rates, and the associated limits on monetary easing through conventional interest cuts, may be a fact of life for the foreseeable future. Responding to these constraints, monetary policymakers in advanced economies have turned increasingly to "new" or

[5]See Barrett (2018), Blanchard (2019), Eichenbaum (2019), and Garín and others (2019), among others, for a recent discussion.

[6]See Mauro and Zhou (forthcoming); Bianchi, Ottonello, and Presno (2019); and Moreno Badia and others (2020) for a discussion and cases where risks of a turn in market sentiment against a sovereign can limit their actions.

[7]See Laubach and Williams (2003); Chapter 3 of the April 2014 WEO; Furman (2016); Holston, Laubach and Williams (2017); Yellen (2018); and Rachel and Summers (2019); among others, for discussion and evidence on how the natural rate of interest in many economies has drifted down.

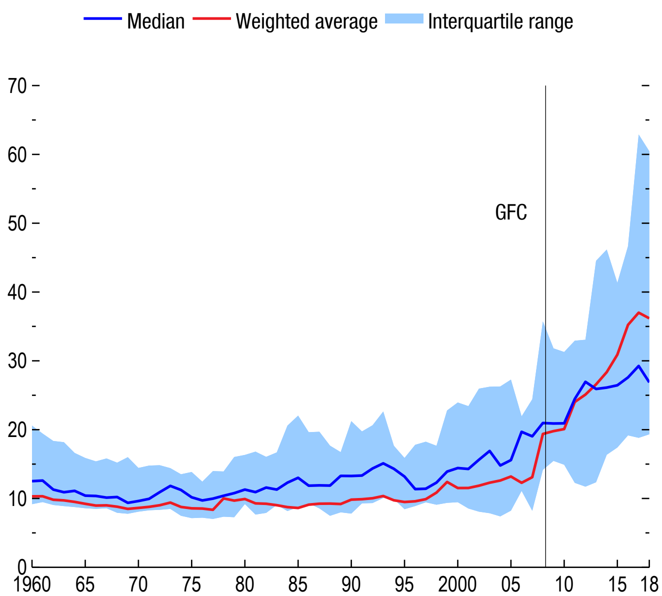
[8]See Summers (2013), Teulings and Baldwin (2014), and Rogoff (2015).

unconventional monetary policy tools to achieve further easing, using forward guidance, large-scale asset purchase programs, and negative interest rates on bank reserves.[9]

During and after the global financial crisis, forward guidance reinforced central banks' accommodative stances by shaping expectations about interest rates and other monetary policy measures.[10] This departed from central banks' past communication styles by directly signaling their willingness to pursue extraordinary policy actions or to keep interest rates at a specific level for an extended period of time. The success of this strategy depends on the market's perceptions of the central bank's credibility in following through on their announcements. On one hand, central banks can choose to be more general in their communication, without making explicit commitments about specific policy actions. On the other hand, they can choose to be explicit with data or state-contingent commitments to maintain an announced policy path. There are trade-offs between these styles. The first allows policymakers room to maneuver if there are surprises, but at the risk that the market does not firmly believe their commitment. The second can influence market expectations substantially and reduce uncertainty, but at the cost of diminished flexibility to surprises. Forward guidance will continue to grapple with these trade-offs. Several studies find forward guidance to be effective in reducing borrowing costs and stimulating loan growth when rates are low, although the range of effect estimates is wide.[11]

Figure 2.3. Central Bank Balance Sheets
(Percent of GDP)

The size of central bank balance sheets increased significantly since the global financial crisis with the implementation of large-scale asset purchase programs.



Sources: European Central Bank; Ferguson, Schaab, and Schularick (2015); Haver Analytics; and IMF staff calculations.
Note: The central bank balance sheet is central bank total assets as a share of nominal GDP. After a country joins the euro area, it no longer enters separately from the euro area as a whole, reflecting the euro area's unified monetary policy from 1999 onwards. The euro area central bank balance sheet to GDP is Eurosystem total assets to total euro area GDP. Shaded areas denote the interquartile range of the variable. The weighted average uses nominal US dollar GDP weights. Time coverage across countries is unbalanced. GFC = global financial crisis (2008).

[9]Bernanke (2020) refers to unconventional monetary policy tools simply as "new," since there is sufficient experience for them to be considered an ordinary part of the central bank toolkit. This section draws exclusively on the large existing literature on unconventional monetary policy and its effectiveness. Recent overviews include Bayoumi and others (2014), Borio and Zabai (2016), Dell'Ariccia, Rabanal, and Sandri (2018), BIS (2019a; 2019b), and Sims and Xu (2019).

[10]See Moessner, Jansen, and de Haan (2017) for a review of the theory and practice of forward guidance.

[11]See He (2010), Woodford (2013), Campbell and others (2012), Kool and Thornton (2012), Filardo and Hofmann (2014), Charbonneau and Rennison (2015), Coenen and others (2017), Andrade and Ferroni (2018), Swanson (2018), and Moessner and Rungcharoenkitkul (2019), among others. It is important to highlight that it is inherently difficult to identify the exact impact of forward guidance due to its typically joint implementation with other unconventional monetary policy measures.

With large-scale asset purchases, the central bank can still provide monetary stimulus by supporting long-term bond prices and lowering long-term yields, even if the short-term policy rate is near or at zero.[12] Asset purchases were used extensively by advanced economies during and after the global financial crisis, leading to a marked increase in the size of central bank balance sheets over recent years (Figure 2.3). The literature suggests that these measures eased financial conditions and helped boost output and inflation across many economies, although a fair amount of uncertainty around these estimates remains. Model-based evidence using counterfactual simulations on the US economy shows that large-scale asset purchases alleviated the fall in annualized real GDP growth by almost 6 percentage points in the first quarter of 2009. Estimates for the United Kingdom point to a similar picture over the same period, with annualized output growth being higher by about 5 percentage points due to the Bank of England's gilt purchases on long-term yield spreads.[13] The purchase of large quantities of government bonds may also play a signaling role, convincing markets that the central bank is committed to a loose policy stance.[14] Some economists have highlighted undesirable secondary consequences that could follow from further large-scale asset purchases, including greater central bank balance sheet asset quality risks and threats to central bank independence arising from perceptions that it constitutes monetary financing.[15]

Negative interest rate policies have hitherto taken the form of relatively small interest rate charges on commercial banks' reserve holdings at the central bank in a few advanced economies. The overall assessment has been that they have reinforced central banks' accommodative stance in economies where they have been implemented without marked harmful effects (Box 2.1).[16] However, it is possible that pushing rates even more negative or keeping them negative for longer could have sufficiently detrimental effects on bank profitability and, in turn, lead to lower lending and tighter financial conditions.[17] Recent empirical literature studying the impacts on Europe and Japan generally finds that lending volumes have increased and lending rates have fallen, providing aggregate demand support, while banks have modified their behavior to reduce the impact of negative rates on their profitability.[18] For policymakers to pursue even lower negative interest rates in the future, a variety of legal, regulatory, and tax law changes could be required.

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[12]See Borio and Zabai (2016) and BIS (2019a, 2019b) for more detailed descriptions on the implementation of large-scale asset purchases. See Gambacorta, Hofmann, and Peersman (2014) for empirical evidence on the effectiveness of quantitative easing.

[13]See Baumeister and Benati (2013) and Borio and Zabai (2016) for an overview of empirical estimates on the impacts of large-scale asset purchases on output.

[14]See Bauer and Rudebusch (2014) and Coenen and others (2017) on the interaction between forward guidance and large-scale asset purchases.

[15]See Dudley (2013) and Orphanides (2018). In addition to asset quality concerns, risks could rise from stretched asset price valuations.

[16]The April 2020 *Global Financial Stability Report* includes a chapter analyzing the impact of the lower for longer environment on bank profitability, including through a forward-looking scenario analysis.

[17]See Brunnermeier and Koby (2019), Eggertsson, Juelsrud, Summers, and Wold (2019), BIS (2019a), and Box 2.1 for discussion of this theoretical possibility.

[18]See Demiralp, Eisenschmitd, and Vlassopoulos (2017), Basten and Mariathasan (2018), Eisenschmidt and Smets (2019), and Lopez, Rose, and Spiegel (2019).

Given that policy rates are already very low in many advanced economies and unlikely to return to their precrisis levels for a prolonged period, policymakers will need to rely more than before on these new monetary policy tools to counter future downturns. While there is broad agreement that unconventional monetary policy tools have been effective in helping to stimulate the economy during the Great Recession, there is considerable debate over their efficacy going forward and possible side effects, including increased financial risk-taking. Strengthening macroprudential policies and preemptively implementing them could help deal with any potential financial sector vulnerabilities.[19] Nonetheless, these new monetary policy tools would still be useful in easing financial conditions in a downturn. But it will be important to avoid overreliance on them and to ensure that fiscal policy plays an appropriate role in stabilizing the economy. Monetary policy can support fiscal stimulus in a recession by remaining accommodative and keeping interest rates low. The next section looks at the scope for fiscal policymakers to stimulate in the low rate environment.

Fiscal Space, Public Debt, and Low Interest Rates

When considering a more expansionary fiscal stance, a government has to evaluate the trade-offs between actions today versus possible needs for stimulus in the future, given its available and expected fiscal resources. This means that fiscal policymakers' actions in responding to an adverse shock will be partly a function of their ability to raise spending or lower taxes relative to a pre-existing baseline without endangering market access and debt sustainability—their fiscal space.[20] Fiscal space depends on a multitude of factors, including a country's macroeconomic context (domestic and external conditions and structural gaps), market perceptions and sentiment, and the dynamics of the public debt-to-GDP ratio.[21]

Although there is no unique indicator or set of indicators that fully captures a country's fiscal space, the public debt-to-GDP ratio is a key observable indicator related to countries' ability to borrow and capacity to act countercyclically in a downturn. The literature suggests that countries with higher ratios of public debt to GDP prior to a crisis or downturn tend to have less countercyclical fiscal policies and worse outcomes.[22] In new research, Romer and Romer (2019) find that fiscal policymakers in advanced economies are more reluctant to stimulate after an adverse shock when initial public debt-to-GDP ratios are higher. This reflects concerns about potential rises in risk premiums (and hence borrowing costs) and loss of market access, as well as

[19]See recent debates by Bernanke (2020), Rogoff (2020), and Summers (2020). See Chapter 1 of the October 2019 *Global Financial Stability Report* on how macroprudential policy can mitigate financial stability risks from rates being "low for long." For an emerging market perspective, see Chapter 3 of the April 2020 WEO on how macroprudential regulation can stabilize GDP growth in the face of adverse global financial shocks.

[20]See IMF (2016, 2018) for a definition of fiscal space and a discussion of the various aspects and considerations driving its assessment by country. The quantification of a country's fiscal space makes no judgment on whether or not it should be used or further built up in a given situation. See also Debrun and others (2019) for a discussion on how to think about the sustainability of a country's debt.

[21]For country-specific, multi-dimensional assessments of fiscal space, please refer to IMF Country Reports.

[22]See Jordà, Schularick, and Taylor (2016) and Romer and Romer (2018).

a more general reduced willingness to act by policymakers. Moreover, other work also points to monetary policy accommodation being less effective when public debt to GDP is high.[23]

In view of historically high levels of debt in many advanced economies, to what extent have interest rate declines in recent years affected governments' capacities to borrow and provide fiscal support? While lower interest rates imply lower interest payments on new government debt, they are not enough on their own to justify higher borrowing. It is also important to simultaneously assess how a government's ability to raise revenue to service the debt is evolving, which will be a function of the economy's size. Both the interest rate on debt and nominal growth—in particular, their difference—matter for the dynamics of an economy's public debt-to-GDP ratio.[24]

As an illustration of these effects, the chapter examines how debt dynamics have evolved compared with forecasts since late 2015—a period during which interest rates were on a declining path and growth recovering.[25] Interest rates and primary deficits have been, on average, lower than expected since late 2015, while nominal growth has been higher (Figure 2.4, panel 1).[26] How have these unanticipated developments in countries' interest rates, nominal growth, and primary deficits affected the evolution of debt over the past four years?

Taken together, on average, these changes have pushed down the debt-to-GDP ratio over 2016–18 below what was expected at the end of 2015, potentially increasing the amount of borrowing governments could undertake while keeping expected medium-term debt unchanged (Figure 2.4, panel 2).[27] Overall, a lower interest rate–growth differential has helped slow debt growth since 2015, playing a roughly equal role in debt dynamics to changes in primary deficits.[28] Collectively, these developments have contributed to a lower debt-to-GDP ratio in 2018 than what was expected in 2015 for about two-thirds of advanced economies. The median unexpected decline in debt coming from lower interest rate–growth differentials is about 1

[23]See De Luigi and Huber (2018), who find that expansionary monetary policy helps stabilize in a downturn, but less so when the economy is in a high public debt to GDP regime.

[24]See Online Annex 2.2 for the equation of motion describing the dynamics of the public debt-to-GDP ratio and its relationship to the paths of interest rates and nominal growth.

[25]The October 2015 WEO projections are the starting point from which expectations are taken, given that they incorporate the expected effects of the large-scale asset purchase programs undertaken prior to that date in advanced economies (including the European Central Bank's public sector purchase program). See BIS (2019a) for details on the starting dates of the large-scale asset purchase programs across advanced economies. The 2018 end point for the changes shown reflects the latest available final data across the sample. See Online Annex 2.2 for discussion on the robustness of the findings to the starting date.

[26]The correlation between unexpected changes in the primary deficit-to-GDP ratio and the unexpected change in nominal growth is weakly negative but not statistically significant. The sign of the relationship is consistent with positive growth surprises lowering the primary deficit-to-GDP ratio, possibly through increased revenues.

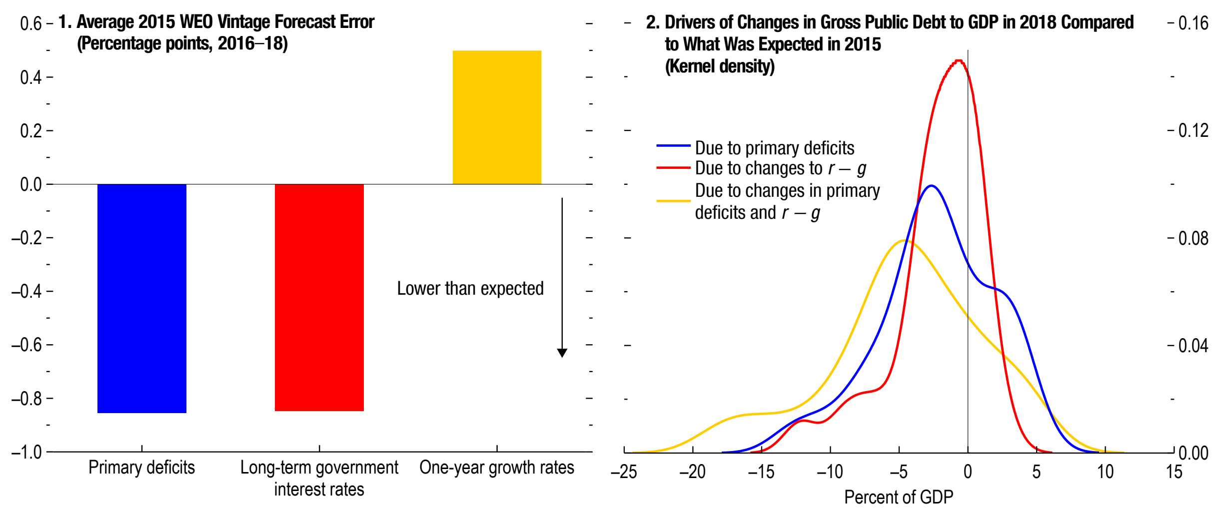
[27]Alternative forecast vintages yield similar findings. See Online Annex 2.2 for further details. The exercise is similar in spirit to that in Deutsche Bundesbank (2017) for euro area economies.

[28]The share of explained deviations in unexpected debt changes from unexpected interest rate–growth differentials ($r - g$) changes is about 50 percent, based on the economic importance measures in Sterck (2019). In principle, the unexpected changes in debt due to $r - g$ and that due to the primary deficit-to-GDP ratio could be related. For example, a decline in $r - g$ arising from surprisingly higher growth may be associated with a decrease in the primary deficit-to-GDP ratio, reflecting improved tax revenue performance and a larger denominator. The accounting decomposition exhibited here does not attempt to attribute such comovements between $r - g$ and the primary deficit-to-GDP ratio to one or the other. However, analysis indicates that their correlation is essentially zero, suggesting that the rough shares provide a broadly accurate picture of the contributions of $r - g$ and the primary deficit-to-GDP ratio to unexpected debt changes. See Online Annex 2.2 for further details.

percent of GDP, while that from lower primary deficits is about 2 percent of GDP. However, for some countries (about one-third of advanced economies), debt outturns have been worse than expected, with interest rate–growth differentials rising or primary deficits increasing more than anticipated.

Figure 2.4. Sources of Unexpected Changes to Public Debt

Overall, lower $r - g$ has helped slow debt growth since 2016, but changes in primary deficits have played a larger role in debt dynamics.



Source: IMF staff estimates.
Note: The forecast error for each indicated variable in panel 1 is calculated as the average across the annual differences between actual outturn and forecast from the October 2015 WEO vintage over 2016–18. Panel 2 shows the density distributions of impacts on 2018 debt ratios (in percentage points) of changes to fiscal factors relative to their 2015 forecasts. The exercise takes as given that the expected medium-term ratio of public debt to GDP is stable. The October 2015 WEO projections are used as the starting point from which to take expectations given that they incorporate the expected effects of the large-scale asset purchase programs undertaken prior to that date in advanced economies (including the European Central Bank's public sector purchase program). See Bank for International Settlements (2019a). The 2018 end point for the changes shown reflects the latest available final data across the sample. See Online Annex 2.2 for further details on data and the calculations. $r - g$ = interest rate–growth differential; WEO = *World Economic Outlook*.

An important caveat is that this analysis focuses simply on the accounting contributions of unexpected falls in interest rate–growth differentials and the primary deficit to GDP since 2015 to the unexpected change in the debt-to-GDP ratio over the same period. Since countries could choose to use the savings from unexpected and persistent falls in interest rate–growth differentials to undertake additional borrowing, some countries may have seen little reduction in their expected debt paths and little increase in their fiscal space.[29] Moreover, even if lower interest rate–growth differentials do create additional borrowing capacity, countries with high debt levels may remain exposed to sharp increases in spreads, including during rollover crises.[30]

The exact implications of a lower interest rate–growth differential for a country's scope for fiscal stimulus depend on country-specific circumstances, but these estimates suggest that the

[29]Furthermore, as noted in footnote 28, this accounting decomposition neglects the possible comovement between unexpected changes in debt due to $r - g$ and to the primary deficit, which could either magnify or attenuate the unexpected decline in the debt-to-GDP ratio. See Garín and others (2019) for a model exhibiting such comovement and discussion of its possible consequences for debt dynamics.

