CHAPTER 4

CROSS-BORDER IMPACTS OF FISCAL POLICY: STILL RELEVANT?

Positive cross-country spillovers from collective fiscal action by the world's largest economies helped speed the recovery from the global financial crisis nearly a decade ago. But do fiscal spillovers still matter today? The answer is yes—but the extent depends on circumstances in both the countries that generate fiscal shocks and in those that are recipients of the shocks. This chapter combines new empirical research and model-based simulations to show that fiscal spillovers tend to be low when a fiscal shock originates from a country without output gaps, but the impact intensifies when a source or recipient country is in recession and/or benefiting from accommodative monetary policy—which suggests that spillovers are large when domestic multipliers are also large. The chapter also finds that spillovers from government spending shocks are larger than those associated with tax shocks, that the transmission of fiscal shocks may be stronger among countries with fixed exchange rates, and that fiscal spillovers impact the external positions of source and recipient countries alike. Model-based simulations suggest that the cross-border effects of budget-neutral fiscal reforms are generally modest, though large reforms can trigger spillovers, especially if they affect cross-border investment decisions. Overall, this evidence draws attention to the cross-border repercussions of corporate tax reform in the United States, for example, or of an increase in public investment in Germany.

Introduction

What is the potential for fiscal policy to affect macroeconomic outcomes in other economies through cross-border spillovers? This question has been at the center of the policy debate, especially in the aftermath of the global financial crisis, when many countries experienced persistent economic slack, and monetary policy interest rates approached the effective lower bound. Fiscal stimulus was then advocated widely, especially in major economies with sufficient fiscal space. This was not least because excess capacity and low interest rates would help limit crowding out of private spending and the expected positive spillovers would make collective efforts to boost activity more effective.

More recently, the global effects of fiscal policy have been discussed amid possible changes in the macroeconomic policy mix in Japan and the United States. Debate is also ongoing about the role of fiscal policies in addressing excess external imbalances, including whether euro area countries with excess current account surpluses should raise fiscal spending, which could also support growth in the currency union.

Recent improvements in economic conditions in many countries and their implications for monetary policy raise questions about the size of potential spillovers from fiscal stimulus today. Cyclical positions have improved across the board over the past few years, although with differences across countries (Figure 4.1). For example, the United States is operating at close to full employment and, as a result, the Federal Reserve has begun to normalize monetary policy conditions. At the same time, although euro area economies and Japan are experiencing an encouraging cyclical recovery, output gaps remain negative in many of these countries and core inflation is stubbornly low, prompting monetary authorities to commit to accommodative policies for an extended period. As the chapter discusses, cyclical conditions and the associated ability or willingness of monetary policy to act, both in countries emitting and receiving the fiscal shock, are key determinants of the magnitude of its impact.[1] Considerations regarding fiscal space in source countries are also relevant—if term premiums increase and financial conditions tighten following a fiscal stimulus, spillovers could be smaller.

Against this backdrop, the chapter aims to answer the following questions:

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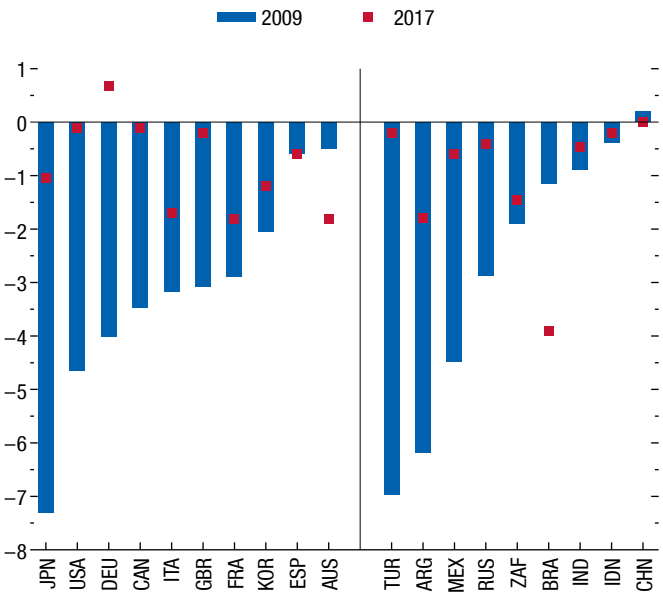
[1]Throughout the chapter, countries from which fiscal shocks originate are referred to as "source" or "shock-emitting"; countries affected by these shocks are referred to as "recipient" or "shock-receiving."

Figure 4.1. Output Gap in Selected Countries
(Percent)



Source: IMF staff estimates.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.

- Are fiscal spillovers large from a global or regional perspective? How do they depend on the fiscal instruments involved (for example, government spending or taxes)? How do they depend on fiscal space in source countries?
- To what extent does the size of fiscal spillovers depend on cyclical and monetary policy conditions, in both source and recipient countries?
- How do fiscal spillovers depend on exchange rate regimes?
- What is the impact of fiscal shocks on external positions and exchange rates in source and recipient countries?
- Do fiscal reforms generate spillovers, even if the reforms are budget neutral?

The chapter sheds light on these issues by looking at the implications of fiscal policy changes in some major advanced economies for activity across a large group of advanced and emerging market economies. The empirical analysis is based on a newly constructed data set of government spending and tax revenue shocks for five systemic economies between the first quarter of 2000 and the second quarter of 2016, identified using the structural vector autoregression methodology of Blanchard and Perotti (2002). Information from the five source-country shocks is combined using the strength of trade links with a range of advanced and emerging market recipient countries to assess global spillovers.

To analyze the role that economic slack, constraints on monetary policy, and exchange rate regimes play in transmission, the chapter uses an econometric framework that can flexibly test for the presence of nonlinear effects. Model-based simulations then help to illustrate the complex cross-border transmission channels of fiscal shocks. This approach offers insights into potential changes in the external positions of source and recipient countries, as well as the dynamic behavior of key macroeconomic variables, and elucidates spillovers from different types of fiscal reforms.

The chapter's findings add to the existing empirical literature on fiscal spillovers by expanding the scope of the analysis. Previous empirical studies focus on a relatively small sample of recipient countries—often those of the Organisation for Economic Co-operation and Development (OECD) or euro area (Beetsma and Giuliodori 2004; Beetsma, Klaassen, and Wieland 2006; Auerbach and Gorodnichenko 2013; Nicar 2015; Blanchard, Erceg, and Lindé 2016; Goujard 2017; Poghosyan 2017), and several studies consider only one fiscal instrument (government spending) and/or only fiscal consolidation episodes. The chapter also adds to the literature, extending the analysis of economic slack, monetary policy accommodation, and the role of exchange rate regimes in determining spillovers from fiscal shocks.

The chapter suggests that fiscal spillovers still matter, but their size depends on the type of fiscal action and on economic circumstances in both source and recipient countries:

- *Fiscal spillovers are larger for spending shocks.* On average, a 1 percent of GDP fiscal stimulus in a major advanced economy can raise output in recipient countries by 0.08 percent over the first year. But spillovers are larger for government spending shocks than for tax shocks, consistent with the literature that points to higher domestic multipliers for spending shocks—output in recipients can increase by 0.15 percent following a spending hike, versus 0.05 percent after a tax cut. Model simulations reinforce this message and provide more granular evidence—for example, changes in public investment tend to have larger cross-border effects than changes in public consumption.

- *Relatively weak cyclical positions imply larger spillovers.* Although modest in normal times, spillovers are larger when cyclical conditions are weak, likely due to the reduced crowding-out effects of public spending on private sector activity.
- *Monetary policy constraints also increase spillovers.* When monetary policy in either source or recipient countries does not counteract fiscal shocks—for example, because the effective lower bound is binding—spillovers are much larger than during normal times.
- *Currency pegs between source and recipient countries may amplify spillovers.* There is some evidence suggesting that fiscal shocks tend to have larger spillovers on recipient countries with currencies pegged to the source country's currency than on those with flexible exchange rates.
- *Fiscal policy can change external positions in source and recipient countries.* Trade balances deteriorate in source countries following a fiscal expansion, with a consequent improvement in recipients' external positions.
- *An increase in term premiums may dampen spillovers.* If fiscal stimulus at the source increases the term premium—for instance, because of concerns about debt sustainability—spillovers are somewhat lower compared with a constant term premium scenario.
- *Under some circumstances, fiscal reforms come with spillovers as well.* Most budget-neutral fiscal reforms have limited cross-border effects, although large reforms can generate significant spillovers. For example, a reform that substantially reduces corporate income tax rates and is offset by higher consumption taxes in major economies can have repercussions in the rest of the world, including through higher global interest rates and cross-border reallocation of investment and profits.

These results point to several important policy lessons that are relevant now. Although fiscal space is currently more limited, and improved cyclical conditions in many countries mean that spillovers from fiscal policy are likely to be lower than during the global financial crisis, the analysis suggests that fiscal stimulus in major economies can nonetheless be important in lifting economic activity abroad, although not everywhere. For example, given the cyclical position and gradually less accommodative monetary policy conditions in the United States, a US fiscal stimulus would likely have relatively modest cross-border spillovers, especially if stimulus takes the form of tax policy measures. In the euro area—where there is fiscal space in some countries—stimulus could have larger spillovers. This is in the context of prospects for continued monetary policy accommodation and still-significant slack in some recipient countries.

The impact on external imbalances would also depend on the source of fiscal stimulus, as stimulus in the United States is likely to increase imbalances, whereas stimulus in some surplus euro area countries could reduce them. Where countries are considering significant reductions in corporate income tax rates, the analysis suggests associated changes in investment-location and profit-reporting decisions by multinational corporations could have significant negative spillovers on activity and the fiscal position of nonreforming countries.