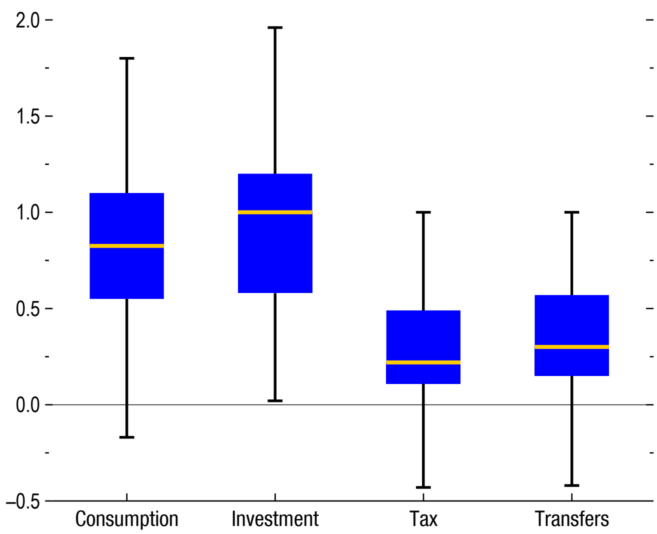
[30]See Cole and Kehoe (2000) and Aguiar and others (2016) for more on the drivers of rollover crises and the potential for multiple equilibria. See also Mauro and Zhou (forthcoming) for evidence suggesting an association between a high debt-to-GDP ratio and rollover crises, independent of initial interest rate–growth differentials.

decline in interest rates relative to nominal growth has improved the dynamics of public debt-to-GDP in the average advanced economy. In fact, the median 1 percent of GDP unexpected decline in the debt-to-GDP ratio since 2015 attributable to lower interest rate–growth differentials is comparable to the average fall in the primary fiscal balance-to-GDP ratio associated with recessions in advanced economies prior to the global financial crisis.

Looking ahead, the scope for fiscal support in future downturns depends on the persistence of interest rate–growth differentials, as countries' debts are repaid over many years. Other analysis suggests that the common component of the interest rate–growth differential across advanced economies is highly persistent, reinforcing the view that lower financing costs are likely to continue (Box 2.2). That said, it is important for fiscal policymakers to use wisely whatever fiscal space they have in responding to a recession, considering the instruments available and the context. This is the topic of the next section.

Figure 2.5. Fiscal Multipliers: One-Year Horizon
(Units of real output)

Average fiscal multipliers for public spending from the literature are about 1, with that for public investment slightly higher than that for public consumption. Average multiplier estimates for taxes and transfers are about a quarter that size.



Source: Gechert and Rannenberg (2018).
Note: The chart reports the median (gold line), the 25th and 75th percentiles (lower and upper boundaries of the blue box), and the extremes (lower and upper whiskers) of the distribution of fiscal multiplier estimates from the literature. The multiplier is defined to be the change in real output for a unit change in the indicated fiscal instrument.

Fiscal Multipliers by Instrument and Context

What's the best way for fiscal policymakers to deliver stimulus—spending increases or tax cuts? How do fiscal policy's effects depend on the state of economy and the response of monetary policy? Fiscal multipliers—how much real output changes for an increase in fiscal stimulus—provide answers to these questions. Some theories of the business cycle and recent empirical research suggest that fiscal policy has larger effects during recessions and periods of economic slack.[31] Other studies point to powerful effects of fiscal stimulus when nominal interest rates are at the effective lower bound or monetary policy is accommodating.[32]

The size of multipliers varies by fiscal instrument—how stimulus is delivered. A meta-analysis of the vast literature on fiscal multipliers points to average estimates for public spending on goods and services (government purchases) of about 1, with that for public investment slightly higher than that for public consumption, although there is a large degree of variability (Figure

[31]See Auerbach and Gorodnichenko (2012b); Baum, Poplawski-Ribeiro, and Weber (2012); DeLong and Summers (2012); Cottarelli, Gerson, and Senhadji (2014); Fazzari, Morley, and Panovska (2015); and Whalen and Reichling (2015).

[32]See Almunia and others (2010); Christiano, Eichenbaum and Rebelo (2011); Blanchard and Leigh (2013); and Chodorow-Reich (2019).

2.5). Multiplier estimates from taxes and transfers are about a quarter that size, on average. Overall, the evidence suggests that public spending on goods and services is more effective.

Why might this be the case? Theoretically, multipliers would be higher when the fiscal stimulus feeds fully through to aggregate demand, as is the case with public spending on goods and services or via cash transfers to households with high propensities to consume out of current income.[33] Multipliers would also be expected to be larger when leakages from the economy are low (that is, the economy is more closed), when there is economic slack, or when monetary policy is accommodative (that is, when interest rates do not rise in response to fiscal stimulus). The empirical evidence on higher multipliers during recessions and under different monetary policy stances has, however, been mixed.[34] Other country-specific characteristics can also impact the size of the multiplier. For instance, the public debt-to-GDP ratio at the time of the stimulus might affect the size of the multipliers through expectations of fiscal adjustments in the near future or sustainability concerns that could raise interest rates.[35]

Combining the recent estimation methodology proposed by Ramey and Zubairy (2018) and the identification scheme based on forecast errors in public spending from Auerbach and Gorodnichenko (2012a, 2012b, 2013, 2017), new estimates on the cumulative fiscal multiplier under economic slack and accommodative monetary policy suggest that fiscal policy is indeed powerful in these circumstances.[36] The baseline multiplier from public spending on goods and services estimated using this approach is about 1, on average, across horizons, broadly in line with the literature (Figure 2.6, panel 1). As expected, the picture changes once economic conditions are considered. If the unemployment rate in a country is above its average, the one-year fiscal multiplier rises to above 1.5, while it falls below 1 if the unemployment rate is below its average (Figure 2.6, panel 2). The statistically significant difference between these two multipliers bolsters the idea that fiscal policy effectiveness depends on the tightness of the labor market. In contrast, there is no strong evidence that the multiplier differs across the business cycle phase as captured by output growth (expansions versus recessions).[37]

When interest rates are low and close to their effective lower bound, the fiscal multiplier is above 2 and statistically significantly different from the multiplier when interest rates are far from the effective lower bound (Figure 2.6, panel 3). In other words, fiscal stimulus is extremely effective when monetary policy does not lean against it. These estimates are robust to alternative definitions of accommodative monetary policy. For instance, fiscal stimulus is more potent under a fixed exchange rate regime or currency union when monetary policy does not allow

[33]See Jappelli and Pistaferri (2014) for a discussion and empirical evidence on how the marginal propensity to consume varies with household characteristics and its implications for fiscal policy. Public spending through targeted transfers to households with higher marginal propensities to consume generates higher fiscal multipliers than transfers to other households. See also McKay and Reis (2016).

[34]Differences across studies likely reflect differences in sample, identification, and estimation approaches. See Online Annex 2.3 for further discussion.

[35]See Corsetti, Meier, and Müller 2012; Ilzetzki, Mendoza, and Végh 2013; and Auerbach and Gorodnichenko 2017. See Online Annex 2.3 for further discussion.

[36]The shock to public spending on goods and services is computed as the real-time forecast errors of public consumption spending growth relative to GDP. See Online Annex 2.3 for further details.

[37]Expansions and recessions are defined as years of positive or negative growth respectively.

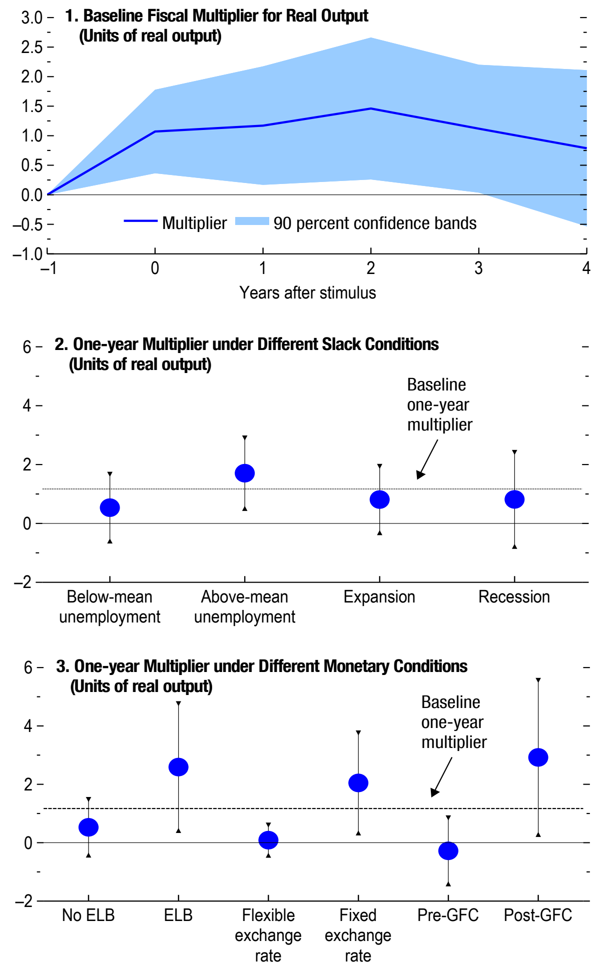
interest rates to rise or is unresponsive to the local fiscal impulse. Moreover, the multiplier estimated over the period since the global financial crisis—which is marked by low interest rates across most advanced economies—is higher than in the precrisis period and close to that estimated at the effective lower bound.[38] Taken together, the results suggest that the fiscal multiplier is larger during periods of labor market slack and when monetary policy is supportive of fiscal stimulus—exactly the conditions that would apply were a downturn to occur when policy rates are so low.

Discretionary fiscal stimulus, appropriately tailored to the specific circumstances and the nature of the negative shock that materializes, can offer powerful countercyclical support, particularly if the political willingness to act promptly and in a targeted fashion is high. But it is sometimes delayed because it requires political agreement as a precondition, which may be difficult to achieve.[39] For example, discretionary fiscal responses to the global financial crisis took several months to be announced, let alone adopted and implemented.[40] Putting in place institutions that automatically undertake fiscal stimulus to counter an adverse shock can potentially enhance the effectiveness and timeliness of the stabilizing response.

Traditional automatic stabilizers—such as the progressivity of the tax code, the unemployment insurance system, or the means-tested social safety net—are mechanisms already built into government

Figure 2.6. Fiscal Multipliers

Fiscal multipliers are larger during periods of slack and when monetary policy supports fiscal stimulus—exactly the conditions that would apply were a downturn to occur when policy rates are so low.



Sources: Bank for International Settlements; Haver Analytics; Ilzetzki, Reinhart, and Rogoff (2019); IMF, *International Financial Statistics*; national sources; Organisation for Economic Co-operation and Development Economic Outlook; and IMF staff calculations.
Note: Panel 1 shows the response of real output over time to a unit public spending shock in year $t = 0$. The public spending shock is equivalent to a 1 percent of GDP increase in public consumption. Shaded area denotes the 90 percent confidence band. In panels 2 and 3, blue dots show the point estimates for the one-year multiplier under the indicated economic conditions (alternative slack or monetary conditions). The black whiskers show the 90 percent confidence interval around the estimate. The effective lower bound is considered to be binding when short-term policy rates are below 0.75 percentage points. Below- and above-mean employment are defined by country relative to their own experience. See Online Annex 2.3 for further details on the definitions of the economic conditions and on the model specification and estimation. ELB = effective lower bound on interest rates; GFC = global financial crisis.

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[38]There is a large degree of overlap between the sample defined by the effective lower bound and that by the period since the global financial crisis. Among advanced economies, only Japan and the United States had extremely low rates before 2008 (Miyamoto, Nguyen, and Sergeyev 2018; Ramey and Zubairy 2018).

[39]For a prominent, early example of this argument, see Friedman (1948).

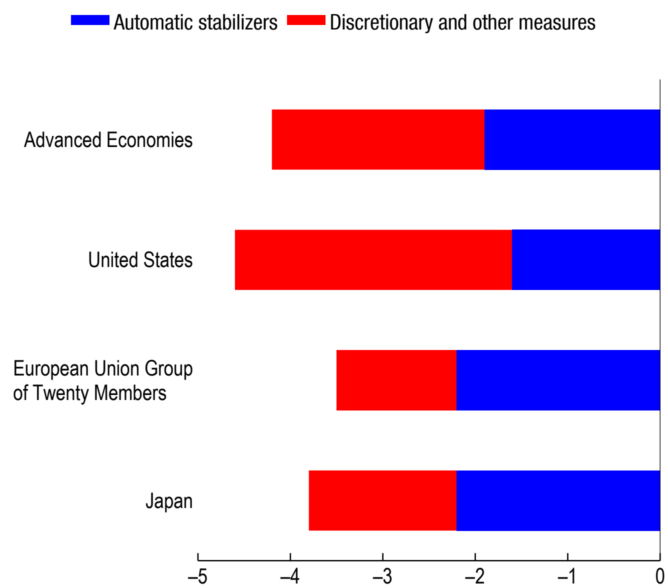
[40]See IMF (2013) for a breakdown of the lags for Group of Twenty countries.

budgets that increase spending or decrease taxes automatically when the economy slows and then reverse when it turns around.[41] Because they do not require political action before being activated, established automatic stabilizers can respond swiftly to shocks and help stabilize the economy. The temporary and predictable nature of their stimulus also makes them appealing, enabling households and firms to incorporate them into their planning.

How much countries rely on discretionary measures versus automatic stabilizers varies widely, and using one does not preclude use of the other. The response to the global financial crisis involved a mix (Figure 2.7). Macroeconomic stabilization, though, has typically not been the primary aim in the design of traditional automatic stabilizers, which are more focused on social protection goals or equity considerations.[42] Recent proposals for new kinds of automatic stabilizers attempt to address stabilization objectives directly, explicitly linking the automatic activation of spending and tax measures to the state of the economy through a macroeconomic trigger, such as a rise in the unemployment rate.[43] The effectiveness and associated fiscal costs of rules-based fiscal stimulus to respond to a downturn are explored in the next section.

Figure 2.7. Average Overall Fiscal Balance Change from 2007 to 2008–10
(Percent of GDP)

The response to the global financial crisis involved a mix of automatic stabilizers and discretionary fiscal responses, but the latter took a while to be adopted and implemented.



Source: IMF (2009).
Note: Other measures include noncrisis related spending or revenue measures (such as changes in defense spending), as well as the impact of nondiscretionary effects on revenues beyond the normal cycle.

Enhancing Stabilization with Rules-Based Fiscal Stimulus

To explore and evaluate the performance of rules-based fiscal stimulus, the chapter uses the IMF's workhorse G20MOD model calibrated for a representative advanced economy, adapted to allow for the possibility that the economy is at the effective lower bound of interest rates for a prolonged time, which is highly relevant to today's circumstances.[44] The model abstracts from

41See Chapter 1 of the April 2020 *Fiscal Monitor* for a detailed discussion of traditional automatic stabilizers across countries and ways to strengthen their stabilizing properties.

42See Baunsgaard and Symansky (2009).

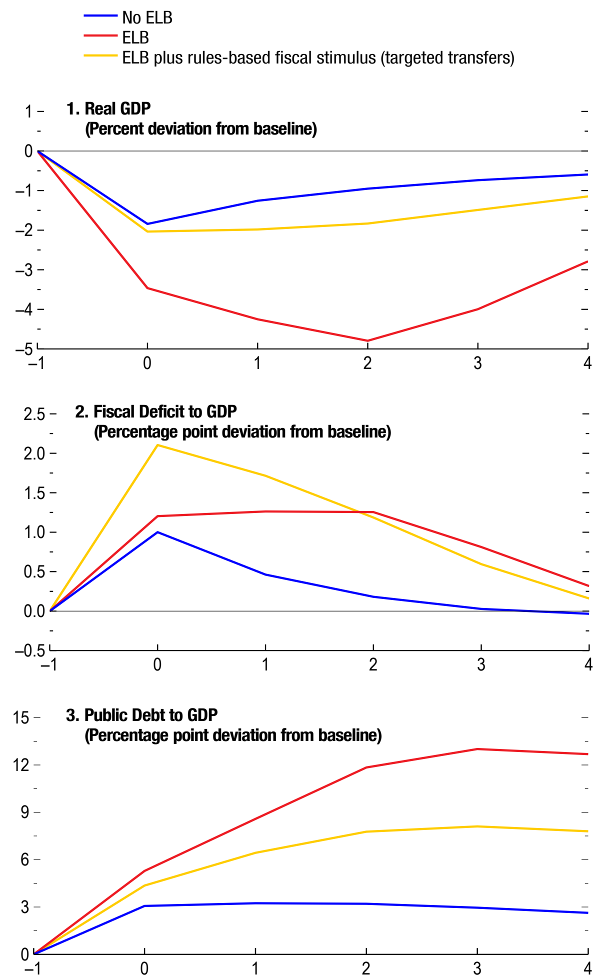
43For example, Sahm (2019) proposes direct payments to individuals as an automatic stabilizer at the onset of a recession. Eichenbaum (2019) argues for setting up a more general system of asymmetric, automatic stabilizers based on selected macroeconomic indicators hitting pre-specified targets. Blanchard and Summers (2020) advocate such stabilizing fiscal policies, describing them as semiautomatic stabilizers.

44See Online Annex 2.4, Andrle and others (2015a), and Andrle and Hunt (forthcoming) for more details about the model structure, how it incorporates more realistic nonlinearities into the simulations, and its calibration.

sovereign risk concerns, focusing firmly on how policies can facilitate business cycle stabilization. The rules-based fiscal stimulus provides stimulus in response to rises in the unemployment rate above its natural level, which then unwinds as the rate comes down over time.[45] For the illustration here, it is roughly calibrated to the benchmark rule proposed by Sahm (2019)—a half percentage point rise in the unemployment rate above its natural rate generates fiscal transfers targeted to liquidity-constrained (poorer) households equivalent to about 0.7 percent of GDP.[46] The model results suggest that a rules-based fiscal stimulus could be extremely powerful in countering a downturn, particularly when interest rates are stuck at the effective lower bound and monetary policy is constrained. Figure 2.8 compares the dynamic responses of a representative advanced economy to a typical negative aggregate demand shock under different types of monetary policy stance and fiscal policy reactions.

Figure 2.8. Responses of Economic Outcomes to a Negative Demand Shock

A rules-based fiscal stimulus could be extremely powerful in countering a downturn when interest rates are stuck at the effective lower bound and monetary policy is constrained. Debt-to-GDP dynamics are better with a rules-based fiscal stimulus than without when interest rates are at the effective lower bound. The prudent action at the effective lower bound is then to have a prompt and vigorous countercyclical fiscal response to a negative demand shock.



Source: IMF staff estimates.
Note: Targeted transfers go to liquidity-constrained households. See Online Annex 2.4 for further details on the model and analysis. *x*-axis represents number of years after shock. ELB = effective lower bound on interest rates.

If the economy is far from the effective lower bound on interest rates and monetary policy can operate fully, then real GDP follows the path of the blue line, dropping about 1.5 percent and then gradually converging to its trend path (Figure 2.8, panel 1). However, if the economy is at the effective lower bound, and monetary policy is unable to provide support on its own, then there is a large and persistent drop in GDP of almost 5 percent to such a shock (red line). In both cases, traditional automatic stabilizers are included and calibrated to their current sensitivity.[47] If the

[45]In other words, the stimulus measures are temporary, lasting only so long as the trigger is operating. For a detailed discussion of considerations in the selection of macroeconomic triggers, see Sahm (2019).

[46]See Online Annex 2.4 for further details on the design of the rules-based fiscal stimulus in the context of the model. In the model, liquidity-constrained households are unable to borrow and save, using all of their income for consumption (that is, they have a high marginal propensity to consume). Consequently, income transfers to them have more powerful expansionary effects on aggregate demand than those to households who might opt to save the additional income.