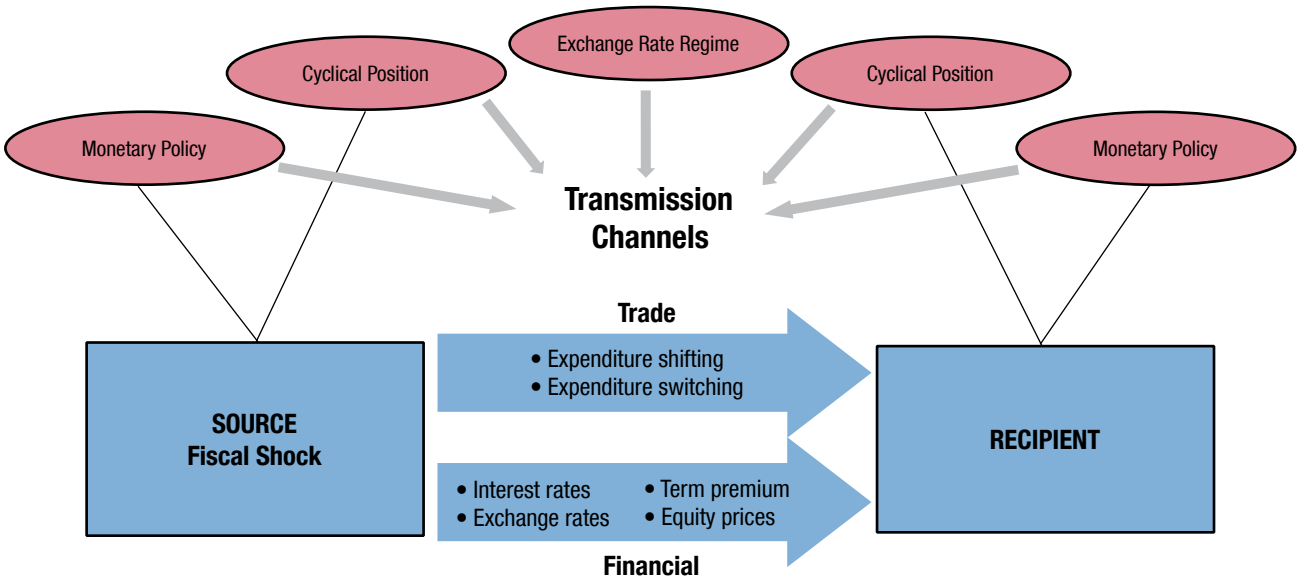
Spillovers from Fiscal Policy—A Conceptual Framework

The cross-border impact of fiscal policy changes in a given country depends on their initial domestic effects and the transmission mechanisms of shocks. This means that factors affecting the source's domestic fiscal multiplier are relevant for determining spillovers on recipient countries. The fiscal shock is propagated through different channels—primarily associated with trade links—with the final impact also depending on the economic and policy conditions in the recipient countries (Figure 4.2). This section provides a brief overview of the domestic impact of fiscal shocks, outlines their possible transmission channels, and discusses the factors affecting transmission.

Domestic Impact of a Fiscal Shock

A large body of literature on domestic fiscal multipliers suggests that cyclical and policy conditions play a role in the response of a domestic economy to fiscal shocks. In general, multiplier estimates vary significantly across countries, sample periods, and methodologies. While a comprehensive summary is beyond the scope of this chapter (see, for example, Batini and others 2014), dynamic stochastic general equilibrium and structural vector autoregression models developed since the early 1990s suggest that the size of multipliers tends to be modest (between zero and one over the first year) in "normal times"—generally understood as circumstances in which the economy

Figure 4.2. The Transmission of a Fiscal Shock



Source: IMF staff compilation.

does not have a significant output gap—and depends on a number of structural characteristics, including a country's trade openness, exchange rate regime, labor market rigidities, and size of public debt.[2] Outside normal times, multipliers can vary with the state of the business cycle (generally larger in a downturn than in an expansion, although the empirical evidence is not conclusive) or the degree of monetary accommodation (larger when monetary policy is unresponsive, such as at the effective lower bound).[3] All else equal, a larger domestic multiplier should be associated with greater cross-border spillovers.

The composition of the fiscal intervention—whether it is based on government spending or revenue measures—also influences the size of the domestic multiplier. Many studies have found that, for advanced economies, short-term spending multipliers tend to be larger than revenue multipliers (for example, see a survey in Mineshima, Poplawski-Ribeiro, and Weber 2014). This has been explained using traditional Keynesian theory—for example, while an additional dollar of government spending contributes directly to higher aggregate demand, a dollar of tax cuts can be either spent or saved by firms and/or households (that is, the marginal propensity to consume can be less than one). Recent empirical evidence using the narrative approach has found somewhat larger tax multipliers than spending multipliers, although narrative-based evidence on the latter is primarily limited to defense-related spending.[4] Yet other studies suggest that the relative magnitude of the

[2]For example, see Cole and Ohanian (2004); Kirchner, Cimadomo, and Hauptmeier (2010); Corsetti, Meier, and Müller (2012); Gorodnichenko, Mendoza, and Tesar (2012); Born, Juessen, and Müller (2013); and Ilzetzki, Mendoza, and Vegh (2013). A multiplier of one would suggest that a change in the fiscal balance translates—dollar for dollar—into a similar change in GDP.

[3]For example, see Erceg and Lindé (2010); Christiano, Eichenbaum, and Rebelo (2011); Eggertsson (2011); Woodford (2011); Auerbach and Gorodnichenko (2012a, 2012b); Owyang, Ramey, and Zubairy (2013); Nakamura and Steinsson (2014); Riera-Crichton, Vegh, and Vuletin (2015); Blanchard, Erceg, and Lindé (2016); and Canzoneri and others (2016). However, Ramey and Zubairy (forthcoming) found little evidence of state dependence of the government spending multiplier based on historical data from the United States.

[4]The narrative method, pioneered by Romer and Romer (2010), makes use of narrative records, such as budget documents and speeches, to identify the size, timing, and principal motivation for fiscal actions. The Romer and Romer (2010) data set also divides fiscal policy changes into those made for reasons related to prospective economic conditions and discretionary actions (for example, actions aimed at reducing public debt), thereby allowing for a causal analysis of the impact of fiscal policy on output. See also Ramey (2011); Cloyne (2013); Mertens and Ravn (2013); and Guajardo, Leigh, and Pescatori (2014).

spending and revenue multipliers may differ between consolidation and expansion episodes and among different degrees of monetary accommodation.[5]

Channels of Cross-Border Transmission

In standard open-economy macroeconomic models, a fiscal shock is transmitted abroad primarily through the trade channel, which consists of two effects:[6]

- *Expenditure shifting* (sometimes referred to as "leakages") refers to the direct impact of a fiscal policy change on the source country's import demand through changes in domestic consumption and investment, which affects trading partners. Here, the marginal propensity to import by both the public and private sectors plays a key role—if most spending changes are in nontradable sectors and do not translate into a higher or lower level of imports, spillovers from expenditure shifting may be smaller. Larger and more open economies tend to import more, suggesting that fiscal policy changes in these countries will have larger spillovers on others through the expenditure shifting channel.
- *Expenditure switching* refers to the impact of a fiscal shock operating through changes in the real exchange rate, which can trigger substitution between domestic and foreign goods consumption. For example, in a Mundell-Fleming-Dornbusch framework, fiscal expansion puts upward pressure on interest rates, the nominal exchange rate appreciates in the source country, and domestic prices increase.[7] The resulting real appreciation boosts import demand as foreign goods become cheaper. This effect will be more significant, especially in the short term, when the nominal exchange rate is fully flexible; where nominal exchange rates are fixed, relative price—and hence real exchange rate—adjustments can take longer. Either way, expenditure switching effects imply that a fiscal shock can have nontrivial cross-border spillovers, even if its domestic impact is muted, because the boost to import demand can occur without an increase in domestic income.

In addition to the trade channel, the response of financial variables to a fiscal shock can trigger spillovers through changes in global financial conditions. A fiscal policy change in a large economy can impact global interest rates, exchange rates, and the slope of the yield curve—the latter stemming from any perceived or actual impact of the policy change on long-term fiscal sustainability in the source country. The financial channel can work in the opposite direction to the trade channel. For example, the higher interest rates and exchange rate appreciation associated with an expansionary fiscal shock in the source country can increase the cost of foreign currency borrowing and worsen the balance sheets of corporations and households in recipient countries if there are currency mismatches, generating negative spillovers. Equity prices may also adjust, with cross-border repercussions.

Overall, the relative strength of each transmission channel will depend on the extent of trade and financial linkages between the source and recipient countries. Thus, the net spillover impact of a fiscal shock is an empirical question.

Factors Affecting the Transmission

Like the domestic fiscal multiplier, cross-border spillovers from fiscal actions tend to vary with economic circumstances. Two factors play particularly important roles:

- *Cyclical position:* The domestic multiplier—and hence spillovers through expenditure shifting—may be larger when the source country has more economic slack. For example, a fiscal stimulus that boosts public employment would be more likely to crowd out private employment when labor markets are tight (Michaillat 2014), resulting in smaller domestic and spillover impacts; the same logic applies to the case of fiscal tightening. Another possibility is that a fiscal stimulus relaxes borrowing constraints (which tend to be tighter during a downturn), for example, by raising the value of collateralizable assets along with demand, helping to increase credit and investment (Canzoneri and others 2016). Somewhat similarly, if the recipient country is operating close to full capacity when an external fiscal shock hits, greater demand in tradable sectors may crowd out activity in the rest of the economy, resulting in a more muted impact on overall economic activity.
- *Monetary policy constraints:* Whether monetary policy accommodates the fiscal shock matters, and it is relevant for both source and recipient countries.

[5]For example, see Eggertsson (2011); and Erceg and Lindé (2013).

[6]For example, see Fleming (1962); Mundell (1963); Dornbusch (1976); and Obstfeld and Rogoff (1995).

[7]Notice that other frameworks can deliver different exchange rate predictions (see Obstfeld and Rogoff 1995).

Under normal circumstances, monetary policy reacts to counter the demand and price effects of a fiscal shock. However, when monetary policy is stuck at the effective lower bound, the domestic and spillover effects can be greater. For example, if nominal interest rates in the source country do not rise in response to higher expected inflation following an expansionary fiscal shock, real interest rates decline, crowding in domestic demand and increasing the multiplier (Blanchard, Erceg, and Lindé 2016).[8] In this case, the reduction in the real interest rate in the source country may lead its real exchange rate to depreciate, changing the direction of the expenditure switching effect. In a recipient country, when at the effective lower bound, monetary policy will do little to dampen the effect of the external shock.

Aside from conjunctural factors, institutional or structural features such as the *exchange rate regime* can also affect the transmission of fiscal shocks and hence the size of spillovers. On one hand, most theoretical frameworks predict that lack of nominal exchange rate flexibility delays real exchange rate adjustments to a fiscal shock, dampening the expenditure switching effect and hence the size of spillovers. On the other hand, currency pegs can strengthen expenditure shifting between the source and recipient—for example, by reducing expected exchange rate volatility and cross-border transaction costs, which is helpful in forming trade relationships (Klein and Shambaugh 2006; Qureshi and Tsangarides 2010; Aglietta and Brand 2013)—and potentially increase spillovers. This may be particularly relevant in currency unions, as long-standing economic and institutional integration and the use of a common currency can strengthen trade (Rose and van Wincoop 2001; Berger and Nitsch 2008). The exchange rate regime also matters for the transmission of fiscal shocks through the financial channel. For example, under flexible regimes, spillovers from an expansionary fiscal shock can be dampened if currency mismatches in balance sheets of households and corporations in the recipient country make depreciations contractionary. Ultimately, which of these considerations dominates is an empirical question.

[8]This insight works for both contractionary and expansionary shocks. Low interest rates prevent the central bank from counteracting a contractionary shock by reducing rates further, while in the case of an expansionary shock, it may be fully accommodated if the central bank aims for a more accommodative stance than feasible; in either case, spillovers are amplified.

Spillovers on Economic Activity: Empirical Evidence

This section examines the relevance of fiscal spillovers in practice and how they vary with economic circumstances. It does so by looking at a very broad sample of source and recipient countries and analyzing different types of shocks under both fiscal consolidations and expansions. It first describes the empirical strategy used to estimate spillovers and then presents the estimated impact on economic activity in recipient countries.

Empirical Strategy

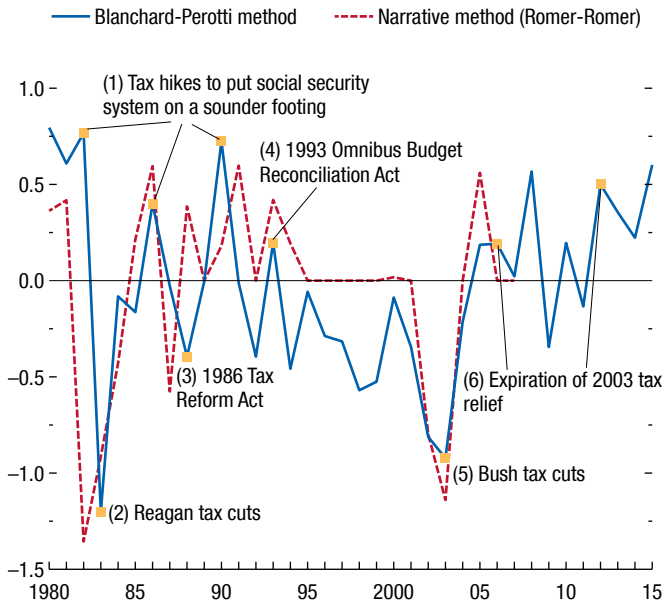
The baseline approach jointly identifies government spending and revenue shocks in five major advanced economies—France, Germany, Japan, the United Kingdom, and the United States—using the structural vector autoregression methodology of Blanchard and Perotti (2002).[9] A key assumption is that discretionary fiscal policy does not respond contemporaneously to unexpected changes in output, as it takes time for policymakers to assess the output shock and make spending and/or tax decisions, including passing and implementing new legislation. The assumption is more likely to hold in the short term, and therefore the identification uses quarterly data.[10]

The shocks identified by this approach offer a sensible narrative of the fiscal policies adopted over the past several decades. Comparison of structural shocks with historical policy records (quantified using the narrative approach in the literature) shows that structural shocks can broadly reflect major policy changes in timing and order of magnitude. For example, for the United States, the structural tax shocks capture tax cuts enacted under the Ronald Reagan and George W. Bush administrations as well as their subsequent expiration. The same is true of tax hikes during the 1980s, which

[9]Although spillovers from fiscal policy in China are potentially important, data limitations prevent the inclusion of China as a source country in the empirical analysis. Later in the chapter, model-based simulations help shed light on the potential spillover effects from China's fiscal policy.

[10]Although the use of quarterly fiscal data comes with challenges, it is instrumental to implementing the identification method used by Blanchard and Perotti (2002). These data (in real terms and seasonally adjusted) are used for shock identification only and for major advanced economies with high-quality statistics. As discussed later in the chapter, it is also reassuring that alternative identification methods that do not rely on quarterly fiscal data yield similar results for spillovers.

Figure 4.3. Tracking Tax Shocks in the United States
(Percent of GDP)



Sources: Romer and Romer (2010); and IMF staff calculations.

were put in place following the Greenspan Commission's recommendations to shore up financing of the social security system (Figure 4.3).[11]

The structural shocks also have a statistically and economically significant domestic impact. Consistent with traditional Keynesian theory and previous empirical work that uses a similar methodology, estimates of domestic multipliers using the structural shocks tend to be larger for spending instruments (slightly above one) than for tax instruments (slightly below one). Some differences are seen in the size of domestic tax multipliers across the five source countries, with the multiplier of the United States being larger than that of European peers or Japan, possibly reflecting different tax structures and the specific tax instruments used (Blagrave and others, forthcoming).

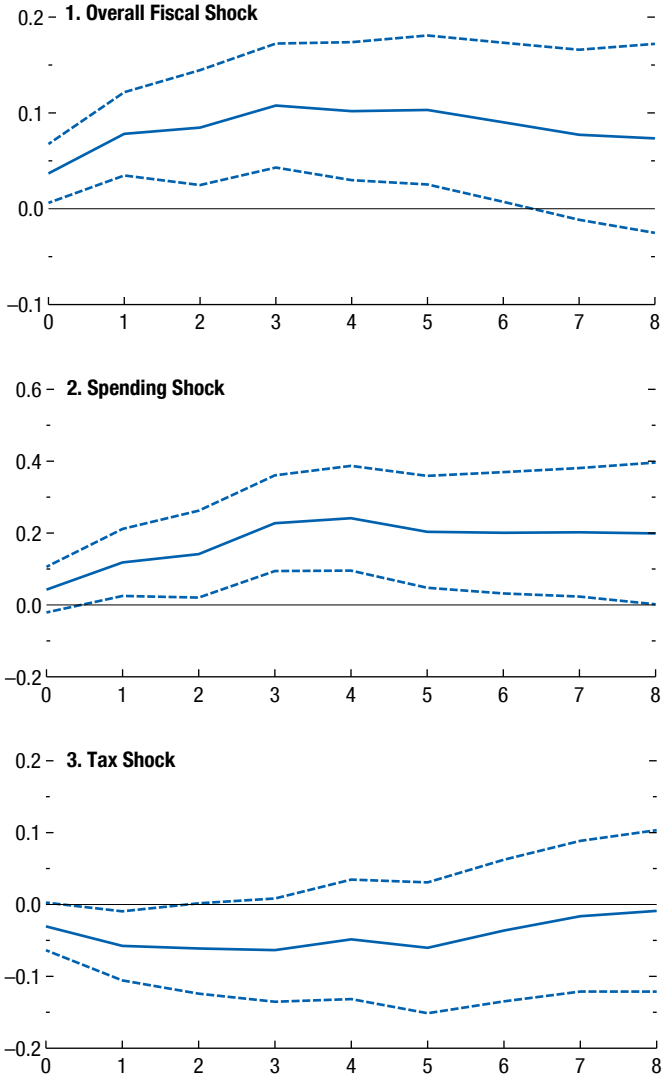
The spillover effects from the fiscal shocks are estimated using the local projections method.[12] The econometric specification relates an economic outcome in a recipient country, such as the level of output, to a fiscal shock from the five source countries—constructed by pooling together shocks from source countries and weighting them by the strength of trade links between the source and the recipient.[13] The baseline specification controls for factors that affect the normal short-term dynamics of output in the recipient country, such as past growth rates and external demand developments. The specification is estimated using quarterly data from the first quarter of 2000 through the second quarter of 2016, and the sample of 55 advanced and emerging market economies represents almost 85 percent of world output. Thus, the panel estimation gives spillover estimates for an "average" country in the sample.[14] For the panel estimation, the shocks are expressed as a share of recipient countries' output to facilitate aggregation across sources. For ease of interpretation of the economic magnitude, results are presented with shocks normalized to an average 1 percent of GDP change in the fiscal position across source countries (see details in Annex 4.2, which shows how panel results are rescaled using relative GDP levels and trade links).

Spillovers on Economic Activity

The results point to significant spillover effects from fiscal policy, especially from government spending shocks. Figure 4.4 shows the estimated response to a foreign fiscal shock of an average recipient country's output over eight quarters. A shock to the fiscal balance—henceforth referred to as the *overall fiscal shock*—is constructed as a shock to government spending minus a shock to tax revenues, such that a positive shock implies a *reduction* in the source country's fiscal balance (or an increase in the deficit). An overall fiscal shock would increase recipient output on impact, reaching a peak around the third quarter after the shock before starting to dissipate (Figure 4.4, panel 1). Estimations for specific fiscal instruments show that spillovers from a government spending shock are larger, more persistent, and more precisely estimated

[11]See Blagrave and others (forthcoming) for more examples.
[12]See Jordà (2005).
[13]The use of trade links to weight the shock is instrumental to obtaining country-specific external fiscal shocks, but it does not preclude spillovers through channels other than trade given that the estimates capture the overall response of recipient-country GDP regardless of the channel of transmission. Combining shocks from several source countries is important to use the variability emanating from different sources, given that trade patterns differ. In particular, while some source countries—such as the United States—can have a global impact, the impact of others is more regional; for example, Germany's and France's trading partners are more concentrated in Europe.
[14]More details about the data and empirical methodology are provided in Annexes 4.1 and 4.2, respectively, as well as in Blagrave and others, forthcoming.