[47]The cyclical sensitivity of traditional automatic stabilizers is taken from Girouard and André (2005) and Price, Dang and Botev (2015). See Online Annex 2.4 for further details.

rules-based fiscal stimulus were operating, the drop in real GDP at the effective lower bound from the adverse demand shock is markedly smaller and actually close to the case where the economy is away from the effective lower bound and monetary policy is able to respond fully (gold line).[48]

Importantly, this finding emerges without making any specific assumptions about fiscal multipliers. Instead, it arises as a natural consequence of the model structure and its deep parameters, calibrated to ensure consistency with empirical evidence on business cycle properties and microeconomic behavior. The implied fiscal multiplier from the model is about 1.2 when the economy is at the effective lower bound, while it is about 0.6 when the economy is away from the effective lower bound. Both parameter values are within the confidence bands of the empirical estimates described in the previous section. If anything, the implied fiscal multiplier from the model at the effective lower bound is conservative.

Nonetheless, the stabilization achieved by the rules-based fiscal stimulus does not come for free (Figure 2.8, panels 2 and 3). The smallest rises in the fiscal deficit-to-GDP and public debt-to-GDP ratios are achieved when the economy is away from the effective lower bound and monetary policy reacts to offset the negative shock (blue line). Yet, the difference in the responses at the effective lower bound between the cases with and without the rules-based fiscal stimulus operating is stark (gold and red lines). The deficit-to-GDP ratio at the effective lower bound rises more with a rules-based fiscal stimulus than without, reflecting the immediate increase in spending from the rules-based measures over and above that from the usual automatic stabilizers. This additional stimulus, though, improves the real GDP and price level paths such that the path of the debt-to-GDP ratio is lower than it would be without the stimulus.[49] In other words, fiscal costs as a share of output are lower if the economy has measures in place for a rules-based fiscal stimulus than if it does not when interest rates are at the effective lower bound. A prompt and large countercyclical fiscal response to a negative demand shock at the effective lower bound puts the debt-to-GDP ratio on a lower path than if it were not undertaken.

Moreover, the implementation of rules-based fiscal stimulus when the effective lower bound is binding also reduces the likelihood of recessions compared to not having it in place. Taking the historical experience of demand shocks, the chapter builds up the distribution of GDP growth under alternative automatic stabilizers to evaluate how they might impact the likelihood of a recession in a representative economy. The blue distribution (Figure 2.9, panel 1) shows the benchmark case, where the economy is away from the effective lower bound and monetary policymakers are able to respond fully. In this case, the probability of recession is about 10 percent (Figure 2.9, panel 2). When the effective lower bound binds periodically though—as shown by the red distribution—there is a large left tail skew, representing greater chances of

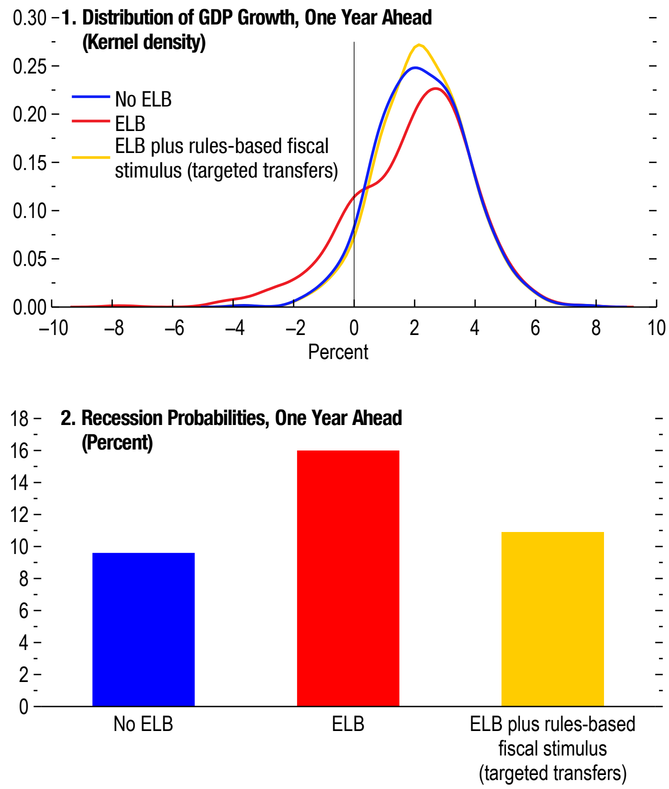
[48]Increasing the sensitivity of existing automatic stabilizers alone does improve stabilization, but not to the same degree. See Online Annex 2.4 for a comparison of scenarios. See also Chapter 1 of the April 2020 *Fiscal Monitor* on ways to enhance the functioning of existing automatic stabilizers.

[49]Note that the rules-based fiscal stimulus helps stabilize real output, which also helps avoid a significant decline in inflation from an adverse shock. Together, the improved paths of real output and the price level contribute to more favorable dynamics of the debt-to-GDP ratio (given that nominal GDP is higher). See Online Annex 2.4 for further details.

negative growth. The probability of a recession in this case rises by over a half to about 16 percent. However, if the economy had rules-based fiscal stimulus measures in place (the gold distribution), the distribution of GDP growth is much closer to that when the economy does not hit the effective lower bound—the left tail shrinks and the probability of a recession drops to about 11 percent, almost at that of the benchmark case.

Figure 2.9. Recession Likelihoods under Alternative Cyclical Policy Tools

When the effective lower bound binds regularly, an economy with a rules-based fiscal stimulus has a lower likelihood of recessions compared to that without.



Source: IMF staff estimates.
Note: Targeted transfers go to liquidity-constrained households. Stochastic simulations are used to generate the distribution of output under the indicated scenario. The simulations draw from demand shock distributions centered at the baseline growth projection. Panel 1 takes demand shocks from the normal distribution calibrated to the empirical variance of the shocks. Panel 2 takes demand shocks from the empirical distribution. A recession is defined as a year with negative annual growth. See Online Annex 2.4 for further details on the stochastic simulation methods employed. ELB = effective lower bound on interest rates.

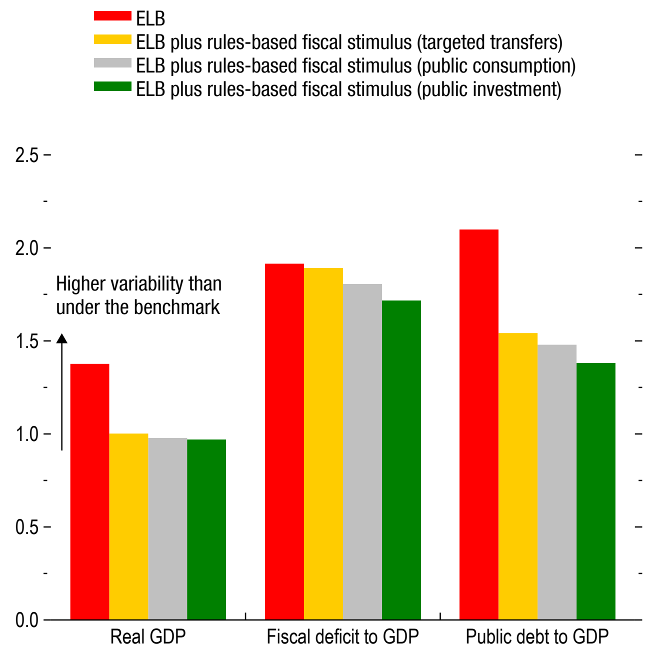
The rules-based fiscal stimulus examined so far increases public spending through targeted transfers to liquidity-constrained households. However, alternative instruments could be considered. Consistent with the empirical evidence on fiscal multipliers, it appears that a rules-based stimulus using public investment could lead to lower variabilities of real GDP, public debt, and deficits than that using targeted transfers (Figure 2.10). Similarly, public consumption as the spending instrument also performs better than targeted transfers, but less well than public investment. It is important to note that public investment spending in the model is shovel-ready, efficiently delivered, and raises potential output—requirements that may be difficult to fulfill in practice. In general, though, economic fluctuations are always lower with rules-based fiscal stimulus measures in place—regardless of the spending instrument—than without.

When it comes to the practical implementation of enhancements to automatic stabilizers in an economy, many specific design choices—which the chapter has abstracted from—will matter:

- The macroeconomic trigger for the rules-based fiscal stimulus in the model simulations is based on deviations from the natural rate of unemployment, which can be difficult to measure in real-time. Sahm (2019) advocates for the 12-month moving average of the unemployment rate for the United States, but which exact trigger (and its measurement) works best may well differ by economy.
- Identifying liquidity-constrained households to target for transfers—the public spending instrument considered as the baseline for the rule—may be tough to do. Instead, easier-to-observe income variables could be used to identify qualifying households. This could have the benefit of ameliorating any rises in inequality in recessions, which tend to hit the poor harder.[50]
- Alternative spending instruments for the rules-based fiscal stimulus could be considered, which could help governments achieve other goals while also stabilizing the economy. For example, if it were possible to establish a priority list of needed public investments, then those projects could be brought online more quickly in a downturn, boosting long-term prospects.[51]
- Measures to increase the cyclical sensitivity of traditional automatic stabilizers will also help. But they would need to take careful account of any disincentive effects they may entail, as described in Chapter 1 of the April 2020 *Fiscal Monitor*.
- In general, country-specific characteristics and circumstances should guide the design choices for any rules-based fiscal stimulus, including the macroeconomic trigger variables

Figure 2.10. Economic Fluctuations under Alternative Spending Instruments for Rules-Based Fiscal Stimulus
(Relative variability to the benchmark of unconstrained monetary policy)

Economic fluctuations are always lower with a rules-based fiscal stimulus—regardless of the spending instrument—than without when the effective lower bound binds regularly. Shovel-ready, useful public investment spending generates slightly lower variabilities of real GDP, public debt, and deficits than other instruments.



Source: IMF staff estimates.
Note: Relative variability is the ratio of the variance of the indicated variable to that under the benchmark scenario where the ELB does not bind regularly and monetary policy operates fully. Targeted transfers go to liquidity-constrained households. Stochastic simulations are used to generate the variability of output, the deficit, and debt under alternative rules-based fiscal stimulus instruments. See Online Annex 2.4 for further details on the model and stochastic simulation methods. ELB = effective lower bound on interest rates.

[50]See Boushey and others (2019) for evidence from the United States on how recessions disproportionately impact disadvantaged groups.

[51]See Chapter 1 of the April 2020 *Fiscal Monitor* for a discussion of how to improve the efficiency of public investment and formulate a pipeline of appraised projects. Such investments could be green, supporting governments' climate change mitigation and adaptation objectives. See OECD, UN, and WBG (2018) for a discussion of the economic transformation and associated investments required to address climate challenges.

(aligned with the business cycle) and instrument selection (based on country-specific needs and what delivers high multipliers).

Summary and Concluding Remarks

Since the 1980s, policy rates have gradually trended down and public debts up in advanced economies. The deep shocks of the global financial crisis and subsequent Great Recession called for concerted and unusually strong expansionary monetary and fiscal responses, exacerbating these trends. With average policy rates lower and public debts higher than they have been over the past 60 years, concerns about policymakers' ability to effectively respond to downturns have emerged.

Against this background, this chapter asked how policymakers can best prepare for and counter future recessions. Even though rates are close to zero in many advanced economies, unconventional or "new" monetary policy tools are available to central banks, which may be able to deliver further stimulus, if needed. However, there is unease in some quarters about their more intensive use, with concerns about their effectiveness going forward, side effects, and potential threats to central bank independence.

Attention then turned to how fiscal policy can best counter adverse shocks and ensure that there is not an excessive reliance on monetary policy for macroeconomic stabilization. While it is true that public debts are higher, the analysis suggests that greater abilities to service debt—as captured by the low or even negative interest rate–growth differentials—are improving countries' debt dynamics. Moreover, based on its past behavior, a low average –interest rate–growth differential seems likely to persist. That said, country-specific vulnerabilities to shifts in market sentiment remain important considerations in determining fiscal space and deciding how expansionary fiscal policy can be in response to a downturn.

The choice of fiscal instrument and the macroeconomic context influence the effectiveness of fiscal stimulus against adverse shocks. Findings from the literature and new analysis point to public spending—investment, consumption, or transfers targeted to liquidity-constrained households—as the most effective in stabilizing output. They also suggest that economic slack and interest rates near the effective lower bound make fiscal stimulus even more powerful, strengthening arguments for its use to counter future downturns where these conditions would exist.

Given historical delays in the implementation of discretionary fiscal stimulus, there is a case for enhancing traditional automatic stabilizers and adopting rules-based fiscal stimulus measures. A model-based analysis of a rules-based fiscal stimulus that automatically and temporarily increases public spending in response to rises in unemployment suggests that it could be a powerful stabilization tool, particularly when interest rates are at the effective lower bound and monetary policy is accommodative. Even though fiscal stimulus comes with a cost (deficits and debt rise), the rise in the public debt-to-GDP ratio is lower with a strong countercyclical fiscal response than it is without. In other words, the prudent action at the effective lower bound is to respond immediately and forcefully to an adverse shock with stimulus. Moreover, the likelihood of recessions when the economy is near the effective lower bound is lower when measures for a rules-based fiscal stimulus are in place. The stabilization achieved by rules-based fiscal stimulus comes close to that when monetary policy actions are unconstrained.

To ensure a timely and effective response to a recession and improve the economy's resilience, policymakers should consider enhancing existing automatic stabilizers and adopting rules-based fiscal stimulus measures. They are doubly important when the economy is operating close to the effective lower bound on interest rates and discretionary fiscal policy lags are long. Moreover, the high degree of synchronization of business cycles across advanced economies implies that a coordinated push to improve the responsiveness of fiscal policy to downturns would entail even greater gains.[52]

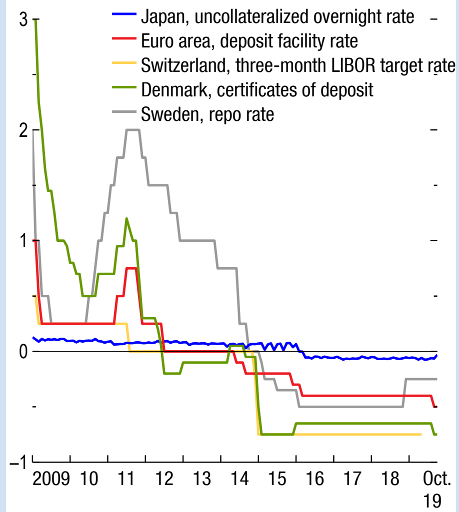
[52]See Online Annex 2.1 for evidence on the rise in synchronization of business cycles across advanced economies. See Gaspar, Obstfeld, and Sahay (2016) on how an internationally coordinated response to a common adverse shock is more beneficial.

Box 2.1. Can Negative Policy Rates Stimulate the Economy?

As conventional monetary policy has collided with the effective lower bound on policy rates since the global financial crisis, central banks in many advanced economies have expanded their toolkit to include asset purchases, forward guidance (public communication by the central bank about the likely future path of monetary policy and its objectives and intentions), and negative policy rates. This box illustrates recent experiences with negative interest rate policy in several advanced economies, focusing on banks.

Following Denmark in 2012, a number of other countries, as well as the European Central Bank, introduced negative interest rates (Figure 2.1.1), while other countries continue to examine the possibility. Central banks have enforced negative interest rates through charging commercial banks for reserves they hold at the central bank, often at different rates across different levels of reserves.[1]

Figure 2.1.1. Monetary Policy Rates
(Percent)



Sources: National central banks; and Thomson Reuters Datastream.
Note: The data shown are at monthly frequency. The line for Switzerland is missing from June 2019 onwards, reflecting its switch from the three-month LIBOR rate to a new policy rate as its target. LIBOR = London Inter-bank Offered Rate.

In principle, the effects of cutting interest rates below zero are similar to conventional policy cuts when the interest rate is above zero. Responding to the cost change, individual banks will reduce their excess reserves by increasing lending and purchasing other financial assets. In this way, the policy seeks to reduce lending rates to the broader economy, increase credit supply, boost prices across financial markets and, thus, stimulate aggregate demand by raising corporate profits and reducing corporate delinquency and default rates. By allowing interest rates to become negative, central banks have greater room to be expansionary.[2]

However, monetary policy easing close to the effective lower bound may have both positive and negative effects, making monetary policy transmission more complex. The introduction of negative rates in the euro area signaled to the market that policy rates could go below zero, and the European Central Bank was able to lower and flatten the yield curve.[3] This policy change created a wedge between safer, more liquid and riskier, less liquid assets, and incentivized banks to rebalance their portfolio from liquid assets to corporate lending, with sizable positive real effects on firms.[4]

The author of this box is Andrea Presbitero.

[1]See Agarwal and Kimball (2019) for a discussion of how to implement negative rates, including tiering.

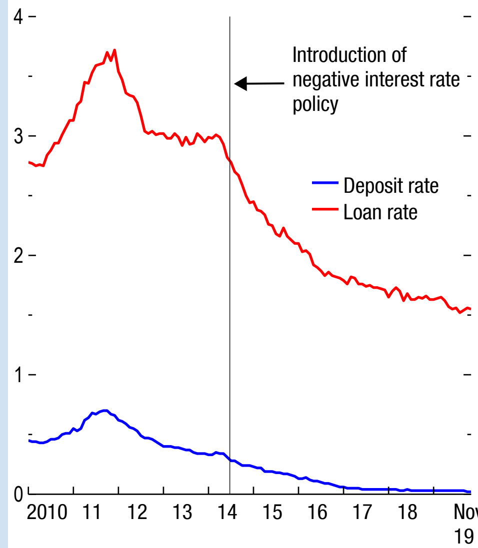
[2]See Rogoff (2017).

[3]See Rostagno and others (2019).

[4]See Ruge-Murcia (2006) and Bottero and others (2019) for more details and evidence on this mechanism.

At the same time, banks are often reluctant to pass negative rates on to depositors, who could opt to simply withdraw and hold their funds in cash. Given that deposit rates are stuck at zero, banks can experience a compression of interest margins if loan rates decline (Figure 2.1.2), which could reduce profitability.[5] Because of this negative net worth effect, banks might choose to reduce the supply of credit and take on more risk.[6] Accordingly, the loss of bank profitability from a decline in the spread between lending and deposit rates could weaken the transmission of monetary policy stimulus through the banking system and potentially have an adverse effect on aggregate output.[7]

Figure 2.1.2. Loan and Deposit Rates to Nonfinancial Corporations in the Euro Area
(Percent)



Source: European Central Bank Statistical Data Warehouse.
Note: The deposit rate is the overnight rate for nonfinancial corporations. The loan rate is the cost of borrowing for nonfinancial corporations, defined as the interest rate on all business loans, including revolving loans and overdrafts.

The portfolio rebalancing and net worth channels are not mutually exclusive and their relative importance—and therefore, the overall effect of negative rates on the economy—is likely to differ depending on: (1) local credit market conditions, such as banks' reliance on deposit funding and short-term liquid assets, which measure the banks' exposures to the two channels; and (2) banks' market power, which may affect their ability to pass negative rates on to depositors and their capacity to compensate the decline in net interest margin by charging higher fees for services. Moreover, higher asset prices and stronger aggregate demand from more expansionary monetary policy could raise banks' profitability through lower loan loss provisions and higher capital gains.

While recent studies lack compelling evidence that bank profitability has been severely curtailed by mildly negative policy rates, this might change if rates were to become deeply negative or stay mildly negative for longer periods. Most of the offsetting forces to a decline in profitability due to a compression of interest margins, such as capital gains, may not persist, so that margin compression might dominate in the medium term, making the net worth channel more prominent with adverse effects on banks' profitability and lending capacity. Finally, if negative rates were to last a prolonged period of time, the cumulative effects of increased risk-taking by the financial and corporate sectors could undermine financial stability.[8]

[5]However, there might be exceptions. There is evidence that at least some euro area banks have been able to pass negative rates on to depositors (Altavilla and others 2019). Second, the contractionary effect of negative rates depends on a reduction of bank profitability. See Lopez, Rose, and Spiegel (2020) and Rostagno and others (2019), among others, and also Chapter 2 of the April 2020 *Global Financial Stability Report* for a discussion of the consequences of low rates more generally on bank profitability.

[6]See Heider, Saidi, and Schepens (2019).

[7]See Brunnermeier and Koby (2019); Eggertsson, Juelsrud, Summers, and Wold (2019); and Wang and others (2019).

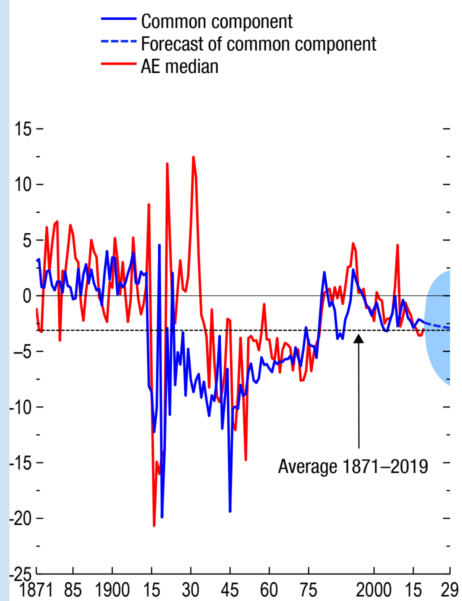
[8]See Committee on the Global Financial System (2018).

Box 2.2. The Persistence and Drivers of the Common Component of Interest Rate–Growth Differentials in Advanced Economies

As highlighted in the main text, unanticipated lower interest rates and higher growth rates in recent years have tempered the rise of debt-to GDP ratios for many advanced economies. As countries' debts are repaid over many years, the persistence of the interest rate–growth differential ($r - g$) is also a key determinant of the scope for fiscal support in a future downturn. The more persistent are declines in $r - g$, the larger the debt savings over the longer term, holding future primary deficits unchanged. If declines are temporary, with $r - g$ likely to revert toward higher levels, any additional room for borrowing could be much smaller (again, all else equal). This box examines the evolution of the interest rate–growth differential over time and how it might shed light on the likely persistence of this differential in the future.

Figure 2.2.1. Common Component of Interest Rate–Growth Differentials

(Percentage points)



Sources: Bank for International Settlements; Haver Analytics; IMF, *International Financial Statistics*; Jordà and others (2019); national sources; and IMF staff estimates.
Note: The sample includes 15 advanced economies. Blue shaded shows 95 percent confidence interval of forecast. The forecast is estimated from a set of candidate autoregressive moving-average model with lags determined by the Akaike information criterion, which selects an AR(1) model. Confidence intervals are computed using post-1950 data. Expected inflation and growth computed as a smoothed average within distinct monetary eras: 1871–1913, 1914–18, 1919–38, 1939–45, 1946–71, 1972–90, 1991–2007, 2008–19. See Online Annex 2.2 for further details on the analysis. AE = advanced economy.

A cross-country, long time series analysis of the interest rate–growth differential for a selection of advanced economies since 1871 suggests that the bulk of its variability is country-specific or transitory.[1] However, a common and highly persistent component accounts for about 20 percent of the overall variation (Figure 2.2.1). This component is more important than this figure might suggest, as it captures all the non-transitory variation which is common across countries and is thus the critical component for understanding international trends in $r - g$.[2] A simple time series statistical model used to forecast this common component suggests that it is expected to remain broadly at current levels for the foreseeable future, with approximately an 85 percent chance that this differential is negative ten years from now. In other words, low and negative $r - g$ looks more like a return to normal than an aberration.

The author of this box is Philip Barrett.

[1]The nominal interest rate used in this exercise is the short-term policy rate, as it excludes factors such as risk- and term-premia which are themselves endogenous to other fiscal variables.

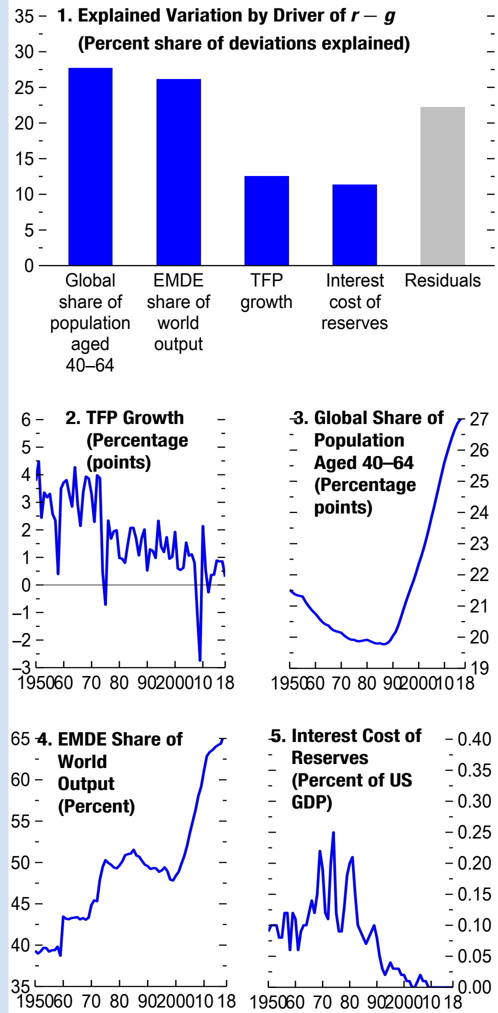
[2]Specifically, country fixed effects (capturing country-specific, time-invariant factors) and expectational errors in growth and inflation (which are purely transitory and unpredictable components) explain about 60 percent of the overall deviations in $r - g$ across countries and time. See Online Annex 2.2 for more details on the specification of the panel data model.

Complementing the simple statistical analysis of the common component of $r - g$, a regression analysis can help identify its deep drivers and allow an assessment of their likely persistence. Key factors highlighted in the literature include:[3]

- a persistent decline in global productivity (as captured by global total factor productivity growth), affecting both r and g;
- global population aging (as captured by the increasing share of the global population that is 40–64 years old) may affect both r and g through higher saving rates and potentially ambiguous effects on growth;[4]
- the rise of emerging market and developing economies (as captured by their share of world output), which have higher desired saving rates and a proclivity to save overseas; and
- financial repression that keeps interest rates low through regulations on financial market participants (as proxied by the opportunity cost of unremunerated reserve requirements in the United States as a share of GDP).[5]

A regression analysis of the common component of $r - g$ since 1950 suggests that all these drivers are significant. However, the most important are the increase in the share of global population aged 40–64 years old and the rise of emerging market and developing economies in the global economy (Figure 2.2.2, panel 1). Since 1950 these two variables have steadily trended upward, in line with the long-run behavior of $r - g$. In contrast, global total factor productivity growth and the

Figure 2.2.2. Drivers of the Common Component of Interest Rate–Growth Differentials



Sources: Federal Reserve; Maddison Project; United Nations; and IMF staff calculations.
Note: Panel 1 bars show the share of absolute variation in the common component of $r - g$ which is explained by the candidate drivers (panels 2–5) from a linear regression. See Online Annex 2.2 for further details on the data and analysis. EMDE = emerging market and developing economy; $r - g$ = interest rate-growth differential; TFP = total factor productivity.

[3]See Andrade and others (2018), among others.

[4]The relationship between interest rates and population aging reflects life cycle considerations, with increased saving expected to occur just prior to retirement (Bloom, Canning, and Graham 2003). The debate on the relationship between growth and population aging remains unsettled, with some arguing that it will lower growth through lower labor force participation and technological change (Gordon 2016) while others argue that it raises growth through increased uptake of automation and other productivity-enhancing technologies (Acemoglu and Restrepo 2017).

[5]Required reserves are legally mandated reserve holdings of US banks at the Federal Reserve. The opportunity cost of required reserves is the interest saving that the US public sector gains from this requirement. Before 2009, banks received no interest on these reserves, which are unavailable for lending. Since 2009, the Federal Reserve has paid interest on required reserves, eliminating this interest saving for the United States. To the extent that the US banking system provides a backstop for global finance, unremunerated reserve requirements may be thought of as a tax on safe assets worldwide. See Online Annex 2.2 for details on how this measure correlates closely with that from Abiad, Detragiache, and Tressel (2010).

opportunity cost of required reserves in the United States have been more variable (Figure 2.2.2, panel 2–5).

Future movements in these variables could influence $r - g$ beyond the ways captured in the statistical forecasting model. For example, growth in the global population share of the middle-aged has slowed sharply in the last decade. In future, this share is expected to remain broadly constant at current levels. If past relationships continue to hold, then this will likely ease the downward pressure on interest rate–growth differentials as demand for savings declines. Similarly, the share of emerging market and developing economies is unlikely to continue to grow as sharply as in recent years.

Although the impact of small changes in the interest rate–growth differential may eventually be large, a meaningful impact may take several years to materialize, simply because countries take many years to repay their debts. As a result, other factors may matter more in the near term. For instance, sudden increases in risk premia—even if temporary—can cause public debt to GDP to grow sharply. This could include unanticipated negative events that prompt shifts in investor sentiment towards safe-haven assets, which in turn can push up spreads unexpectedly for some countries.

Overall, the risk-free interest rate–growth differential serves as a useful baseline for the likely future path of public debt-to-GDP ratios. The evidence presented in this box suggests that low differentials are more likely a return to long-term normality than a rare event. Yet this finding is potentially sensitive to changing long-term factors, including demographic pressures and the composition of the global economy, as well as short-term risks to spreads.

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CHAPTER 2 COUNTERING FUTURE RECESSIONS IN ADVANCED ECONOMIES: CYCLICAL POLICIES IN AN ERA OF LOW RATES AND HIGH DEBT

Online Annex

Annex 2.1 Data Sources, Sample Coverage, and Variable Definitions

Data sources used in the chapter are listed in Annex Table 2.1.1. In general, the sample is the group of advanced economies as defined by the *World Economic Outlook* (WEO), for a total of 36 economies. The exact samples used varies with the analyses and exercises based on the time coverage and data available. See Annex Table 2.1.2 for the economies included, time coverage, and the analytical and statistical samples where they appear.

Data from the WEO database are extended backwards for key indicators using several sources as possible. The following indicators are extended backwards using their respective additional sources listed in Annex Table 2.1.1: gross public debt; nominal GDP; real GDP; short-term government interest rate; and long-term government interest rate. Construction of long-run historical data for short-term monetary policy rate varies by country, with the vast majority of countries' data coming from national sources.

Forecast errors are utilized in several analytical exercises—the analyses of contributions to the interest rate–growth differential ($r - g$) and debt dynamics (see Annex 2.2 for details) as well as in the analysis of fiscal multipliers (see Annex 2.3 for details). Forecast errors used in the analyses of contributions to $r - g$ and debt dynamics are calculated using forecasted annual data from World Economic Outlook database vintages beginning in 1990. Forecast errors used in the analysis of fiscal multipliers are calculated using forecasted annual data from OECD Economic Outlook database vintages beginning in 1985.

Annex Table 2.1.1. Data Sources

Indicator	Source(s)
Short-term policy rate	Bank for International Settlements; Global Data Scource; Haver; International Financial Statistics; and national sources.
Primary fiscal balance to GDP	Mauro and others (2015); and World Bank.
Gross public debt to GDP	Jordà and others (2019); Mauro and others (2015); IMF Historical Public Debt Database; and World Economic Outlook database.
Central bank assets to GDP	European Central Bank; Haver; and Ferguson and others (2015).
Nominal GDP	Jordà and others (2019); and World Economic Outlook database.
Real GDP	Mauro and others (2015); Global Data Source; Maddison Project database; and World Economic Outlook database.
Short-term government interest rate	Global Data Source; Jordà and others (2019); Organisation for Economic Co-operation and Development; and World Economic Outlook database.
Long-term government interest rate	Global Data Source; Jordà and others (2019); Organisation for Economic Co-operation and Development; and World Economic Outlook database.
Primary deficit	World Economic Outlook database.
Population by age	United Nations.
Interest cost of reserves	Federal Reserve.
Long-run total factor productivity	Bergeaud, Cette, and Lecat (2016).
Real public consumption	OECD Economic Outlook database.
Exchange rate classification (flex vs. fixed)	Ilzetzki, Reinhart, and Rogoff (2019).
Systemic banking crisis classification	Laeven and Valencia (2018).

Source: IMF staff compilation.

Annex Table 2.1.2. Sample of Economies Included in Analytical Exercises

Economies	Years	Exercise[1] I	II	III	IV
Australia; Austria; Belgium; Canada; Denmark; Finland; France; Germany; Greece; Iceland; Ireland; Italy; Japan; Luxembourg; Netherlands; New Zealand; Norway; Portugal; Spain; Sweden; Switzerland; United Kingdom; United States.	1960–90	X			
Australia; Austria; Belgium; Canada; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Iceland; Ireland; Israel; Italy; Japan; Korea; Latvia; Lithuania; Luxembourg; Malta; Netherlands; New Zealand; Norway; Portugal; Singapore; Slovak Republic; Slovenia; Spain; Sweden; Switzerland; Taiwan Provice of China; United Kingdom; United States.	1991–2018	X			
Australia; Austria; Belgium; Canada; Cyprus; Czech Republic; Denmark; Finland; France; Germany; Greece; Iceland; Ireland; Israel; Italy; Japan; Korea; Luxembourg; Malta; Netherlands; New Zealand; Norway; Portugal; Slovak Republic; Slovenia; Spain; Sweden; Switzerland; United Kingdom; United States.	2016–19		X		
Australia; Austria; Belgium; Canada; Czech Republic; Denmark; Finland; France; Germany; Ireland; Italy; Japan; Korea; Netherlands; New Zealand; Norway; Portugal; Slovak Republic; Spain; Sweden; Switzerland; United Kingdom; United States.	1985–2018			X	
Belgium; Denmark; Finland; France; Germany; Italy; Japan; Netherlands; Norway; Portugal; Spain; Sweden; Switzerland; United Kingdom; United States.	1871–2019				X

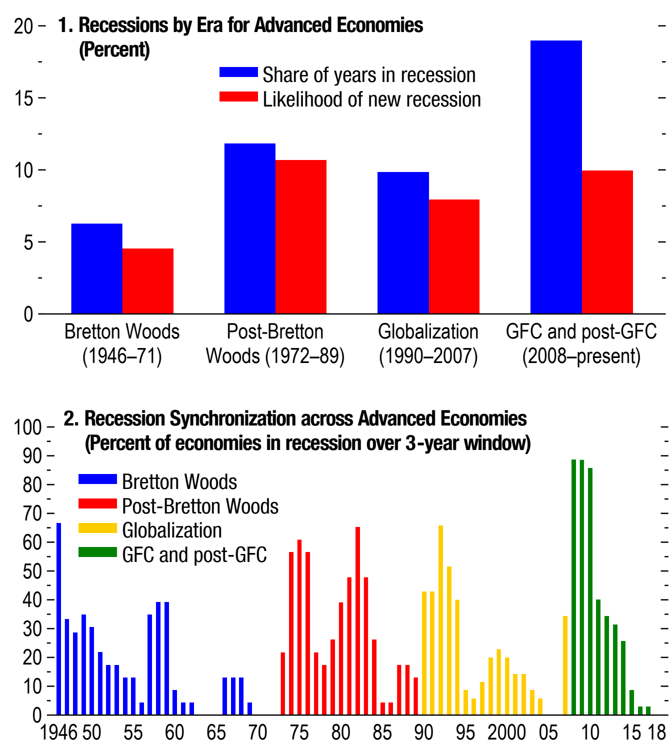
Source: IMF staff compilation.

[1]Analytical exercises performed in the chapter. I = monetary and fiscal policy trends (Figures 2.1–2.3); II = public debt decomposition (Figures 2.4); III = fiscal multipliers (Figures 2.5 and 2.6); and IV = persistence and drivers of $r - g$ (Figures 2.2.1 and 2.2.2).

Additional Stylized Facts

Figure 2.1.1, panel 1 exhibits how recessions since 2008 have become longer and the likelihood of a recession has risen compared to the 1990s and early 2000s. Figure 2.1.1, panel 2 shows how the degree of synchronization of recessions across advanced economies has increased on average in the current era compared to earlier periods.

Annex Figure 2.1.1. Recessions in Advanced Economies

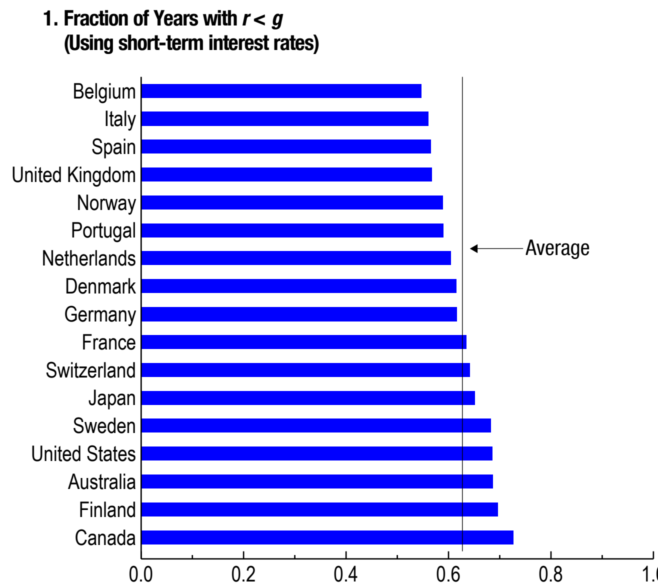


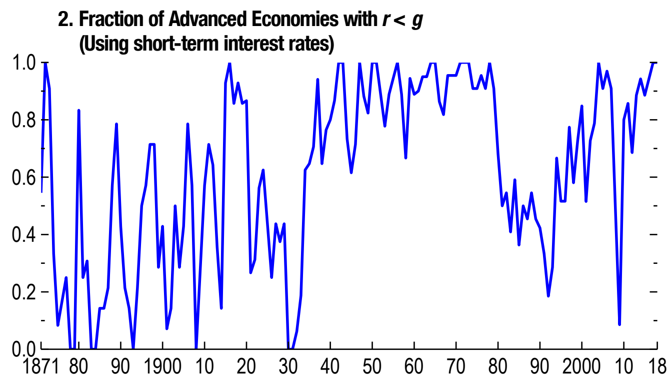
Sources: Maddison Project; Mauro and others (2015); and IMF staff calculations.
Note: Recessions are defined to be years with negative output growth. The percent of advanced economies in a recession at a point in time t is calculated as the number of advanced economies in a recession in either years (t–1), t, or (t+1), divided by the total number of advanced economies. GFC = global financial crisis.