Figure 4.4. Dynamic Responses of Recipient Countries' Output to Fiscal Shocks
(Impact on output level, percent; quarters on x-axis)



Source: IMF staff calculations.
Note: $t = 0$ is the quarter of the respective shocks. Solid lines denote point estimates and dashed lines denote 90 percent confidence bands. Shocks are normalized to an average of 1 percent of GDP across source countries.

than those from a tax shock of equal size (Figure 4.4, panels 2 and 3).[15] This is consistent with the evidence pointing to larger domestic spending multipliers than domestic tax multipliers—as discussed earlier. Data constraints prevent a more detailed empirical examination of spillovers from specific spending or tax instruments, such as government consumption or investment—an issue assessed later in the chapter through model-based simulations.

Spillovers are economically significant and in line with earlier estimates. For example, a 1 percent of GDP overall fiscal shock in an average major advanced economy would raise output in the average recipient country by about 0.08 percent over the first year. For a government spending increase of the same magnitude, the average spillover impact in recipient countries increases to 0.15 percent over the first year; for a tax hike of similar size, output falls by about 0.05 percent (Figure 4.5). As expected, spillovers from fiscal shocks are substantially lower than domestic fiscal multipliers in source countries, but still relevant.[16] These are of the same order of magnitude as those found in previous work—for example, Beetsma, Klaassen, and Wieland (2006)—although differences in country and time samples as well as shock identification make a direct comparison challenging.[17] While the spillover estimates in this section are averages across different economic and policy conditions, subsequent analysis also shows that there is a large difference between estimates in normal times and those in times of economic slack, for example.

Further analysis of components of recipient-country output corroborates the importance of trade for the transmission of fiscal shocks (Figure 4.6), consistent with the conceptual framework outlined above. In particular, a positive fiscal shock from abroad is estimated to raise recipient-country bilateral exports to the source countries. With higher export demand, firms expand investment to build production capacity, generating a second-round effect on recipient-country investment, whereas the impact on consumption appears negligible. The boost to exports and investment increases imports, some of which come from source countries. With bilateral imports rising by much less than bilateral exports, however, the recipient's trade balance with the source countries improves following the fiscal shock.

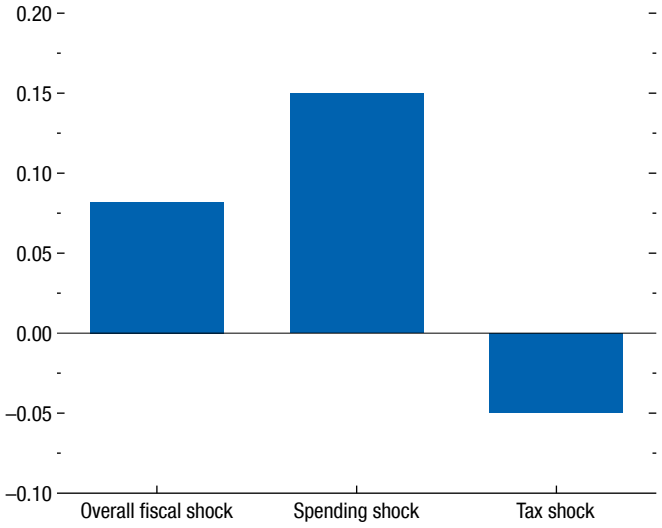
[15]These effects are assumed to be symmetric during fiscal expansions and consolidations—the panel analysis cannot disentangle a potential asymmetry from different policy actions.

[16]As discussed earlier, fiscal shocks in the chapter yield domestic spending multipliers slightly above one and tax multipliers slightly below one, on average, across the source countries.

[17]Beetsma and others (2006) find that a 1 percent of German (French) GDP shock to government spending results in a European GDP response of about 0.14 (0.08) percent after two years. For a tax shock, spillovers are about –0.05 (–0.03) percent. Compared with studies that express shocks in units of recipient-country GDP (Auerbach and Gorodnichenko 2013; Goujard 2017), estimates are also broadly similar. A detailed comparison to the literature is provided in Blagrave and others, forthcoming.

Figure 4.5. Spillovers of Fiscal Shocks on Recipient Countries' Output

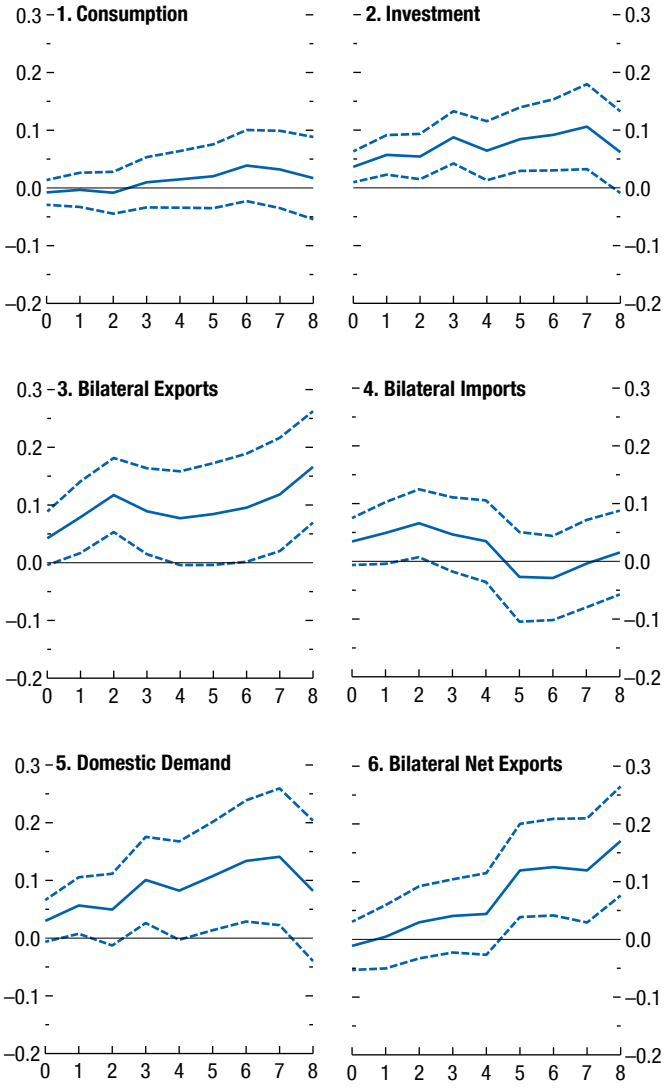
(One-year average impact on output; percent)



Source: IMF staff calculations.
Note: Shocks are normalized to an average of 1 percent of GDP across source countries.

Figure 4.6. Dynamic Responses of Components of Recipient Countries' Output to a Fiscal Shock

(Percent of output; quarters on x-axis)



Source: IMF staff calculations.
Note: $t = 0$ is the quarter of the shock. Solid lines denote point estimates, and dashed lines denote 90 percent confidence bands. Responses to an overall fiscal shock are presented. Shocks are normalized to an average of 1 percent of GDP across source countries.

The empirical spillover estimates are robust to alternative specifications and shock-identification strategies. For example, the baseline results do not change much with the inclusion of additional control variables (for example, the recipient-country short-term interest rate, output gap, unemployment rate, and fiscal stance).[18] Estimates are also similar—though slightly larger—using a panel vector autoregression estimation methodology that allows for potential feedback effects of exchange rates and interest rates on output. In addition, estimates using comparable fiscal shocks obtained from alternative identification strategies—namely forecast errors and narrative approach—also yield spillover estimates that are similar in size and dynamics. This provides reassurance that the baseline results are not driven by the structural vector autoregression methodology for identifying fiscal shocks.[19] Annex 4.3 gives more details about robustness tests.

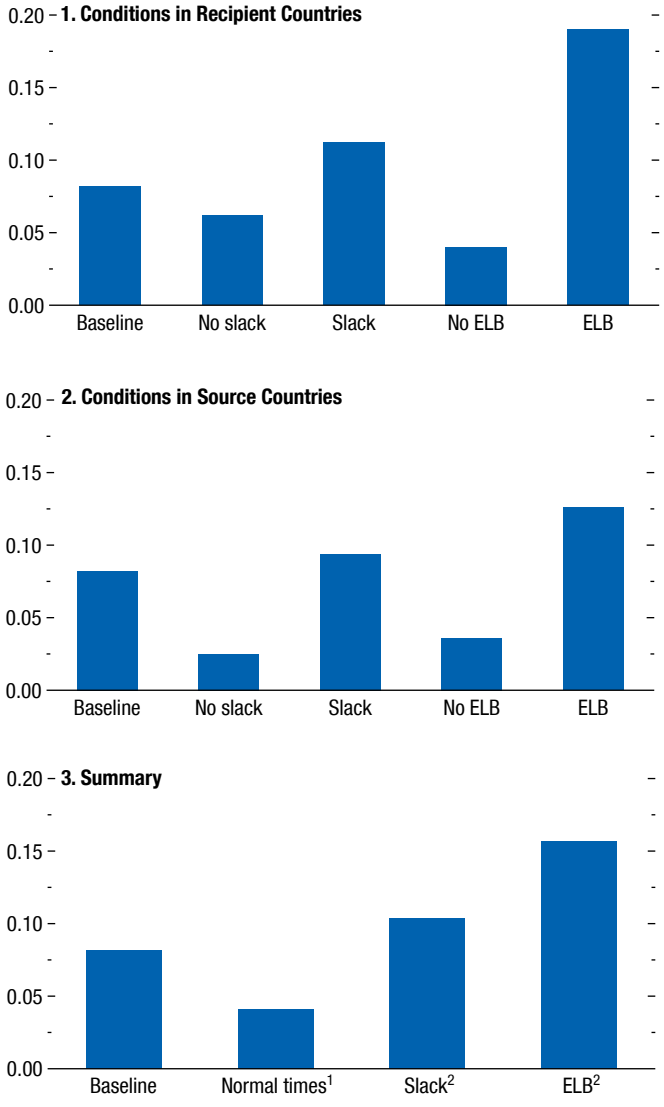
[18]These robustness checks can be found in Blagrave and others (forthcoming).