Annex 2.2. Interest Rate-Growth Differentials, Primary Deficits, and Contributions to Debt Dynamics

This section of the annex provides additional details on the backward-looking analysis of how unanticipated developments in countries' interest rates, nominal growth, and primary deficits affected the evolution of debt. It also presents more background information on interest rate–growth differentials ($r - g$) and the related analyses on the persistence of $r - g$ featured in Box 2.2. First, it provides some stylized facts about the evolution of the interest rate–growth differential over the long run, using a sample of 17 advanced economies and covering the period between 1871 and 2018. The following subsection outlines a framework for assessing the relationship between unanticipated changes in debt-to-GDP and unanticipated changes in key fiscal variables relative to expectations from a past date. This framework is used to generate Figure 2.4 in the main text. The subsequent subsection describes an alternative framework to conduct a purely backwards-looking accounting decomposition of outturns. Then, the statistical model that forecasts the path of the interest rate–growth differential underlying Figure 2.5 is described. The next subsection provides the background to construct Figure 2.6 and explains how to identify and predict the common international component of interest rate–growth differentials, and to understand its drivers. A final section concludes with a forward-looking estimate of the potential impact on debt-to-GDP arising from a further unexpected decline in $r - g$, conditional on the maturity structure of new debt.

Annex Figure 2.2.1. $r - g$ in Advanced Economies





Sources: Bank for International Settlements; Haver Analytics; IMF, *International Financial Statistics*; Jordà and others (2019); national sources; and IMF staff calculations.
Note: Sample includes 17 advanced economies.

Some Stylized Facts on Interest Rate–Growth Differentials

Advanced economies in the sample experienced negative interest rate–growth differentials a majority of the time between 1871 to 2018 (Annex Figure 2.2.1). However, the median $r - g$ across these advanced economies at each point in time fluctuated markedly in periods prior to World War II (Annex Figure 2.2.2). Between World War II and throughout the 1970s, the median $r - g$ was negative, while through the 1980s it varied near zero. During the 1990s, the median $r - g$ was positive, but then declining, with the overall trend mostly negative, apart from a brief positive period around the Global Financial Crisis (GFC).

A Simple Government Budget Constraint

As a preliminary, to derive the simplified budget constraint, one starts with nominal debt and deficit, labeled B_t and D_t, respectively. The budget constraint under the simplified assumption that all debt has one-period maturity is given by:

$$B_t = D_t + B_{t-1}(1 + r_{t-1}).$$

r is the nominal interest rate on debt. Denoting nominal output by Y_t and the debt and deficit ratios (to GDP) by $b_t = B_t/Y_t$ and $d_t = D_t/Y_t$ respectively the budget constraint can be rewritten as:

$$b_t = d_t + b_{t-1}(1 + r_{t-1}) \times \left(\frac{Y_{t-1}}{Y_t}\right)$$

And thus:

$$b_t = d_t + b_{t-1}\left(\frac{1+r_{t-1}}{1+g_t}\right),$$

where nominal growth is given by $g_t = Y_t/Y_{t-1} - 1$. Using a first order Taylor approximation, the gross interest rate–growth ratio is approximately the net difference:

$$\left(\frac{1+r_{t-1}}{1+g_t}\right) \approx 1 + r_{t-1} - g_t.$$

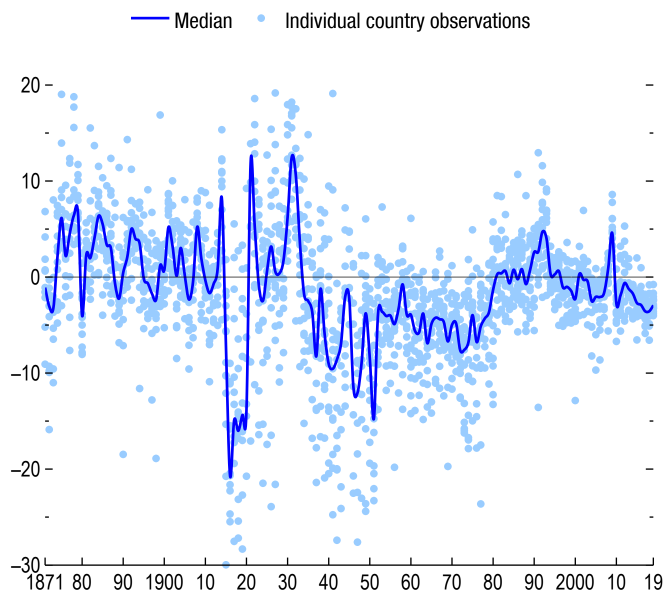
Substituting in and rearranging yields a simplified version of the government's budget constraint:

$$b_t - b_{t-1} = d_t + (r_{t-1} - g_t)b_{t-1}.$$

The importance of the interest rate–growth differential can be seen from this last equation. equation. It says that the change in the government's debt-to-GDP ratio b from period $t - 1$ to t is equal to the primary deficit d (current government spending minus current income, excluding interest payments, relative to GDP) in period t plus the difference between the nominal interest rate r at time $(t - 1)$ and nominal GDP growth g at time t, quantity times

Annex Figure 2.2.2. Interest Rate–Growth Differentials in Advanced Economies

(Percentage points)



Sources: Jordà and others (2019); Organisation for Economic Co-operation and Development; and IMF staff calculations.
Note: The sample includes 35 advanced economies. Time coverage is unbalanced across countries.

outstanding ($t-1$) debt to GDP.[1] As the interest rate–growth differential falls, the change in the debt-to-GDP ratio also comes down, all else equal.

Thus, this simplified version of the budget constraint illustrates that it is the difference between the nominal interest rate and nominal growth, known as the interest rate–growth differential or $r-g$ that is essential to understand public debt dynamics. Changes in interest rates affect the numerator of the debt-to-GDP ratio, while changes in nominal growth rates impact the denominator.[2]

A Framework for Decomposing Unanticipated Debt Changes into Unanticipated Changes in Fiscal Indicators

Next follows an outline of a framework which can trace through the impact of unanticipated changes to interest, growth, and primary deficits to the unanticipated change debt levels relative to past expectations. This is also built around a government budget constraint, but extends the simple case outlined in the preceding section.

Notation

Growth: Annualized nominal log output growth between periods t and $t+j$ is denoted by g_t^j. That is:

$$g_t^j = \frac{1}{j}(\log Y_{t+j} - \log Y_t)$$

Interest rates: The one-period policy rate at the central bank is denoted by r_t^{rf} (the risk-free rate). The government debt yield curve at time t is represented by $\{r_t^j\}_{j\geq 1}$, where j is the maturity of debt and r_t^j is the log yield on maturity j debt. That is, the government can sell a zero-coupon bond of maturity j for price $e^{-jr_t^j}$.

Term, risk and other premia may potentially drive the yield curve away from the expected future sequence of short rates. The bond premium at horizon j is therefore given by:

$$\tau_t^j = r_t^j - \frac{1}{j}\sum_{k=0}^{j-1} E_t r_{t+k}^{rf},$$

where E_t is the expectation operator conditional on information at time t.

Debt Structure

It is assumed that the government issues only long-term debt with exponentially decaying coupons (see Hatchondo and Martinez 2009). This means that for each unit of debt outstanding, the government pays a coupon c and makes a principal repayment λ. The remaining quantity of outstanding debt is then $1-\lambda$. Thus, a unit of debt issued in period t will

[1] In practice, the selection of the nominal interest rate in the analysis of debt dynamics will depend on the research question. For example, whether the average effective rate on outstanding debt or the yield to maturity on newly issued debt is appropriate depends on how payments are attributed to interest and principal. A further discussion of these choices and what is used in the subsequent exercises is provided further below.

[2] Nominal growth may also affect debt dynamics through its impact on the government's borrowing needs in a period. For example, tax revenues could rise with higher growth and incomes, reducing the primary deficit.

yield a stream of payments $(c+\lambda)$, $(1-\lambda)(c+\lambda)$, $(1-\lambda)^2(c+\lambda)$, and so forth in subsequent periods.

The price of the bond is therefore the price of this stream of future claims, priced from the yield curve:

$$q_t = (c+\lambda)\sum_{j=1}^{\infty}(1-\lambda)^j e^{-jr_t^j}.$$

The yield-to-maturity, $\bar{r}_t$, is the constant yield which prices the bond:

$$q_t = (c+\lambda)\sum_{j=1}^{\infty}(1-\lambda)^j e^{-j\bar{r}_t}$$
$$= \frac{c+\lambda}{e^{\bar{r}_t}-(1-\lambda)}.$$

These equations can be inverted to get an explicit formula for the yield-to-maturity:

$$\bar{r}_t = \log\left(1-\lambda+\frac{1}{\sum_{j=1}^{\infty}(1-\lambda)^j e^{-j\bar{r}_t}}\right). \qquad (1)$$

Government Budget Constraint

The government issues new debt to cover its gross financing needs–the primary deficit plus coupon payments and amortizing debts. Total outstanding debt is the sum of non-maturing debt plus new debt issuance. Let b_t denote the debt-to-GDP ratio at the start of period *t* and s_t be the primary surplus ratio during period *t*. Then the debt-to-GDP ratio evolves according to:

$$b_{t+1} = (1-\lambda)b_t e^{-g_t^1} + \frac{1}{q_t}\big((c+\lambda)b_t - s_t\big)e^{-g_t^1}.$$

Substituting in for prices, ones gets the following:

$$b_{t+1} = (b_t - \theta_t s_t)e^{\bar{r}_t - g_t^1},$$

where

$$\theta_t = \left(\frac{1-(1-\lambda)e^{\bar{r}_t}}{c+\lambda}\right).$$

This is approximately one (to first order) if:

$$c = (1-\lambda)\bar{r}_t.$$

Sample and Data for Backward and Forward Decomposition Exercises

The underlying data for the illustration depicted in the chapter comes from the IMF October 2015 WEO forecasts for 30 advanced economies for 2016–18. This vintage is selected since the projections from then incorporate the expected effects of the large-scale asset purchase programs undertaken prior to that date in advanced economies (including the ECB's public sector purchase program). The 2018 end point is selected since that is when the latest final data on public debts and deficits are available. Each forecast vintage contains a contemporaneous measure of the ten-year government bond spread and the sequence of five-year forecasts of the policy rate. Assuming that these are valid measures for r_t^{10} and $E_t r_{t+k}^{rf}$ respectively (for $k=0,\ldots,5$), one can compute the ten-year bond spread from:

$$\tau_t^{10} = r_t^{10} - \frac{1}{10}\sum_{k=0}^{4} E_t r_{t+k}^{rf} - \frac{1}{2} E_t r_{t+5}^{rf}. \qquad (2)$$

This is equivalent to assuming that the five-year forward policy rate is an unbiased forecast of policy rates at the six- to ten-year horizon. Another assumption is that the term spread grows linearly with the yield curve horizon:

$$\tau_t^j = \frac{1}{j}\tau_t^{10}.$$

Robustness checks also use a variant where $\tau_t^j = \tau_t^{10}$ for all *j*.

These assumptions produce a full yield curve for government interest rates up to *j=10*. For *j>10,* the expectations hypothesis is supplemented in equation (2) with the assumption that the bond premium is constant. That is:

$$r_t^j = \frac{10}{j} r_t^{10} + \left(\frac{j-10}{j}\right)\left(E_t r_{t+5}^{rf} + \tau_t^{10}\right).$$

Using this yield curve, one can compute the yield-to-maturity $\bar{r}_t$ using equation (1) for any given maturity λ. As λ is the inverse of the Macaulay duration of the bond, it is set to $\lambda = 1/8$ to match the average debt maturity of countries in the sample.

The government budget constraint only holds for net debt (financial liabilities minus financial assets of the general government), hence, it needs to be modified to:

$$b_{t+1} = (b_t - \theta_t s_t)e^{\bar{r}_t - g_t^1} + \eta_t,$$

where η_t is the period-*t* stock-flow adjustment, which is computed as a residual from the data.

Backward-Looking Decomposition

For each country, three alternative histories are computed, based on the 2015 forecasts for primary surplus ratios, nominal growth rates and nominal interest rates. Let $\widetilde{s_t}$ be the 2015 WEO forecast for primary surplus ratios in a given country. Then one can compute an alternative history for the evolution of the debt ratio using:

$$\tilde{b}_{2015} = b_{2015}$$

$$\tilde{b}_{t+1} = \left(\widetilde{b_t} - \theta_t \widetilde{s_t}\right)e^{\bar{r}_t - g_t^1} + \eta_t.$$

Similarly, one can compute similar alternate histories for the debt stock under the assumptions that nominal growth and interest rates followed their 2015 forecasts. In the case of interest rates, this requires computing the yield curve and yield-to-maturity at each point in time. The cross-country distributions for the contributions of unanticipated changes in these components to the unanticipated change in the debt path are shown in Figure 2.4, panel 2.

Correlations underlying the changes in Public debt

As a supplement to Figure 2.4, Table 2.2.1 presents key moments of the cross-sectional distributions of components of changes in debt ratios since 2015 for WEO forecast vintages prior to 2015. This table summarizes effect of each component on the evolution of the debt ratio 2015-2018 by: their average, cross-country standard deviations, and correlations. Numbers cited in the chapter come from the rightmost column of this table. The difference in the median impact on debt ratios of $r - g$ compared to primary deficits is typically small (around 1-3pp) relative to the cross-country standard deviation within each component (around 3-8pp). In other words, the average variation across components is a relatively small determinant of changes in the debt ratio relative to the variation across countries within components.

Annex Table 2.2.1. Summary Statistics for Unexpected Changes of Fiscal Variables on Debt Ratio, 2015–18, by WEO Forecast Vintage

Vintage	2013	2014	2015
Median impact on debt ratio			
News about $r - g$	-2.94	-2.79	-1.47
News about primary deficits	-1.00	-0.05	-2.35
Mean impact on debt ratio			
News about $r - g$	-5.70	-3.81	-2.20
News about primary deficits	-0.06	-0.20	-2.30
Cross-country standard deviation of impact on debt ratio			
News about $r - g$	8.27	7.05	3.27
News about primary deficits	5.99	5.35	4.23
Relative contributions to cross-country debt ratio differences			
News about $r - g$	58%	57%	44%
News about primary deficits	42%	43%	56%
Correlation of news about r – g and primary deficits			
Point estimate	-0.14	0.08	0.11
p-value	0.48	0.67	0.58

Source: IMF staff calculations.

Forward-Looking Decomposition

The forward-looking decomposition holds fixed the 2024 WEO debt level and then iterates back to 2019 by inverting the budget constraint. For example, for an alternate sequence of future nominal growth rates $\tilde{g}_t$, the start-2019 debt level can be computed from:

$$\tilde{b}_{2024} = b_{2024}$$

$$\tilde{b_t} = \theta_t \tilde{s_t} + \left(\tilde{b}_{t+1} - \eta_t\right) e^{-\bar{r}_t + \tilde{g}_t^1}$$

For an alternate sequence of future short-term policy rates, a new yield curve and yield-to-maturity are computed at each point in time, and the same methodology applied to generate a counterfactual debt level in 2019. Annex Figure 2.2.3 shows by how much advanced economies could hypothetically increase their borrowing while keeping debt stable at its 2024 projected level if interest rate–growth differentials were to drop by a further 100 basis points. This experiment also measures the impact of past changes in $r - g$ on borrowing capacity so long as the persistence of those changes was also in line with the data (see the subsequent section on the common component of $r - g$ and its persistence for the estimates used).

If such a decline were to happen through an increase in nominal growth, then the increase in borrowing capacity is moderate, averaging about 3 percentage points of GDP across advanced economies.

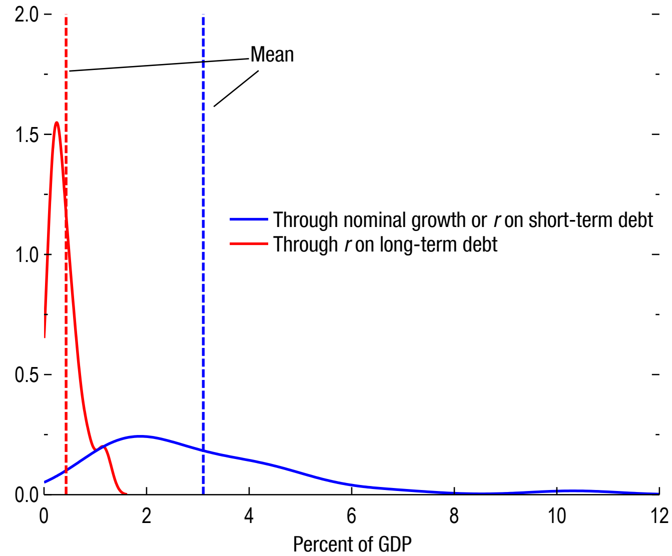
If instead the decline in $r - g$ were to occur due to short-term policy rates, however, depends on how that change is that transmit through the yield curve; the impact on government borrowing costs depends on the maturity of debt. At the average 8-year maturity of debt in advanced economies, the impact is small, averaging only a fraction of 1 percent of GDP. For declines in short-term interest rates to have a similar impact to declines in short-term growth rates, all debt would need to be short-term (i.e. one-year maturity).

If the shock is permanent, the impact of a given change in the interest-growth differential is much larger. Moreover, the sensitivity to debt maturity goes away when the decline in short-term interest rates is permanent. In this case, there is no difference between the impact if debt is one period or infinitely long-lived.

In general, countries with larger debts are more sensitive to changes in interest rate–growth differentials, as $r - g$ determines the growth rate of the debt ratio. A given change in $r - g$ therefore leads to a larger change in borrowing capacity when the debt ratio is higher. This applies equally to negative shocks. The magnitude sensitivities computed here are not a function of the sign of the shock and are still valid for increases in $r - g$ (albeit with a negative sign). And so higher-debt countries are more exposed to increases in interest rate–growth differentials.

Annex Figure 2.2.3. Additional Borrowing Capacity if $r - g$ Falls 100 Basis Points
(Kernel density)

If the interest rate–growth differential were to fall further, the average additional borrowing capacity consistent with debt stability would be about 3 percent at most, depending on how it would be financed. In general, the savings gained scales with the size of debt outstanding.



Sources: Bank for International Settlements; Haver Analytics; IMF, *International Financial Statistics*; Jordà and others (2019); national sources; and IMF staff calculations.
Note: Chart shows the cross–country distribution of the increase in the debt ratio consistent with achieving the forecast debt levels in 2024 (as of the January 2020 WEO vintage) if $r - g$ were to fall by 100 basis points in 2019. Specifically, the thought experiment assumes an unexpected 100 basis point drop in the common component of $r - g$ across countries, which then evolves according to the statistical model used in Figure 2.2.1. The persistence of this decline is assumed to match the persistence of the estimated common factor for $r - g$ under alternative assumptions about debt maturity.

Comparison to an Accounting Decomposition

The backward-looking exercise described here explains current debt levels as a result of the changes in the economic environment relative to what was expected. As shocks can be persistent and yield curves are forward looking, it is only through a comparison relative to expected outcomes that the timing of the impact of past shocks can be correctly identified.

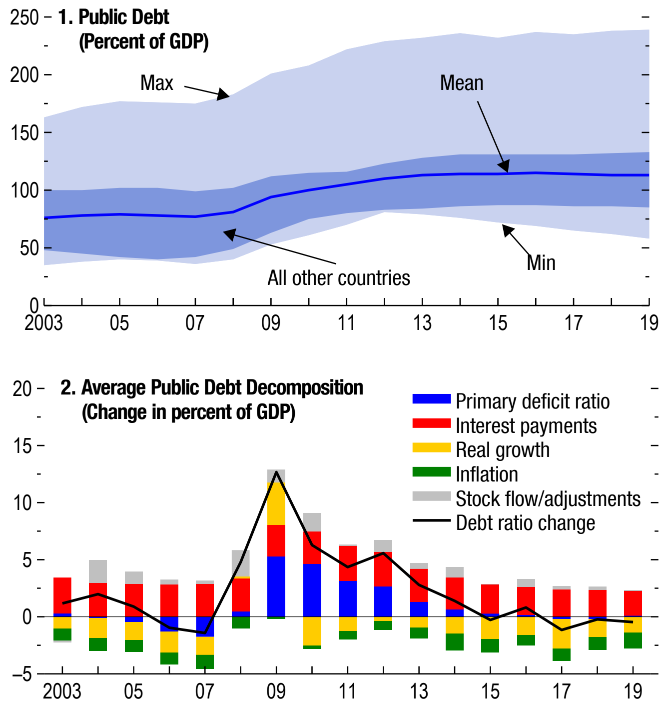
Nevertheless, it can also be instructive to compare the results of the foregoing exercise (presented in Figures 2.4) to the results of a purely accounting decomposition. This explains movements in debt by the realized components of the budget constraint: primary deficits, interest and growth rates, inflation, and a stock-flow adjustment.[3]

[3] This last component is required because the overall deficit is equal to the change in net debt, whereas the final decomposition is presented in terms of changes to gross debt. This difference principally arises from treatment of public acquisition of financial assets. This has a net zero impact on government wealth and so is excluded from the primary deficit. However, funding for the acquisition of such assets creates a gross financing need, increasing gross debt (all else equal).

Such an approach has an obvious disadvantage relative to the exercise described in the preceding section; the timing of the impact of changes will not be properly identified. For example, changes in yield curves in a given year will affect realized interest payments for many subsequent years. A comparison to the anticipated yield curve will correctly assign the impact of these changes to the date when the yield curve changes, whereas the realized decomposition will attribute them to the horizon at which interest is paid. These could be very different, particularly for long-maturity bonds.

Yet his method does have an advantage: clarity. There are fewer assumptions required about yield curves and the like – it is entirely an accounting decomposition.

Annex Figure 2.2.4. Relative Average Public Debt to GDP and Decomposition, G7 + Spain



Source: IMF staff calculations.
Note: Public debt is measured by general government gross debt. Average decomposition across advanced economies is shown for the bottom panel. G7 = Group of Seven (Canada, France, Germany, Italy, Japan, United Kingdom, United States).

Annex Figure 2.2.4 shows this decomposition averaged across the G7 plus Spain. The top panel shows the evolution of gross debt since 2003. The bottom panel explains the year-to-year change in average debt ratios as a function of the accounting terms. The black line in the lower panel thus equals the slope of the blue line in the upper panel.

During the global financial crisis, debt levels rose sharply across advanced economies. This was principally due to a sharp increase in primary deficits from 2009 onwards (blue bars) plus a sharp decline in real growth and inflation in 2008–9. Primary deficits fell until 2015, slowing the rate at which the debt ratio grew.

Since 2015, primary deficits and interest payments have been very close to pre-crisis levels. Yet debt ratios are stable at much higher levels. This implies that higher primary deficits during the crisis broadly offset the gains from lower interest-growth differentials.

More recently, debt ratios have started to drift down (since around 2016). Mechanically, this has been due largely to higher nominal growth. Yet, as the analysis in the main text highlights, this underplays the role of fiscal consolidation in recent years. Fiscal policy was expected to be mildly expansionary over these years but has instead been broadly balanced (and very heterogeneous across advanced economies).

Forecasting *r – g*

This section outlines the methodology used in Box 2.2 and Figure 2.2.1, describing how to isolate the common international component of $r - g$ and how to construct its forecast.

Data

The interest rate–growth differential used for forecasting is the difference between the annual average short-term policy rate and the annual nominal growth rate.

This choice of interest rate has several advantages. First, it strips out variation in risk premia, which are often endogenous to fiscal policy. It is also clear that one can compare the annual short-term rate to the annual nominal growth rate (with longer maturity bonds the comparison is to equivalently longer periods of growth).

Nevertheless, this approach does suppress other sources of variation not due to short-term policy rates, including term premia. Yet this is not overly costly when studying the long-term variation in interest rates. The long decline in government interest rates since the early 90s has been driven overwhelmingly by reductions in future expected policy rates, not term premia.

This source of variation in $r - g$ is interpreted as the primitive shock driving realized interest rate–growth differentials. For example, the mapping of changes in policy rates into debt levels in the preceding subsection is done so through a yield curve which includes various premia. But the fluctuations in that yield curve are only due to current and future expected short-term policy rates.

Theoretical Basis

The Euler equation in the Ramsey-Cass-Koopmans and associated models relates asset prices to investors' valuation of their payoffs (Galí 2008). One application of this to nominal risk-free interest rates (when investors' preferences have logarithmic preferences over consumption) yields:

$$r_t = E_t g_{t+1}^c + E_t \pi_{t+1} + constant,$$

where g_{t+1}^c is investor consumption growth, π_{t+1} inflation and E_t the time t expectation operator. Then if the expected share of consumption in output is constant, $E_t g_{t+1}^c = E_t g_{t+1}^y$ where g_{t+1}^y represents real output growth. Substituting this into the expression for the interest rate and using that nominal growth is the sum of real growth and inflation, one gets that:

$$r_t - g_{t+1} = \left(E_t g_{t+1}^y - g_{t+1}^y \right) + (E_t \pi_{t+1} - \pi_{t+1}) + constant.$$

Thus, the variation in the realized interest-growth differential is driven by the sum of forecast errors on inflation and real growth.

Annex Figure 2.2.5 performs this decomposition for a sample of advanced economies using WEO forecasts for expectations. Errors to growth and inflation explain much of the short-term variation in the interest-growth differential, including during the global financial crisis. Yet the residual (in blue) declines slowly throughout the period, suggesting that slow-moving common forces drive deviations of realized $r - g$ from the theoretical predictions.

Empirical Specification

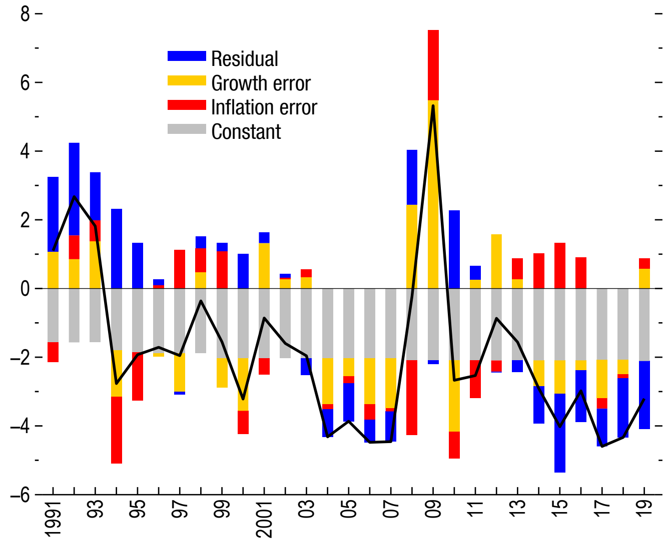
The following equation is estimated using an unbalanced sample of 15 countries starting between 1871 (11 countries) and 1914 and ending in 2019,

$$(r_{i,t} - g_{i,t+1}) = \alpha_i + \delta_t + \beta^{\pi}\pi^*_{i,t+1} + \beta^g g^*_{i,t+1} + \epsilon_{i,t}$$

where $\pi^*_{i,t+1}$and $g^*_{i,t+1}$ are expectations of inflation and real growth respectively, α and δ are country and time fixed effects respectively, and ϵ is a mean zero error term. The inflation andreal growth expectations are constructed in two steps.

First, averages are taken over plausibly distinct monetary eras: Pre-WW1 (1871–1913), WW1 (1914–1918), Interwar (1919–1938), WW2 (1939-1945), Bretton Woods (1946–1971), post-Bretton Woods (1972–1990), Global Financial Integration (1991–2007), Global Financial Crisis and aftermath (2008–2019). Second, these era averages are filtered using an equally-weighted five-year moving average to prevent sudden jumps in the expectation series. Forecast errors for inflation and growth are then the difference between the expectation and the realized outcome.

Annex Figure 2.2.5. Average Contributions of Inflation and Growth Surprises to *r* – *g*
(Percentage points)



Source: IMF staff calculations.
Note: Expectations for inflation and growth calculated from one-year ahead WEO forecasts. The average decomposition across advanced economies is shown.

The time fixed effects therefore capture the extent to which the simplest Euler equation fails to explain the data, sometimes termed "wedges" between theory and reality. Given that the Euler equation framework has strong implications for predictability (specifically, that interest rate–growth differentials are unpredictable white noise), the time fixed effects therefore measure the component of the data which has information about future international trends in interest rate–growth differentials. Moreover, the drivers of these time fixed effects must be factors which are not captured by the simple Euler equation relationship between growth and interest rates. This point motivates the choice of candidate drivers described in Box 2.2 and underlying Figure 2.2.2.

Regression Results

Annex Table 2.2.2 shows the results of regressing nominal interest rate–growth differentials on forecast errors for inflation and real growth. Several points are worthy of note. First, that the magnitude of coefficients on the forecast errors are statistically indistinguishable from unity in the first column when there are no additional explanatory variables included. The simple Euler equation cannot be rejected in the text. Further below, more explanation is provided on the additional columns and their interpretation.

The remaining specifications include country-specific potential drivers of interest rate–growth differentials. As time fixed effects capture international determinants of the interest rate–growth differential, these should be interpreted as factors which might drive interest rate–growth differentials in a given country in ways distinct from the forces shaping international trends.

These other factors are mostly insignificant, suggesting that country-specific trends in, for example, productivity or demographics, have little impact on individual countries' interest rate–growth differentials. Instead, global trends are likely a move important determinant. These non-results therefore an extra motive for focusing on global drivers of interest rate–growth differentials.

Table 2.2.2 also includes details on the share of variance explained by each of the regressors, following the absolute average deviation measure of Sterck (2019). In the baseline case, time fixed effects explain around 20 percent of the total variation. This is quite important, since by construction this is the only component with predictable and cross-country predictive power. It is also very persistent, suggesting that international factors producing unusually low (or high) $r - g$ take many years to dissipate. About 60 percent of the variation come from forecast errors (inflation and growth surprises) and from country fixed effects, but those are transitory and unpredictable, and thus, have no predictive power. Thus, the common component represents almost half of the variability in $r - g$ that can be predicted. That this share increases in the other specifications reflects a negative correlation between the time fixed effect estimated in specification (1) and the time pattern of the addition variables. In contrast, inflation and growth surprises explain around 40 percent of the variation, suggesting that these are an important channel of fluctuations in interest rate–growth differentials.

Annex Table 2.2.2. Interest Rate–Growth Differentials and Forecast Errors

	15 countries: 1871–2019				
	Interest rate-growth differential				
	(1)	(2)	(3)	(4)	(5)
Inflation surprise	–1.022***	–0.368**	–0.297**	–0.367**	–0.364**
	(0.117)	(0.179)	(0.135)	(0.179)	(0.177)
Growth surprise	–1.082***	–0.742***	–0.792***	–0.750***	–0.776***
	(0.156)	(0.198)	(0.164)	(0.202)	(0.175)
Fraction 40–64		0.067	0.025		0.057
		(0.225)	(0.234)		(0.224)
Dependency ratio				0.035	
				(0.133)	
UIP debt gain		–0.098***		–0.098***	–0.098***
		(0.036)		(0.036)	(0.036)
UIP error			0.120***		
			(0.036)		
TFP growth		–0.012	0.015	–0.004	
		(0.166)	(0.156)	(0.17)	
Labor productivity growth					0.043
					(0.137)
NFA-GDP ratio		0.0002	–0.001	0.001	0.0004
		(0.005)	(0.004)	(0.005)	(0.005)
Share of variation					
Of which,					
Growth surprise	0.14	0.16	0.17	0.16	0.17
Inflation surprise	0.28	0.11	0.09	0.11	0.11
Country Fixed Effects	0.11	0.09	0.08	0.09	0.09
Time Fixed Effects	0.19	0.32	0.32	0.32	0.32
Residuals	0.28	0.26	0.26	0.26	0.25
Other variables	0.00	0.06	0.09	0.05	0.07
Residual autocorrelation p-value	0	0	0	0	0
Mean within-country residual persistence	0.67	0.35	0.33	0.33	0.33
	(0.06)	(0.07)	(0.09)	(0.09)	(0.09)
Observations	2125	1466	1511	1466	1466
R^2	0.848	0.299	0.288	0.299	0.3
Adjusted R^2	0.835	0.223	0.213	0.223	0.224

Source: IMF staff calculations.

Note: Double-clustered robust standard errors in parentheses. Share of variation is computed using the average absolute deviation measure by Sterck (2019).

*p<0.1; **p<0.05; ***p<0.01.

Notable exceptions are the variables related to the uncovered interest rate parity condition (UIP). The UIP condition, states that the difference in safe returns in two countries should be equal on average to the appreciation of the bilateral nominal exchange rate. Systematic violation of this condition suggests that capital cannot flow freely to take advantage of differential returns. Thus, violations of UIP can be interpreted as evidence of financial repression. This motivates both the inclusion of the UIP error (defined as the exchange rate differential relative to the US less bilateral exchange rate depreciation versus the dollar) and the product of the UIP error with the outstanding debt stock (which measures the fiscal gains from UIP violation). That the coefficients on these terms are negative and significant suggests that country-specific $r - g$ is low when returns on domestic safe currencies are low relative to foreign-currency alternatives. Financial repression is an important part of the story linking this to low $r - g$; without some sort of quantity restriction on capital, low interest rates mean lower saving and growth in future. Empirically, these findings give further weight to the results in Mauro and Zhou (forthcoming).

Note that the coefficient estimates on forecast errors vary as extra controls are added (columns 2–5). This does not invalidate the earlier conclusion that the simplified Euler equation cannot be rejected. Instead, it simply means that country- and time-varying additional controls are absorbing the predictive capacity of the forecast errors, since they are likely to be correlated with them. Some of these country-specific forces captured by these explanatory variables operate *through* realized inflation or growth, impacting interest rate–growth differentials consistent with the Euler equation. Indeed, to the extent that such channels have an unpredictable component, projecting them onto inflation and growth forecast errors acts to strip them out of forecasts for $r - g$.

Forecasting the Common International Component of $r - g$

To forecast the international component of the interest-growth differential, the time fixed effects are isolated from the estimated form of specification (1). The resulting time series is then fitted with an autoregressive integrated moving average (ARIMA) model. The lag structure is chosen using an Akaike Information Criterion. This selects a model with three autoregressive lags and two moving average terms and no unit root. The long-term persistence is estimated to be 0.87, suggesting a half-life of five years for a unit shock.

Drivers of $r - g$

Data

The exercise on the long-run drivers of $r - g$ uses linear regression with the common international component of $r - g$ as a dependent variable. The choice of explanatory variables is based on the literature—see in particular, Andrade and others (2019), Gordon (2015), Eggertsson, Mehrotra, and Robbins (2019), and Chapter 3 of the 2014 WEO, among others. The sources for these variables are the following:

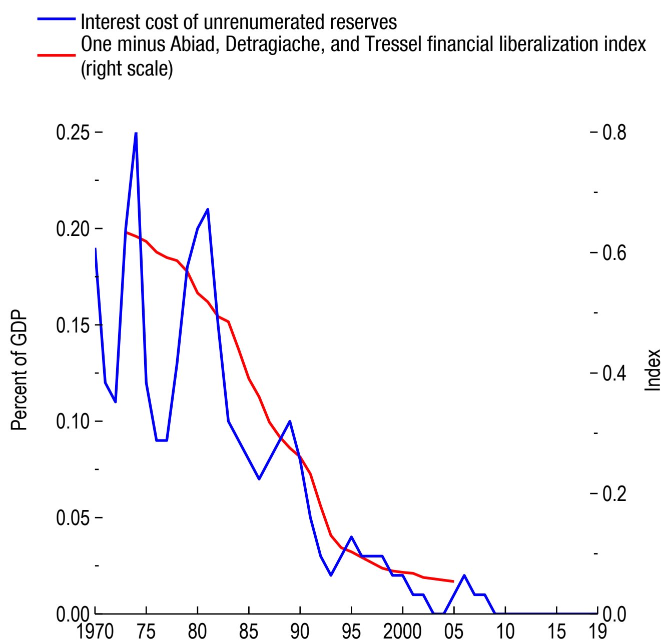
- *Long-run total factor productivity (TFP) data.* These come from the long-run productivity database v2.3 (see Bergeaud, Cette, and Lecat 2016 for details). A subset of the series is matched to the 15 advanced economies used in the $r - g$ forecasting exercise and aggregated. Robustness checks were conducted using measures of labor productivity in the same dataset.

- *Global share of middle-aged.* Global population age shares come from the UN's 2019 Revision of World Population Prospects. Advanced economy shares are calculated by aggregating country-specific age shares from the Human Mortality Database.
- *Share of emerging market and developing economies in the global economy.* World Economic Outlook (WEO) data, are spliced with data from the Maddison Project 2018. Robustness checks also use cumulated current account deficits as a proxy for emerging market and developing economy asset holdings in advanced economies, computed using data from the Jordà-Schularick-Taylor (2017) Macrohistory Database.
- *Opportunity cost of required reserves in the United States.* This is calculated from:

$$cost_t = (Overnight\ rate_t - interest\ on\ reserves_t) \times \frac{Required\ reserves_t}{GDP_t}$$

This is therefore the savings to the Federal Reserve from paying interest on reserves below the market overnight rate, expressed as a fraction of GDP. Since 2009 the Federal Reserve has paid interest on reserve equal to the federal funds rate, so this cost has been zero. Prior to 1955, the overnight rate is measured as the Federal Reserve Bank of New York's discount rate. Subsequently, the federal funds rate is used. In robustness checks the required reserve ratio is also used. An alternative natural measure of financial repression is the UIP differential—the difference in bilateral rates of return between two countries after adjusting for nominal exchange rate depreciation.[4] However, this only measures *relative* financial repression between two countries and cannot be used as a global measure; the average UIP differential is always zero. Instead, the cost of unremunerated reserves is best compared to the financial liberalization index of Abiad, Detragiache, and Tressel (2008). This index uses a variety of measures to compute a single number between 0 and 1 measuring financial liberalization during 1973-2005. As financial repression is simply the opposite of financial liberalization,

Annex Figure 2.2.6. Global Measures of Financial Repression



Sources: Abiad, Detragiache, and Tressel (2008); and IMF staff calculations.
Note: The Abiad, Detragiache, and Tressel (2008) index combines eight measures of financial liberalization, shown here as the average for the sample of 15 advanced economies used in Figure 2.2.1.

[4] If trade in financial and exchange rate markets is free, this will be zero on average. If financial repression acts to depress interest rates without allowing a corresponding depreciation of the exchange rate, this will produce a persistently negative differential. For example, Mauro and Zhou (2020) thus use the UIP differential as a proxy for financial repression.