[19]Forecast errors are constructed as the difference between actual and projected values of the relevant fiscal variable (spending or tax revenues). The shocks based on forecast errors are identified as residuals from a regression of the spending- or tax-based forecast errors on GDP forecast errors and lagged macroeconomic variables.

Spillovers under Different Economic and Policy Conditions

Business cycle and monetary policy conditions in both source and recipient countries, along with the bilateral exchange rate regime, can affect the magnitude of spillovers from fiscal policy. As outlined earlier in the conceptual framework, these factors are expected to affect the domestic impact of fiscal shocks—if

Figure 4.7. Spillovers under Various Economic and Policy Conditions
(One-year average impact on output; percent)



Source: IMF staff calculations.
Note: ELB = effective lower bound. Slack is defined as output gap below zero; and ELB corresponds to short-term interest rates in the bottom 25 percent of cross-country historical distribution. Responses to an overall fiscal shock are presented. Shocks are normalized to an average of 1 percent of GDP across source countries.
[1]Normal times refer to average of no slack and no ELB in both source and recipient countries.
[2]Average estimates for conditions in source countries and conditions in recipient countries.

they pertain to the source country—as well as their cross-border transmission. In general, a larger impact in the source country is expected to give rise to more significant spillovers.

Cyclical Position and Monetary Policy Constraints

To test how cyclical positions and monetary policy affect the impact of fiscal shocks, the baseline econometric framework is augmented to allow for potential regime dependence (see Annex 4.2 for details). The definitions of regimes are based on the prevailing output gap or the level of the short-term interest rate in either source or recipient countries. Specifically, a negative output gap is assumed to represent economic slack, and a short-term interest rate below the 25th percentile of the relevant cross-country distribution is a proxy for monetary policy constrained by the effective lower bound.[20] Results are robust to using alternative definitions of slack, including the unemployment gap or smooth-transition probability as in Auerbach and Gorodnichenko (2013). For the effective lower bound, results are also robust to using an absolute interest rate threshold that is common to all countries.

Consistent with theory and empirical findings in the domestic multiplier literature, spillovers are estimated to be larger during episodes of economic slack than in normal times. For example, if the recipient country has slack when the external fiscal shock hits, its output would rise by 0.11 percent over the first year in response to a 1 percent of GDP overall fiscal shock in an average major advanced economy. By contrast, the response to the same shock would be almost halved—to 0.06 percent—when there is no economic slack (Figure 4.7, panel 1). Differential effects are also observed when the *source* economy has slack, compared with when it does not—with estimates varying between 0.09 percent and 0.03 percent, respectively (Figure 4.7, panel 2).

Spillovers can be even larger when monetary policy is constrained by the effective lower bound, either in the source or the recipient country (Figure 4.7, panels 1 and 2). For example, subject to a 1 percent of GDP overall fiscal shock in an average major advanced economy, the response of recipient-country output can be more than four times greater when its interest rate is exceptionally lower than in normal times.[21] Monetary

[20]Separate distributions are applied for advanced and emerging market economies.

[21]These results—for both slack and effective lower bound cases, in both recipient and source countries—also extend to disaggregated spending and tax shocks (see Blagrave and others, forthcoming, for more details).

policy constraints in source countries have a similar effect on spillovers, as they can amplify the domestic impact of fiscal shocks. Although slack and the effective lower bound have distinct mechanisms to amplify spillovers, it is often difficult to clearly distinguish the two states in empirical estimation because they can coincide in practice, as has occurred in recent years.[22] This caveat should be kept in mind when interpreting the results.

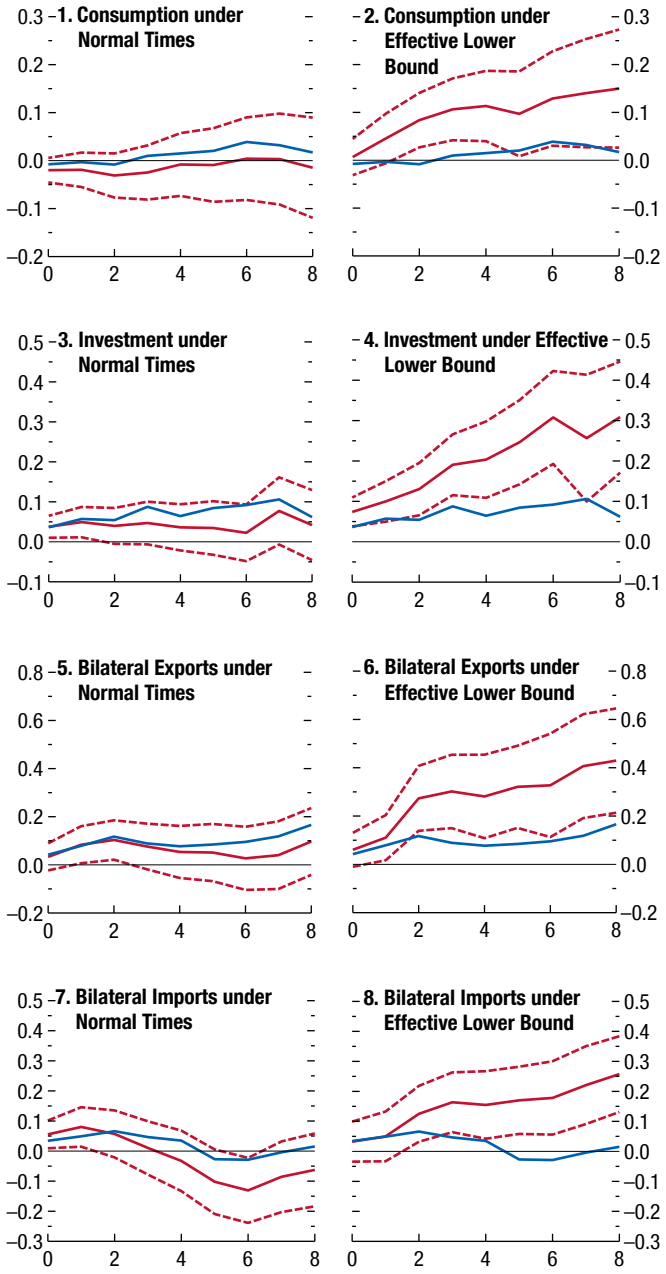
The response of GDP components under monetary policy constraints offers further insights into how a fiscal shock is transmitted to recipient countries (Figure 4.8). Faced with a positive fiscal shock from abroad, consumption—and particularly investment—in a recipient country responds much more strongly when the domestic nominal interest rate is close to the effective lower bound, likely reflecting declining real interest rates associated with higher expected inflation. This is consistent with results from theoretical models (see section on factors affecting transmission) and is confirmed by the results of the model-based simulations presented in the next section. The responses of exports to and imports from the source countries are also stronger when monetary policy accommodates the fiscal shock, in line with the domestic response of investment.

Exchange Rate Regime

As discussed in the section on factors affecting transmission, the exchange rate regime can also impact the size of fiscal spillovers. To investigate this question, this section analyzes whether the impact of a fiscal shock in the United States varies for recipient countries with fixed and flexible exchange rate regimes vis-à-vis the US dollar. The United States—with its global currency and systemic trade importance—is a suitable source country for this exercise. Countries do not typically peg to the British pound or the Japanese yen. In the case of the euro, Germany's and France's trade importance is mostly within Europe, where most sample countries are

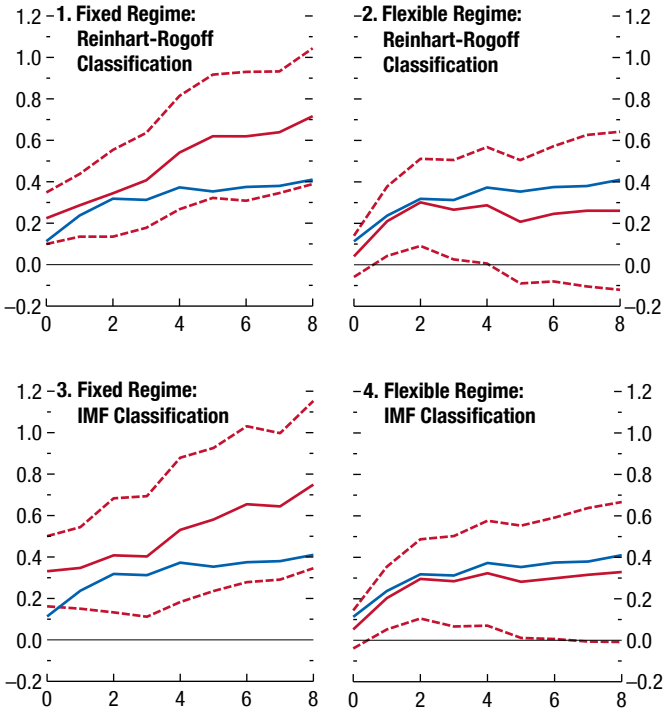
[22]In the post-2000 sample considered in this empirical exercise, about 26 percent of country-quarter observations fall under the definition of "effective lower bound," three-quarters of which coincide with economic slack. Similarly, about 55 percent of observations fall under the definition of "slack," 35 percent of which coincide with the effective lower bound. For example, many advanced economies experienced both severe slack and very low interest rates in the aftermath of the global financial crisis. Japan, in particular, experienced both slack and effective lower bound for 84 percent of the observations during the sample period.