Annex Figure 2.2.6 displays 1 minus the global annual average of this measure for the overlapping samples. The correlation between the two measures is high, at 0.87, and the timing—increasingly fast liberalization in the 1980s before easing in the 1990s—matches that of the interest cost of unremunerated reserves almost exactly.

Share of Variance

Full results are reported in Annex Table 2.2.3. Note that there are no country fixed effects as this is a single time series and not a panel. Shares discussed in Box 2.2 are computed in line with Sterck (2019) using an absolute deviation metric. Moreover, the shares capture the economic significance of explanatory variables rather than statistical significance. Coefficients on TFP growth and the global fraction of middle age are consistently statistically significant. The emerging market and developing economy share is less reliably statistically significant in the robustness checks, but the variation in the share is large so it still explains a relatively large share of the variance of the dependent variable. In contrast, the proxy of the global level of financial repression is not reliably significant. This is in line with the cross-country regressions, which suggest that financial repression in a country can affect its relative interest rate–growth differential, but not the cross-country average.

Annex Table 2.2.3. International Drivers of Interest Rate–Growth Differentials

	15 countries: 1950–2018							
	Interest Rate–Growth Differentials , common component							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TFP growth	–0.660**		–0.879**	–0.331	–0.874***	–0.456**	–1.026***	–0.396**
	(0.259)		(0.350)	(0.208)	(0.339)	(0.184)	(0.336)	(0.175)
Labor productivity growth		–0.750***						
		(0.233)						
Global fraction 40–64	–0.889***	–0.883***				–0.265	–1.247***	–1.371*
	(0.288)	(0.310)				(0.195)	(0.348)	(0.737)
Global dependency ratio			0.124					
			(0.308)					
AE dependency ratio				–1.188***				
				(0.234)				
AE fraction 40–64					–0.285			
					(0.322)			
Interest cost of reserves (GDP ratio)	–12.740	–9.429	–2.512	24.277***	–4.385		–8.677	6.593
	(9.447)	(9.720)	(14.110)	(7.695)	(10.638)		(10.591)	(7.367)
Unremunerated reserves (GDP ratio)						–1.484***		
						(0.334)		
EMDE GDP share	0.290***	0.257***	0.143	0.126***	0.164*	–0.038		–0.053
	(0.057)	(0.063)	(0.090)	(0.042)	(0.091)	(0.079)		(0.077)
AE cumulated CA deficit							–0.212***	
							(0.059)	
Constant	3.884	6.026	–14.536	39.029***	–0.972	7.791**	25.575***	29.405*
	(5.593)	(5.657)	(16.648)	(10.453)	(9.824)	(3.307)	(7.942)	(15.762)
Quadratic time trend	No	No	No	No	No	No	No	Yes
Observations	69	69	69	69	69	69	67	69
R^2	0.620	0.641	0.468	0.687	0.476	0.741	0.535	0.768
Adjusted R^2	0.596	0.619	0.435	0.668	0.443	0.725	0.505	0.746

Source: IMF staff calculations.
Note: Newey-West standard errors in parentheses. AE = advanced economy. EMDE = emerging market and developing economy. TFP = total factor productivity. CA = current account.
*p<0.1; **p<0.05; ***p<0.01.

The importance of the differing drivers of interest rate–growth differentials (Figure 2.2.2) varies over the sample period. For example, the importance of global aging is largely a function of large changes in the last few decades. The significance of these results is also subject to change depending on the sample period (for example, restricting the estimation sample to pre-2007). This is largely a function of the relatively small sample—standard errors increase but point estimates (and, more importantly, their signs) remain broadly stable.

Annex 2.3 Fiscal Multipliers

This section provides details about the estimation of fiscal multipliers during periods of slack and when monetary policy is accommodative. It also presents additional exercises that investigate the channels that might explain why multipliers are higher when the effective lower bound on interest rates is binding and other dimensions of multiplier heterogeneity.

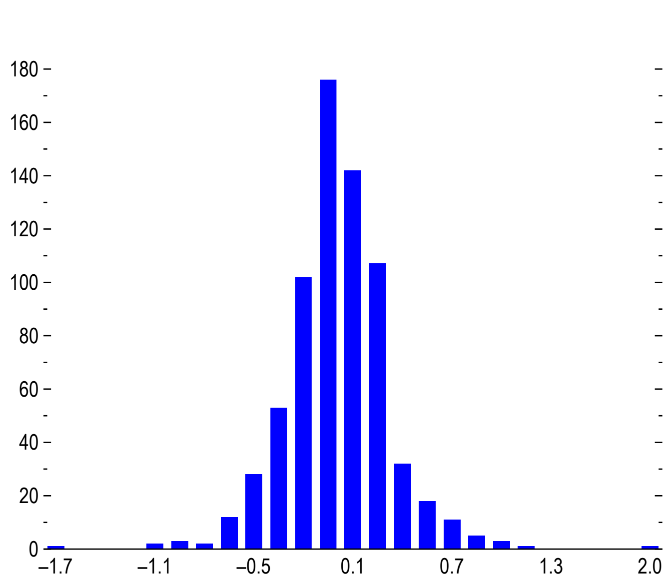
Empirical Model for Government Consumption Multipliers

To compute government consumption multipliers, the analysis follows the methodology developed by Auerbach and Gorodnichenko (2012a, 2012b, 2013, 2017) that exploits forecasts errors to proxy for the unexpected and exogenous movement in government spending. The *real time* forecast errors FE_{it} of government consumption for country *i* and time *t* are defined as:

$$FE_{it} = \%\Delta GC_{it} - E_{t-1}[\%\Delta GC_{it}],$$

where $\%\Delta GC_{it}$ represents the percentage change in actual government consumption in country *i* and year *t* (measured in real time using data realized in year *t+1*), and $E_{t-1}[\%\Delta GC_{it}]$ is the forecast for public consumption growth for year *t* projected in *t-1*.[1] Forecast errors have desirable properties as shocks since they are serially uncorrelated and unanticipated. They also address the problem of fiscal foresight and the importance of anticipation for estimating the effects of government spending shocks (Ramey 2011). To ensure that any remaining predictable component is purged from the estimation, the model also includes a broad set of macroeconomic variables together with other components of spending (for example, transfers) and total revenues. We focus on government consumption, rather than investment, as different components of spending might have different multipliers (Kraay 2012).[2]

Annex Figure 2.3.1. Distribution of Public Consumption Shocks
(Frequency)



Sources: OECD Economic Outlook; and IMF staff calculations.

[1] Comparing forecasts to contemporaneous measures of real time data is important to take account of subsequent data revisions (see Auerbach and Gorodnichenko 2012b)

[2] As discussed in Boehm (2019), if the actual stimulus measures have a different expenditure composition than the one underlying the estimation for total purchases, the resulting multiplier estimates could provide erroneous guidance for policymakers. The empirical evidence on investment multipliers varies markedly. Chapter 3 of the October 2014 *World Economic Outlook* reports public investment multipliers, at around 1.5. In contrast, Boehm (2019) finds that fiscal stimulus packages with large investment components are less effective, with large falls in private investment after government investment shocks due to crowding out. In an earlier contribution, Perotti (2004) estimates no difference in in the effectiveness of public investment versus public consumption in boosting GDP.

The baseline shock definition is based on the OECD Spring forecasts, but the results are robust to using the Fall vintages (see Table 1). The forecast errors FE_{it} are winsorized excluding the bottom 1st and top 99th percentiles to eliminate extreme observations and normalized to transform the shocks into percent of GDP using each country sample average of government consumption as a share of GDP (following Auerbach and Gorodnichenko 2017; Hall 2009; Barro and Redlick 2011). This is useful to capture actual multipliers instead of elasticities (Ramey 2019).

$$share_i^g = \left(\overline{\frac{G_{it}}{GDP_{it}}}\right)$$

$$Shock_{it} = FE_{it} * share_i^g$$

Annex Figure 2.3.1 reports the distribution of the government consumption shocks scaled with real GDP.[3] The distribution of the shocks is centered around zero and varies in a range between 2 and -2 percent of GDP. The sample includes 23 advanced OECD countries.[4]

The baseline specification is the following:

$$\frac{y_{it+h} - y_{it-1}}{y_{it-1}} = \alpha_i^h + \delta_t^h + \beta^h \widehat{G}_{\text{it}} + \sum_{k=0}^{2} \gamma_k^h \boldsymbol{X}_{it-k} + \varepsilon_{it+h},$$

where y_{it} is the real GDP of country *i* in year *t*. The vector of controls $\boldsymbol{X}_{it}$ includes two lags of the following variables: percentage change in real GDP, the shock itself (to control for any serial correlation, see Stock and Watson 2018 for a discussion), the first difference of government revenues, and of government transfers (proxied by security benefits paid by general government). These controls are all scaled by real GDP lagged by one year. The short-term policy rate, the level of unemployment, the degree of trade openness (measured as imports plus exports dived by GDP), a dummy variable for fixed exchange rates regimes, a linear trend and country and year fixed effects are also included as controls. The baseline estimation employs standard errors clustered at the country level that are heteroscedasticity and autocorrelation consistent. Results are robust to the use of Driscoll-Kraay standard errors that account for cross-sectional dependence (see Table 1). The cumulative multiplier is computed adopting the methodology proposed by Ramey and Zubairy (2018) that uses the shocks as instruments to jointly estimate the response of government consumption and real GDP. $\widehat{G}_{it}$ is therefore the predicted government consumption obtained from a first-stage regression where the shock is used as an instrumental variable.[5] This procedure has the advantage to provide consistent standard errors and to underline the properties of the shocks through the first stage F-statistics.[6]

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[3] As an alternative, the share is computed with respect to potential output and the resulting distribution is unchanged.

[4] The countries in the sample are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Slovak Republic, Spain, Sweden, Switzerland, the United Kingdom and the United States.

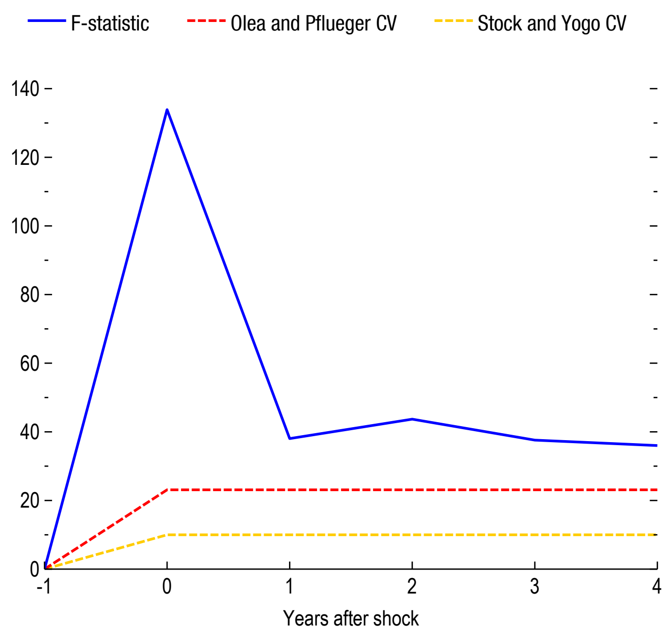
[5] The two stages are estimated jointly.

[6] Alternative definitions of multipliers are often used in the literature, such as the *peak to impact* multipliers (Blanchard and Perotti 2002) and *present value multipliers* (Mountford and Uhlig 2009).

Baseline Results

In line with the literature (see, for instance, Gechert and Rannenberg 2018 and Ramey 2019), the baseline results of the linear model suggest a public consumption multiplier of about 1 throughout the estimation horizon (up to 4 years after the shock hits). The multiplier is different from zero at the 90 percent level in the first 3 periods (see Figure 2.9 in the main text). The first stage F-statistics are above the Stock and Yogo (2005) rule of thumb of 10 throughout the horizon and above the Olea and Pfluger (2013) critical value, which is robust to weak instruments (Annex Figure 2.3.2). This suggests that the forecasts errors are a relevant instrument to predict the endogenous public consumption changes, providing reassurance against weak instruments concerns.

Annex Figure 2.3.2. Instrumental Variable First Stage Tests
(F-statistic on excluded instruments)



Sources: OECD Economic Outlook; and IMF staff calculations.
Note: CV = critical value; dashed lines denote critical values at the 10 percent.

Annex Table 2.3.1 presents a set of robustness tests for the baseline estimation. Column 1 reports the baseline one-year multiplier as a reference. The multiplier excluding the years associated with the global financial crisis (from 2008 to 2010 inclusive) is slightly smaller and equal to 0.95 (Column 2). Column 3 excludes the 1980s, as several countries in the sample start reporting only at the beginning of the 1990s and the results are broadly unchanged. The level of statistical significance is unaffected when Driscoll-Kraay standard errors are computed (Column 4). The one-year multiplier is slightly higher when using the forecasts errors computed with the Fall vintages.

Annex Table 2.3.1. Linear Multiplier Robustness Exercises

	1-year multiplier				
	(1)	(2)	(3)	(4)	(5)
Multiplier	1.240**	0.950***	1.360**	1.240**	1.640**
	(0.600)	(0.365)	(0.647)	(0.613)	(0.802)
Observations	614	545	599	614	631
R^2	0.631	0.527	0.631	0.631	0.316
Number of countries	23	23	23	23	23
Country Fixed Effect	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes
Sample	All	No GFC	No 80s	All	Full
Controls	Baseline	Baseline	Baseline	Baseline	Baseline
Shock	Spring	Spring	Spring	Spring	Fall
Standard errors	Cluster country	Cluster country	Cluster country	Dkraay	Cluster country
F-stat	54.719	48.324	50.260	36.865	38.306

Source: IMF staff calculations.
*p<0.1; **p<0.05; ***p<0.01.

Multipliers During Slack and When Monetary Policy is Accommodative

To estimate state-dependent fiscal multipliers, the procedure proposed by Ramey and Zubairy (2018) is adopted and the baseline estimation is augmented with interaction terms to proxy for different states of the economies captured by an indicator variable I_{it}.

$$\frac{y_{it+h} - y_{it-1}}{y_{it-1}} = \alpha_i^h + \delta_t^h + \beta^h \hat{G}_{it} * I_{it-1} + \beta\lambda^h \hat{G}_{it} * (1 - I_{it-1}) + \sum_{k=0}^{2} \gamma_k^h \boldsymbol{X}_{it-k} + \varepsilon_{it+h}$$

Annex Table 2.3.2. One-Year Multipliers During Different Business Cycle Phases

	1-year multiplier		
	(1)	(2)	(3)
Unemployment below country-specific median	1.000*		
	(0.604)		
Unemployment above country-specific median	1.410*		
	(0.717)		
Unemployment below country-specific mean		0.540	
		(0.689)	
Unemployment above country-specific mean		1.710**	
		(0.728)	
Expansion			0.900
			(0.726)
Recession			0.790
			(0.934)
Observations	614	614	614
R^2	0.634	0.639	0.666
Number of countries	23	23	23
Country Fixed Effect	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	No
Sample	Full	Full	Full
Shock	Spring	Spring	Spring
Standard errors	Cluster country	Cluster country	Cluster country
F-stat	23.974	31.467	21.722
P-value of difference	0.385	0.026	0.918

Source: IMF staff calculations.
*p<0.1; **p<0.05; ***p<0.01.

Annex Table 2.3.2 Column (1) presents the results with the indicator variables taking the value of 1 when unemployment is above the country-specific median, whereas in Column (2) an alternative definition is adopted using the country specific mean. In Column (3), instead, recessions are defined following the Harding and Pagan business cycle algorithm (see also Figure 2.9 in the main text). The first stage F-statistics exceed the rule of thumb value for instrument strength of 10. The results reported in the first two columns indicate that multipliers are above one during periods of slack, however only when slack is defined using the country-specific mean the point estimates under the regimes are statistically different from each other (see last row of Annex Table 2.3.2, where a t-test on the coefficient difference is reported). The findings are not suggestive of higher multipliers during recessions (Column 3). Overall, the adopted specification in a cross-country setting with yearly data is relatively demanding and this might explain the lack of statistical significance in some of the results. The literature also finds mixed results on the role played by slack. Ramey and Zubairy (2018) do not find evidence of higher multipliers in periods of slack in the United States. In contrast, Auerbach and Gorodnichenko (2012b) report multipliers of 2.2 in recessions and -0.3 in expansions.

The same empirical strategy is used to tease out the role of monetary policy accommodation in determining the success of discretionary fiscal actions.[7] In this case the indicator variable takes the value of one when the short-term policy rate is below 0.75 to proxy for the effective lower bound (see Boehm, 2019). Column (1) in Annex Table 2.3.3 indicates a multiplier of above two when monetary policy is constrained by the effective lower bound (ELB) on interest rates. It is important to note that statistical significance is affected by the error structure and the inclusion of the lags of the shock itself. The economic magnitude of the effect, however, is in the range of theoretical estimates of fiscal multipliers at the ELB. A series of theoretical papers reports multipliers substantially higher than one at the ELB, in the range of 2 to 5 (Christiano, Eichenbaum, and Rebelo 2011; Coenen and others 2012; Eggertsson 2011; Woodford 2011). The empirical evidence is still relatively limited given lack of data. Estimates for the US, where time series are longer and include more instances of interest rates at the zero lower bound suggest a multiplier of 1.5 (Ramey and Zubairy 2018). In the case of Japan, Miyamoto, Nguyen, and Sergeyev (2018) report results similar in magnitude. The results of Amendola and others (2019) who exploit shadow rates in the Euro area are suggestive of multipliers between 1.6 and 2.8 at the ELB.

Annex Table 2.3.3. One-Year Multipliers when Monetary Policy is Accomodative

	1-year multiplier		
	(1)	(2)	(3)
No ELB	0.530		
	(0.579)		
ELB	2.590**		
	(1.320)		
Flexible exchange rates		0.090	
		(0.315)	
Fixed exchange rates		2.050**	
		(1.042)	
Pre-GFC			–0.280
			(0.687)
Post-GFC			2.920*
			(1.604)
Observations	614	614	614
R^2	0.657	0.650	0.520
Number of countries	23	23	23
Country Fixed Effect	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	No
Sample	Full	Full	Full
Shock	Spring	Spring	Spring
Standard errors	Cluster country	Cluster country	Cluster country
F-stat	22.754	19.085	24.991
P-value of difference	0.062	0.048	0.004

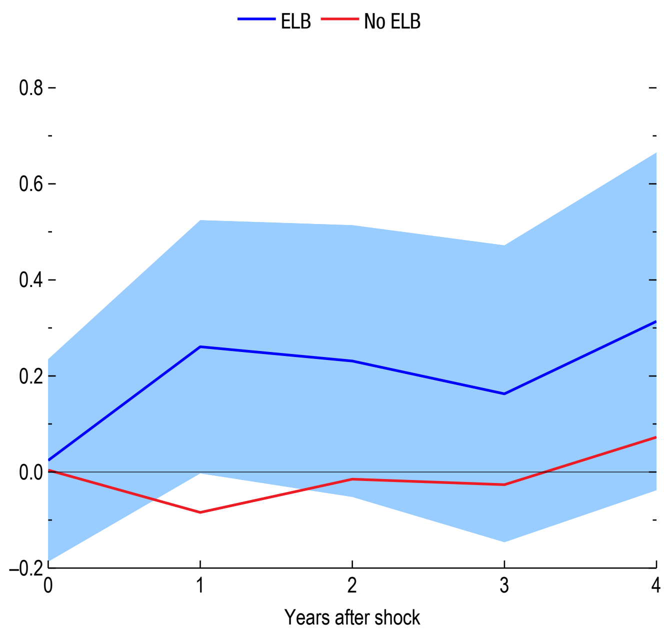
Source: IMF staff calculations.
Note: GFC = global financial crisis; and ELB = effective lower bound on interet rates.
*p<0.1; **p<0.05; ***p<0.01.

Excluding Japan from the sample does not change the results (the effect at the ELB is equal to 2.25). Given the relatively few observations at the ELB (about one-third of the country-year panel) and given the challenges in disentangling episodes of ELB from recessions, an alternative exercise considers fixed exchange regimes in which monetary policy actions are also constrained. The point estimate in Column (2) exhibits a higher multiplier under fixed exchange rates (for similar results see (Ilzetzki, Mendoza, and Végh, 2013). Finally, the evidence on multipliers after the global financial crisis (GFC; Column 2) is also suggestive of higher potency of fiscal stimulus when interest rates are low.

[7] In this specification year fixed effects are omitted, and recessions–identified using the Harding and Pagan (2002) algorithm where negative growth in a year is a recession–and systemic banking crisis are explicitly controlled for. The specification that includes year fixed effects and the baseline controls provides a multiplier at the effective lower bound of around 3.

Why would fiscal policy be more potent when monetary policy is at the ELB? First, when the economy is at the ELB, interest rates do not rise in response to fiscal stimulus and hence the normal crowding-out channel does not operate. Second, the increase in inflation expectations at the ELB permanently reduces real rates and may therefore have a permanent positive effect on aggregate demand (Christiano, Eichenbaum, and Rebelo 2011). Some supportive evidence of this channel is presented in Annex Figure 2.3.3 that reports the impact of the fiscal shocks on one-year ahead inflation expectations from Consensus Economics. In line with the findings of Miyamoto, Nguyen, and Sergeyev (2018) a 1 percent increase in government consumption increases inflation expectations by 0.3 after one year, whereas inflation expectations move around zero in normal times. While the point estimates confirm the role played by inflation expectations, the effect is not statistically significant.

Annex Figure 2.3.3. Response of One-Year Ahead Inflation Expectations
(Units)



Sources: Consensus Economics; Organisation for Economic Co-operation and Development; and IMF staff calculations.
Note: The blue solid line plots the response of inflation expectations to a public consumption shock equal to one percent of GDP under ELB. The red line corresponds to the response during no-ELB periods. The shaded area corresponds to 90 percent confidence interval. ELB = effective lower bound.

Alternative State-dependent Multipliers

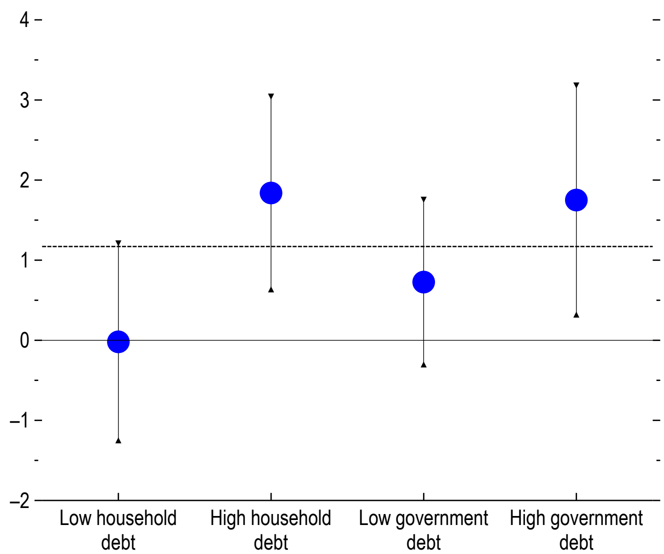
A final empirical exercise computes fiscal multiplier during period of high household and government debt. In line with the findings of Bernardini and Peersman (2017) and Klein (2017) multipliers are higher when household debt is large (Annex Figure 2.3.4).[8] This confirms the idea that expansionary fiscal policy is more potent when consumer deleveraging is high due to a higher propensity to spend (Eggertsson and Krugman 2012).[9] A series of paper have also been asking whether public debt might play a role in determining the size of the multiplier. Discretionary measures in an economy characterized by high debt might trigger fiscal sustainability concerns that in turn raise the cost of borrowing and hence fail to boost output. Ilzetzki, Mendoza and Vegh (2013) find that a stimulus may be less effective in economies with a public debt overhang in a sample of 44 advanced and emerging economies. Corsetti, Meier and Müller (2012), in a sample of OECD countries between 1975 and 2008, find some evidence that

[8] For evidence at the subnational level, see Bernardini and Peersman (2017) and Demyanyak, Loutskina, and Murphy (2019).

[9] Sahm, Shapiro, and Slemrod (2015), on the contrary, argue that deterioration of balance sheets may reduce the effectiveness of fiscal stimulus to boost consumer spending.

high public debt (above 100% of GDP) reduces fiscal multipliers, however the difference in the two sets of multipliers is not statistically significant.[10] Auerbach and Gorodnichenko (2017) also find little variation in the size of multipliers across different public debt states for OECD economies, whereas interest rates and CDS spreads tend to increase more in economies with high debt.[11] In line with the literature, the variation in the estimated multipliers across high and low-debt states in too limited to achieve definitive conclusions. (Annex Figure 2.3.4).[12]

Annex Figure 2.3.4. Fiscal Multipliers during Times of High Debt
(Real output effect)



Sources: Consensus Economics; Organisation for Economic Co-operation and Development; and IMF staff calculations.
Note: The black dashed line corresponds to the baseline linear multiplier. The blue dots plot the point estimates and the black whiskers are 90 percent confidence intervals. High and low debt states correspond to above and below the country-specific median.

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10 Corsetti, Kuester, Meier, and Muller (2013) study the sovereign risk channels in a theoretical model and find that high debt has an effect on fiscal transmission only if monetary policy is constrained.

11 The point estimates in the output regressions are larger under high-debt states than under low-debt ones. Other papers investigating the link between the state of public finances and the size of multipliers are Nickel and Tudyka (2013) for 17 European countries from 1970 to 2010, and Huidron, Kose, Lim and Ohnsorge (2019) in a sample of 19 advanced and 15 developing economies. Broner, Clancy, Erce, and Martin (2018) study both theoretically and empirically the link between foreign debt holdings and multipliers.

12 High-debt states are defined when the debt is above the country-specific median.

Annex 2.4 Model-Based Analysis of Rules-Based Fiscal Stimulus

The analysis of the rules-based fiscal stimulus is carried out using the IMF's G20MOD. The model is one of the modules in the Flexible System of Global Models (FSGM), described in detail in Andrle and others (2015a).

In the model, output is produced using capital and labor, with labor provided by households. Investment is driven by decisions of profit-maximizing and forward-looking firms, subject to investment adjustment costs, resulting in a version of the Tobin's Q model. The cost of borrowing of firms is affected by an endogenous risk premium, which increases in a downturn (financial accelerator). Labor is provided by households at the market wage, with households choosing the rate of labor-force participation.

Private consumption in G20MOD is driven by two types of households: (i) optimizing overlapping-generations (OLG) households with access to financial markets and (ii) liquidity-constrained households. Liquidity-constrained households consume their full disposable income every period. Their disposable income is formed by their after-tax labor income, transfers from the government, and received remittances, if applicable.

Imports of goods and services are driven by the relative prices of domestic and foreign goods and import requirements of domestic consumption, investment, government expenditures, and exports. Exports of goods and services are given by trading partners demand for imports.

There is a fully specified fiscal sector with multiple policy instruments. There is a full stock-flow accounting of fiscal policy with a fiscal balance that accumulates to a stock of debt and reflects the interest rate costs. Fiscal policy stabilizes debt as a percent of GDP in the long run. On the revenue side, households are subject to a labor-income tax, an ad-valorem consumption tax, and lump-sum taxes. Firms pay capital income taxes. On the expenditure side, the model features government consumption, productive government investment, transfers to households, and the interest cost of the outstanding government debt.

Public investment cumulates into public capital stock, which acts as a positive private-sector productivity spillover. Government can differentiate between general transfers to households or transfers only to liquidity-constrained households. In the model, public consumption does not enter utility of households and has no productivity spillovers.

Monetary Policy

Central bank operates under the inflation-forecast targeting regime, responding to an expected deviation of inflation from its inflation target and to an estimate of the output gap. The monetary policy rate is set to level corresponding to the interest rates implied by the monetary policy rule, $INTP_{RULE}$, unless it breaches a pre-specified effective lower bound (ELB), specified by the value of the interest rate floor, $INTMP_{FLOOR}$. The formulation for the monetary policy is thus:

$$INTMP_t = \max\left(INTMP_{FLOOR}, INTP_{RULE}\right)$$

In the baseline simulations, when the ELB is reached, no other form of monetary policy easing is considered (i.e. no quantitative easing, etc.) to keep the analysis tractable. While this is a useful assumption to keep the analysis tractable, the effects of the binding ELB cannot be directly compared to historical experience of economies under the ELB, since quantitative easing and forward guidance have been used. Such policies can be understood in terms of the "shadow" interest rate that would breach the ELB.

Fiscal Policy

To meet its long-run fiscal goals in terms of exogenous debt-to-GDP target, one or a combination of fiscal instruments always needs to adjust or be expected to adjust. The adjustment keeps the government solvent in the long run. The default fiscal rule uses general lump-sum transfers as the adjusting instrument. Over the course of the business-cycle, the exogenous deficit-to-GDP target is met the debt-to-GDP ratio is stabilized in the long run.

The rule explicitly reflects the position in the business cycle (the output gap, $\widehat{Y_t}$) in the size of adjustment of the deficit-to-GDP, $GDEF\_RAT_t$, to its target value:

$$GDEF\_RAT_t = GDEF\_RAT_t^* + \alpha\widehat{Y_t}.$$

The parameter α reflects automatic stabilizing response of the government and is calibrated using the median estimates from Girouard and Andre (2005) and Price, Dang, and Botev (2015).

Rules-based Fiscal Stimulus

The rules-based fiscal stimulus with explicit macro triggers is implemented on top of the baseline fiscal rule (on top of baseline automatic stabilizers). The fiscal impulse, as a share of output, $IMPULSE\_RAT_t$, increases only when the unemployment rate, UR_t, increases above the benchmark value, UR_t^*:

$$IMPULSE\_RAT_t = \phi \max(0, UR_t - UR_t^*).$$

The calibration of the cyclical rule draws on, but is not identical to, a proposal by Sahm (2019). When the unemployment rate increases above the benchmark by half of a percentage point, the impulse of 0.7 percent of GDP is automatically triggered. This corresponds to $\phi = 1.4$, which is used for all fiscal instruments to ease comparisons.

The augmented fiscal rule is defined as follows:

$$GDEF\_RAT_t = GDEF\_RAT_t^* + \alpha\widehat{Y_t} + \phi \max(0, UR_t - UR_t^*),$$

which creates the space for temporary financing by government debt. The other part of the rule specification consists of choosing the fiscal instrument, or a combination of instruments, that are used to stabilize the public finances.

The default instrument in the model is general transfers to all households. Other instruments can be used and each of the used instrument is then augmented by the effect of the cyclical impulse, e.g. for transfers:

$$TR_t = TR_t^* + IMPULSE\_RAT_t \times GDP.,$$

where TR_t^* is an exogenous path of the instrument that would prevail without the use of the rules-based fiscal stimulus.

Simulations of Alternative Fiscal and Monetary Policy

To evaluate the response of the economy to changes in rules-based fiscal stimulus, both deterministic and stochastic simulations are carried out. Given the severe non-linearity introduced by the ELB, both the size of the shock and the initial distance of the interest rates from the ELB matter. Should the shock be small enough that the ELB is not hit, it wouldn't be representative. In the same way, the shock shouldn't be unrealistically large. Stochastic simulations help to fully understand the implications of the rule, with an empirically-motivated range of structural shocks.

All simulations use a global non-linear solution technique, "stacked-time algorithm", suitable for simulating large-scale dynamic general equilibrium (DSGE) models with many state variables, see Juillard (1996) for intuition or Hollinger (2008) for the algorithm used.

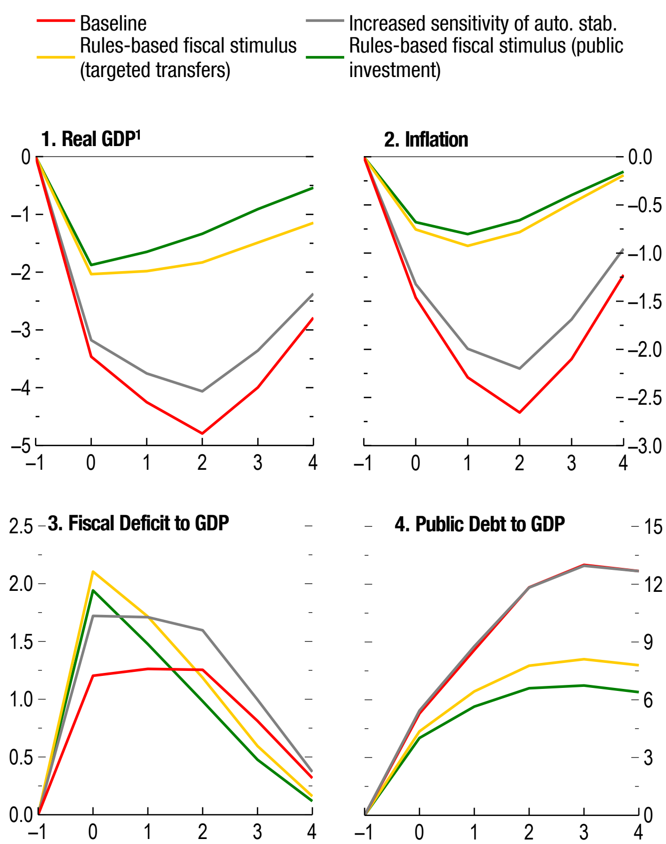
Simulations (Impulse-Response Function)

The economy is exposed to an adverse demand shock. The shock is transitory but persistent "demand shock". It is shock to consumption and investment preferences of households and firms, resulting in a typically-observed response of key macroeconomic variables over the business cycle. Consumption and investment both decline, inflation decelerates, and unemployment increases, for instance. While there are no long-run effects of the demand shock, the potential output of the economy temporarily declines with respect to the baseline growth path, due slower capital formation and a lower level of capital available for production.

When the monetary policy is unconstrained, the central bank cuts the interest rates to counter the adverse economic development. When the monetary policy reaches the ELB, it can no longer accommodate the adverse output shock and the downturn of the economy is much steeper.

Annex Figure 2.4.1. Response to Negative Demand Shock at the Effective Lower Bound

(Percentage point deviation from baseline, unless otherwise noted)



Source: IMF staff calculations.
Note: Targeted transfers go to liquidity-constrained households. X-axis represents the number of years after the shock.
[1]Percent deviation from baseline.

The "fiscal multipliers" in the model, for given coefficient values, depend on multiple things—the choice of the fiscal instrument, if the shock is transitory or permanent, or if monetary policy is or is not accommodative, for instance—see Andrle and others (2015b) for details. For the calibration used, a two-year, debt-financed fiscal expansion of 1 percent of GDP using transfers to liquidity constrained household results in the average increase of real output by 0.57 percent in the first two years. When monetary policy is fully accommodative and keeps monetary policy rate unchanged for two years, the fiscal expansion results in an increase of 1.1 and 1.2 percent in the first and second year, respectively. See Figure 2.4.1 for an illustration of how the choice of fiscal instrument affects the dynamic responses of output and other variables. The rules-based fiscal stimulus helps stabilize real output and also avoid a significant decline in inflation from an adverse shock. Together, the improved paths of real output and the price level contribute to more favorable dynamics of the debt-to-GDP ratio (since nominal GDP is higher).

While the effects of the rules-based fiscal stimulus are intimately linked to the effectiveness of the fiscal instrument and the distance of the economy from the ELB, the effects are not identical. On top of standard analysis of fiscal multipliers an implementation of a widely-understood fiscal rule induces an "expectation effect", where households and firms know about the fiscal rule and they react to the adverse demand shock to a smaller degree, thus lowering the need for the fiscal action itself.

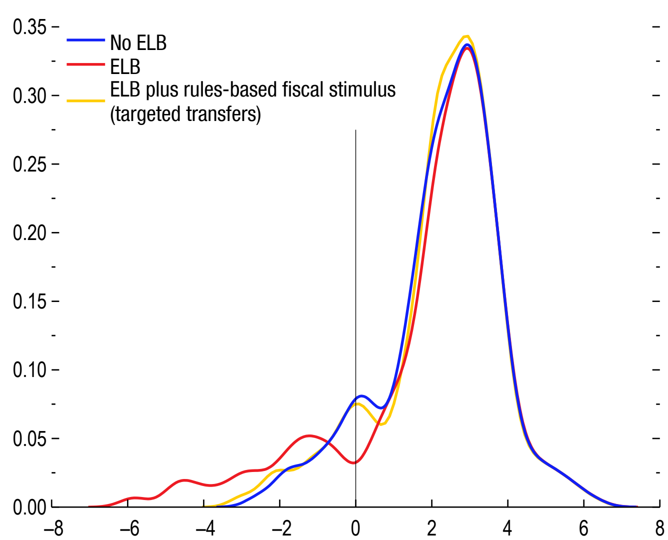
Stochastic Simulations

To extend the impulse-response analysis, the effects of the changes in fiscal and monetary policy framework on the variance and distribution of key macroeconomic variables over the business cycle. This is relevant also due to the inherently non-linear and asymmetric nature of the effective lower bound (ELB) on interest rates and the asymmetric rules-based fiscal stimulus.

The stochastic simulations proceed as follows:

- Using the historical data from 1965—2018 the model is used to estimate the structural shocks. The shocks are estimated by inverting the model and solving for a sequence of unexpected shocks that replicates the observed data. The estimated stochastic shocks also display significant deviations from the Gaussian distribution.

Annex Figure 2.4.2. Distribution of GDP Growth under Alternative Rules-Based Fiscal Stimulus Actions, One Year Ahead
(Percent)



Source: IMF staff calculations.
Note: Targeted transfers go to liquidity-constrained households. Stochastic simulations are used to generate the distribution of output under alternative scenarios. Underlying demand shocks for the stochastic simulations are drawn from the empirical distribution calibrated to the empirical variance and centered at the baseline growth projection. ELB = effective lower bound on interest rates.

- Sampling the shocks from their distribution and simulating the model, the distribution of other variables is obtained. Two variants of stochastic simulations are used: (i) the shocks are assumed to be Gaussian with the standard deviation estimate from the data, and (ii) the shocks are drawn from the kernel density estimate of their unknown distribution function.

The stochastic simulations use N=500 draws, each draw consisting of T=5Y periods, around the baseline projection. For all policy alternatives, instrument choices, and ELB or not, it is important to keep the stochastic shocks identical. The change in the resulting distributions and variance of macroeconomic variables are thus purely deterministic reaction to the change in the policy assumptions. See figure 2.4.2 for an illustration of how the distribution of real output growth varies across policy scenarios given the empirical distribution of underlying demand shocks.

The motivation and the methodology for the stochastic simulations are fully detailed in Andrle and Hunt (2020), with emphasis on estimating structural shocks with large-scale non-linear models, and on the importance of using non-Gaussian, empirical distribution function of shocks for realistic risk assessment.