Figure 4.8. Dynamic Reponses of Components of Recipient Countries' Output under Normal Times and Effective Lower Bound in Recipient Countries
(Percent of output; quarters on x-axis)



Source: IMF staff calculations.
Note: Normal times = no effective lower bound. $t = 0$ is the quarter of the shock. Solid red lines denote point estimates under different conditions; dashed red lines denote 90 percent confidence bands; and solid blue lines represent the unconditional response. Effective lower bound corresponds to short-term interest rates in the bottom 25 percent of cross-country historical distribution. Responses to an overall fiscal shock are presented. Shocks are normalized to an average of 1 percent of GDP across source countries.

Figure 4.9. Dynamic Reponses of Recipient Countries' Output to US Spending Shock under Various Exchange Rate Regimes
(Impact on output, percent; quarters on x-axis)



Source: IMF staff calculations.
Note: $t = 0$ is the quarter of the shock. Solid red lines denote point estimates conditional on exchange rate regime; dashed red lines denote 90 percent confidence bands; and solid blue lines represent the unconditional estimates. Shocks are normalized to an average of 1 percent of GDP across source countries (note that this represents a less than 1 percent of US GDP shock).

either euro area members or peg to the euro, not allowing for enough variation in the data to identify the effect for those with flexible regimes.

The empirical framework is again modified to allow for regime dependence of the fiscal shock—now originating only in the United States—where the regime definition is based on the prevailing bilateral exchange rate arrangement between the United States and the recipient country in a particular period. Specifically, a "fixed" exchange rate regime is defined as encompassing de facto pegs or crawling pegs, classified using two alternative methods: (1) Reinhart and Rogoff (2004) updated by Ilzetzki, Reinhart, and Rogoff (2017a, 2017b)—henceforth called "Reinhart-Rogoff" classification; and (2) the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* ("IMF" classification).[23] More details are provided in Annex 4.1.

The evidence suggests that a government spending shock in the United States generates stronger and more persistent impacts on countries whose exchange rates are pegged to the US dollar than on those whose exchange rates are more flexible (Figure 4.9). This is the case regardless of which exchange regime classification is used. The difference in the output responses between fixed and flexible regimes is statistically significant on impact under both classifications and also during the second year under the Reinhart-Rogoff classification. At the same time, no difference in spillovers is observed between fixed and flexible regimes from an overall fiscal shock or a tax shock (not shown). Taken at face value, this result seems to point to relatively weak expenditure switching effects in the transmission of spending shocks. This weakness could reflect that, for a significant portion of the sample, US monetary policy was constrained by the effective lower bound, limiting interest rate and hence exchange rate movements. Another possibility is that, as discussed earlier, trade integration may be stronger under pegs—beyond what can be captured by the simple import ratios used in weighting the shocks.

The Transmission of Fiscal Shocks—Model-Based Analysis

To complement the empirical analysis, the chapter presents model-based simulations using a multiregion general equilibrium model—the IMF's G20 Model. The model simulations are intended to be illustrative and offer further insights into the macroeconomic adjustment to fiscal shocks—including the response of exchange and interest rates—and more granularity on the impacts of various fiscal instruments. Overall, simulations serve as theory-based cross-checks on the empirical results and provide insights into how fiscal shocks are propagated.[24]

The results are generally consistent with the empirical findings in this chapter: simulations show that spillovers from temporary fiscal shocks can differ

[23]In 2015, for example, the Reinhart-Rogoff classification has more recipient countries classified as having "fixed" exchange rates compared with the IMF classification. The number of fixed-rate countries varies over time. In general, there tend to be more fixed exchange rate regimes in earlier years of the sample.

[24]Additional details on the G20 Model are available in Andrle and others (2015).

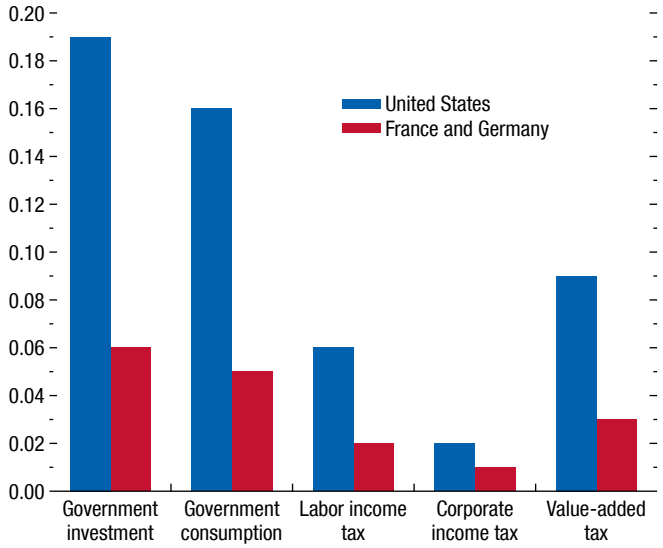
substantially depending on the monetary policy response and the fiscal instruments used. In addition, the responses of GDP components under different assumptions on monetary accommodation closely resemble those identified empirically.[25] In all cases, fiscal shocks are expressed as a share (generally 1 percent) of a particular source country's GDP—this differs from how results were presented in the empirical section and implies that, all else equal, shocks emanating from larger countries will have larger spillover effects.

Spillovers on Output: Fiscal Instruments and Policy Accommodation

The model simulations confirm substantial spillovers from government spending shocks. Specifically, they show that spending shocks have larger spillover effects than do tax shocks.[26] This coincides with results from the empirical analysis described in this chapter. However, structural models offer insights into the impact of specific fiscal instruments as well, as shown in Figure 4.10:

- *Spending instruments:* Government investment shocks in the G20 Model have larger domestic and spillover effects than shocks to government consumption. This is because government investment increases the public capital stock, which is assumed to increase private sector productivity, stimulating private investment and labor demand and in turn raising wages and labor income. By contrast, government consumption does not affect private sector productivity.
- *Tax instruments:* Model simulations suggest that temporary changes in consumption taxes have the largest domestic and spillover effects among tax instruments. Unlike cuts in labor income or corporate taxes, where benefits can be saved, households must increase their current-period spending to take advantage of temporarily lower consumption taxes.[27] In addition, because investment decisions have a long planning horizon and investment can be costly to adjust (Christiano, Eichenbaum, and Evans 2005), the impact of temporary corporate income tax changes is smaller than that of temporary labor income tax changes—the latter affect liquidity-constrained households, which fully adjust consumption in response.

Figure 4.10. Impact of Fiscal Shocks on Global GDP Based on Various Instruments
(Two-year average impact, percent)



Source: IMF, G20 Model (G20MOD) simulations.
Note: All shocks are 1 percent of source-country GDP, lasting two years.

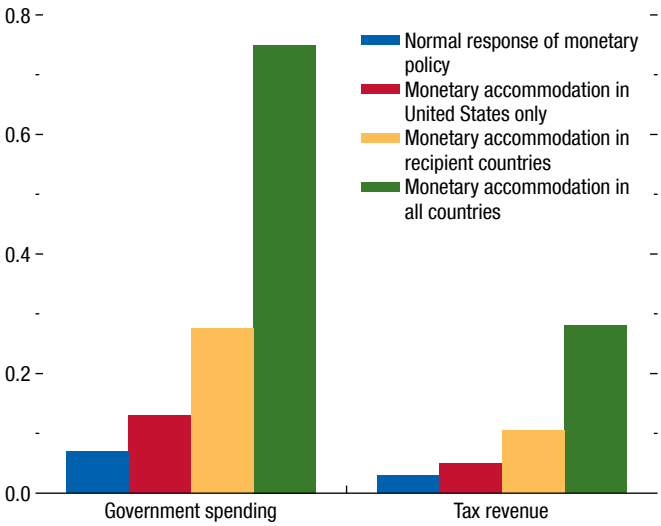
Consistent with the empirical analysis, model simulations show that spillovers on output can vary widely, depending on the response of monetary policy, in both source and recipient countries. Figure 4.11 depicts the impact of the same temporary two-year US government spending and tax shocks considered in Figure 4.10—using the *average* across spending and tax instruments—on recipient-country GDP under different monetary policy assumptions: (1) a rule-based response in both source and recipient countries, (2) accommodation in the United States during the first two years following the fiscal shock, (3) accommodation in recipient countries during the first two

[25]The domestic and spillover effects of permanent fiscal shocks may differ from those of temporary shocks, partly because of their effects on interest rates. For example, permanent fiscal consolidations in large countries may lower global interest rates, thereby crowding in investment and boosting GDP over the long term. Some permanent fiscal reform scenarios are considered in the next section.

[26]For simplicity, the analysis presented here is conducted for France, Germany, and the United States; the intention is to draw broad lessons about the heterogeneity of spillovers across different fiscal instruments. The findings presented here apply equally to other countries' fiscal shocks.

[27]Conversely, when consumption taxes increase temporarily, households can avoid some of the burden by postponing consumption.

Figure 4.11. Spillovers from US Fiscal Shocks with and without Monetary Accommodation
(Two-year average impact on rest of the world GDP, percent)



Source: IMF, G20 Model (G20MOD) simulations.
Note: Normal response of monetary policy is a rule-based response, in countries without fixed exchange rate regimes, where monetary policy responds to an increase in expected future inflation by increasing nominal interest rates to reduce demand and return inflation to target.

years, and (4) accommodation in both the United States and recipient countries during the same period. Spillovers vary markedly depending on the response of monetary policy—for example, they can be about four times larger if monetary policy in recipient countries fully accommodates the shock, as compared with when monetary policy follows the inflation-forecast targeting rule in each country.[28,29] These results are closely aligned with the empirical analysis presented in Figure 4.7—when interest rates in the recipient country are at or near the effective lower bound, spillover effects are estimated to be about four times larger than they are during normal times.

Model-based simulations can also offer insights in terms of regional patterns of the impact of fiscal shocks. Spillovers from stimulus in the United States have the broadest global reach—due to the large size of the US economy and its moderately strong trade links with most regions (Figure 4.12).[30] Spillovers from the United States are largest on countries in Latin America and Canada—all of which account for significant shares of US import demand. For shocks from France and Germany, spillovers are largest on Europe, given deep trade integration, but relatively small on other regions. Finally, fiscal measures in China have meaningful spillovers on each region due to the size and openness of the Chinese economy. By region, spillovers are slightly larger on countries in Asia—given strong trade links—though spillovers on Europe, Canada, and Latin America are not trivial. China's economy, given its growing global clout, is playing an important role in driving spillovers onto neighboring countries through the trade channel and the impact of fluctuations in demand on commodity prices (IMF 2016).

Macroeconomic Adjustment and the Role of Financial Variables

Model simulations can give a richer description of the macroeconomic dynamics behind fiscal spillovers. In particular, simulations allow for an examination of the dynamics of interest rates and exchange rates—because these variables are forward-looking in nature, they respond to changes in the expected future state of the economy, so when a change in fiscal policy is announced or expected, these variables react immediately. This makes it difficult to capture their behavior in empirical exercises using structural shocks, which typically assess the impact of the implementation of fiscal changes.[31] The chapter uses both model-based analysis and an alternative empirical approach that isolates anticipation effects to assess the impact of fiscal shocks on exchange rates and external positions in recipient countries.

To shed light on the dynamics of adjustment following fiscal shocks, Figure 4.13 presents the response of several variables in the United States and the global

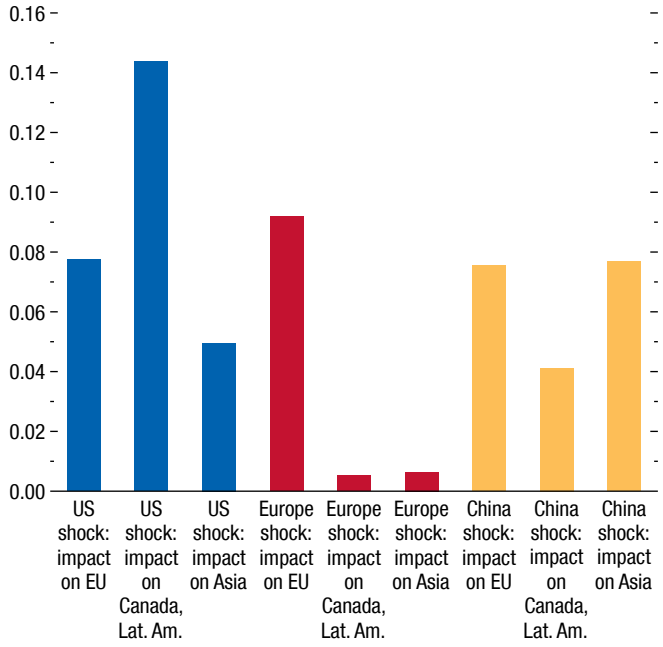
[28]In the G20 Model, monetary policy in countries with flexible exchange rate regimes responds to an increase in expected future inflation by increasing nominal interest rates to reduce demand and return inflation to target.

[29]Spillovers are even larger under the full accommodation scenario—they should be viewed as an upper bound, as such a scenario would require an exceptional coordinated accommodation by monetary policy in all countries.

[30]The regional distribution of spillovers predicted by model simulations closely resembles those implied by the empirical analysis presented earlier. See Blagrave and others (forthcoming) for more details.

[31]Several studies estimating fiscal shocks in structural vector autoregression models find that increases in government spending trigger exchange rate *depreciations*—see, for example, Corsetti and Müller (2006); Kim and Roubini (2008); Monacelli and Perotti (2010); Enders, Müller, and Scholl (2011); and Ravn, Schmitt-Grohé, and Uribe (2012). This empirical result runs counter to the predictions of the Mundell-Fleming-Dornbusch framework, although it is consistent with some new open-economy macroeconomic models (Obstfeld and Rogoff 1995).

Figure 4.12. Regional GDP Impact of Government Spending Shocks from the United States, Europe, and China
(Two-year average impact, percent)

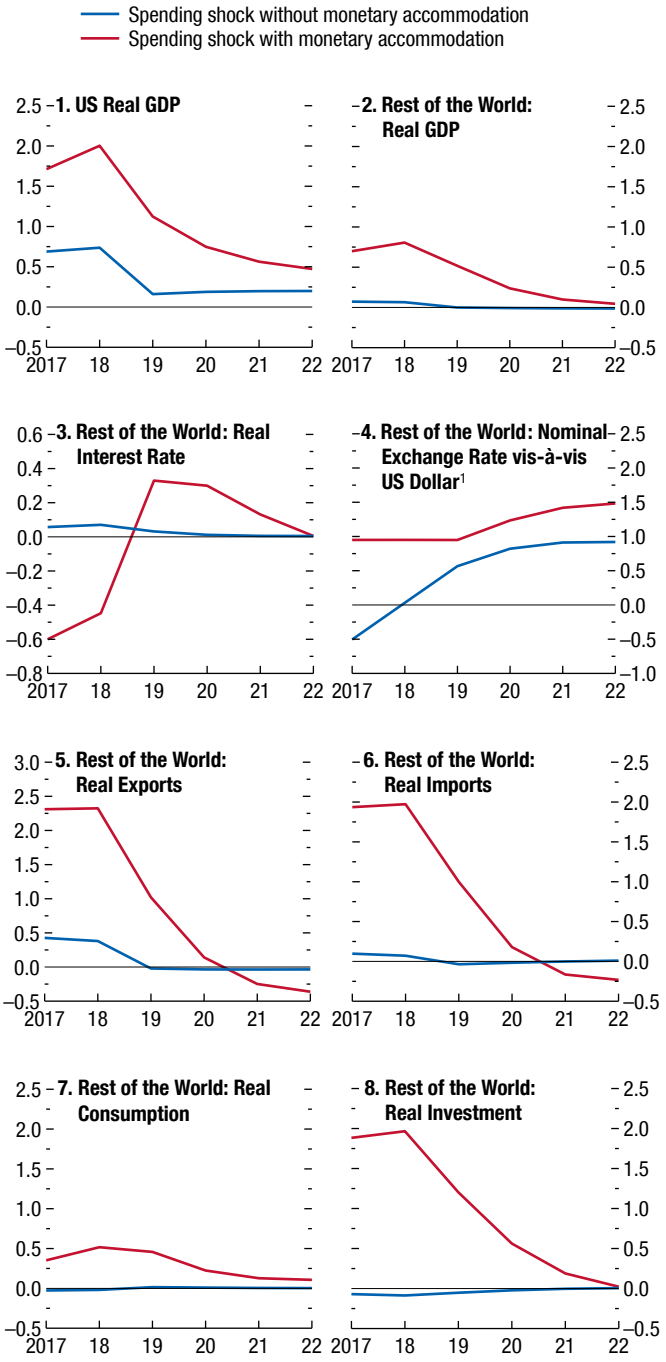


Source: IMF, G20 Model (G20MOD) simulations.
Note: EU = European Union; Lat. Am. = Latin America (Argentina, Brazil, Mexico). Europe shock refers to France and Germany shocks. Shock to government spending is equivalent to 1 percent of GDP, lasting two years. Average level impact over two years with no monetary accommodation in any country is presented.

economy to a temporary government spending increase in the United States. Given the importance of the monetary policy reaction, it presents a two-year stimulus scenario under both a normal monetary policy response (blue line) and monetary policy accommodation in all countries (red line).

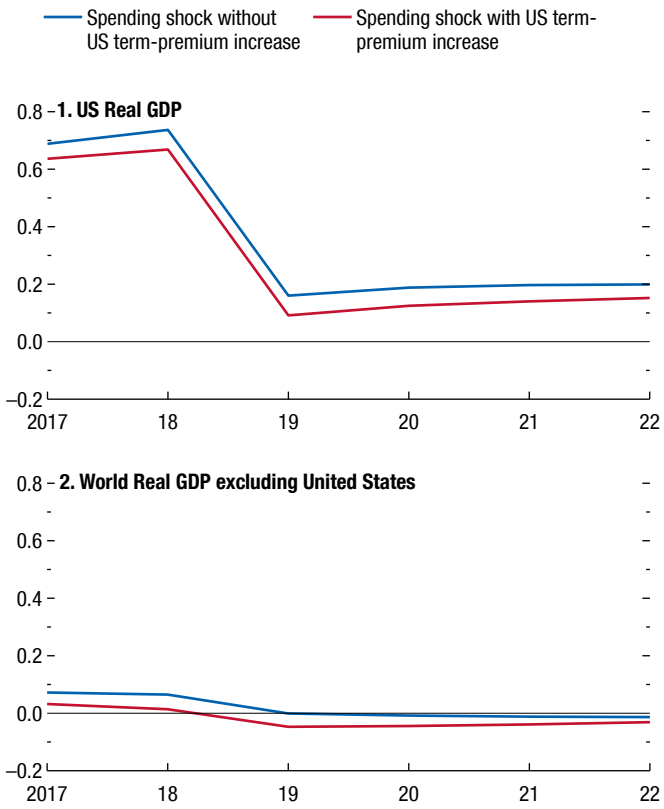
- *Monetary policy response:* Following the fiscal shock, policy rates increase to curb inflationary pressures from the demand shock both in the United States and in recipient countries. The uncovered interest parity condition implies that bilateral nominal exchange rates in relation to the US dollar depreciate in the short term given that the response of US monetary policy is more pronounced than elsewhere—being the source of the shock, inflationary pressures are greater there. The increase in US external demand and the nominal exchange rate depreciation in recipient countries induce a modest increase in exports from the rest of the world, and thus a slight improvement in the corresponding trade balances. However,

Figure 4.13. Dynamic Reponses to a US Government Spending Shock
(Percent deviation from baseline)



Source: IMF, G20 Model (G20MOD) simulations.
Note: Red lines denote the response to a 1 percent of GDP US government spending shock lasting two years with monetary accommodation in both source and recipient countries lasting two years, and blue lines represent the response to the same shock without monetary accommodation in any country.
[1]Increase represents appreciation.

Figure 4.14. Spillovers from US Spending Shock with and without a US Term-Premium Increase
(Percent deviation from baseline)



Source: IMF, G20 Model (G20MOD) simulations.
Note: Red lines denote the response to a 1 percent of GDP US government spending shock lasting two years, with a 25 basis point increase in the US term premium and subsequent spillovers to term premiums in other countries. Blue lines represent the response to the same spending shock with no term-premium increase. No monetary accommodation is assumed for any country.

the increase in world interest rates reduces consumption and investment in the rest of the world. The net effect on GDP is small but positive.

- *Monetary accommodation:* In this scenario, the positive impact on inflation goes unchecked, causing real interest rates to decline. This triggers a strong positive response in both consumption and investment in the rest of the world as the cost of capital and current-period consumption declines. The contrast between the dynamics of consumption and investment under monetary accommodation, as opposed to normal times, is consistent with the empirical findings shown in Figure 4.8. Monetary accommodation also implies a much larger impact on both exports—due to stronger external demand conditions—and imports, due to stronger domestic activity in recipients. The expenditure switching channel operates in the opposite direction under monetary accommodation, with recipient countries' real exchange rates *appreciating* against the US dollar. This occurs because the negative impact on US real interest rates is more pronounced than elsewhere. Recipients' trade balances still improve because of the strong increase in demand from the United States. Overall, as shown in Figure 4.11, the cumulative effect on global GDP is amplified under monetary accommodation.

If the term premium increases following a fiscal impulse—capturing potential concerns about debt sustainability or higher future inflation—and monetary policy responds normally, the impact of stimulus in the United States is reduced and spillovers are marginally smaller (Figure 4.14). In this case, higher interest rates than in the baseline scenario discourage investment and consumption in the United States. Therefore, the net effect on GDP in the rest of the world is slightly smaller, illustrating the potential for an adverse reaction of financial markets to an increase in spending to reduce spillovers.[32] This possibility underscores the importance of having a credible medium-term macroeconomic framework, which gives market participants confidence that inflation will be held in check because debt dynamics are sustainable.

An empirical examination of how exchange rates and external positions respond to fiscal shocks is presented in Box 4.1. To capture anticipation effects, the analysis constructs fiscal shocks based on the methodology of Forni and Gambetti (2016), which identifies these shocks at announcement dates, as captured by changes in professional forecasts. It shows that an increase in government spending in the United States leads to a real appreciation of the dollar and a worsening of the US trade balance, as predicted by standard macroeconomic models.

Fiscal Reforms

The model-based analysis also facilitates the examination of spillovers from so-called fiscal reforms—defined

[32]In this scenario, the increase in the US term premium is assumed to drive up term premiums in other countries as well, according to historical correlations between these variables across countries.

as permanent budget-neutral shifts in the composition of the public sector budget. The scenarios considered so far in the chapter deal with temporary fiscal impulses associated with a change in the fiscal stance in the source country. However, budget-neutral fiscal reforms may also have spillover effects. To demonstrate these differences, the following two scenarios are considered: (1) a budget-neutral corporate income tax reform and (2) a budget-neutral infrastructure spending increase. These illustrative scenarios suggest that fiscal reforms have limited cross-border effects, though significant changes can still generate large spillovers.

Budget-Neutral Corporate Income Tax Reform

The direct spillovers of a (simultaneous) budget-neutral reduction in corporate income tax rates in France, Germany, and the United States—the "source" countries in this scenario—would be slightly negative.[33] The scenario's main assumptions are that corporate tax rates are reduced by 15 percentage points, consumption-tax rates rise to offset the revenue loss, and monetary policy responds normally.[34] The direct impact of the reform is captured by the blue lines in Figure 4.15. As shown in the figure,

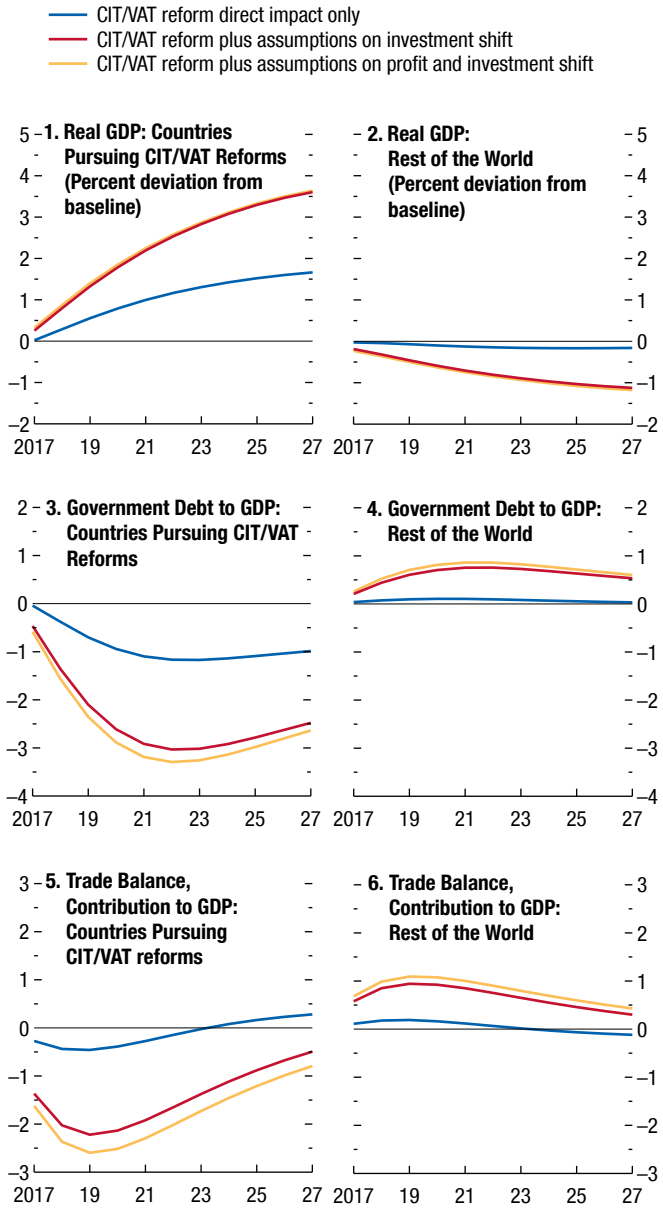
- Real GDP increases gradually as lower corporate income tax rates raise the return to capital in the source countries, stimulating investment. This positive effect on reform-country GDP is only partly counteracted by the increase in the consumption tax rate, which depresses consumption. Although these reforms are initially budget neutral, the expansion of investment increases tax revenues over time, which reduces the deficit and the debt stock in source countries.[35] Their trade balances deteriorate slightly due to investment-driven import demand.
- Given the lack of fiscal stimulus in the short term, the direct spillovers on recipient countries are limited. Over the medium term, GDP in recipient countries is slightly reduced, as recipient countries are now at a

[33]France, Germany, and the United States are considered in this scenario given that they currently have corporate income tax rates above the OECD average, giving them scope for a substantial reduction. Reforms are budget neutral, contingent on the baseline path of output.

[34]In the case of the United States, which has no federal consumption tax, this would imply enacting such a tax.

[35]Absent the offsetting increase in consumption taxes, the corporate income tax reduction would result in a net loss of tax revenues, even after accounting for the increase in the tax base due to stronger investment.

Figure 4.15. Spillovers from Corporate Income Tax Reduction Financed by an Offsetting Increase in Value-Added Tax
(Percentage-point deviation from baseline, unless noted otherwise)



Sources: IMF, G20 Model (G20MOD) simulations; and IMF staff estimates.
Note: Blue lines denote the response to CIT/VAT reforms only, red lines denote the response to CIT/VAT reforms plus assumptions on investment shift, and yellow lines denote the response to CIT/VAT reforms plus assumptions on profit and investment shift. No monetary accommodation is assumed for any country. For rest of the world, no reforms are assumed. CIT = corporate income tax; VAT = value-added tax.

competitive disadvantage with respect to their return to capital, and real interest rates are slightly higher—implying lower investment. This negative impact more than offsets the small impetus to exports associated with increased demand from source countries.

However, beyond this direct effect, fiscal reforms may also affect investment and profit-reporting decisions. As discussed in Devereux (2008) and De Mooij and Ederveen (2008), corporate tax rates influence both intensive and extensive (discrete or location) decisions of firms, suggesting that multinational companies may relocate operations when faced with significant changes in relative tax rates in different jurisdictions. In addition, both studies note that it is feasible for multinational companies to shift profits between countries. In the scenario, the lower corporate income tax rates prompt these firms to shift operations—both investment and the jurisdiction in which profits are reported—to source countries, to the detriment of recipients.

The effect of investment and profit shifting are illustrated by the red (investment shifting only) and yellow (investment and profit shifting together) lines of Figure 4.15. Based on estimates in the literature on profit and investment shifting, the scenario assumes that foreign direct investment in countries not pursuing reforms could decline by about $400 billion—this loss is assumed to be distributed equally across all countries as a share of GDP.[36] By contrast, the countries pursuing reforms are assumed to benefit by a similar amount, above and beyond the immediate impact on investment from the corporate income tax reduction discussed above.[37] Profit shifting is assumed to be a pure fiscal revenue gain for source countries and a corresponding loss for other countries.[38]

The results suggest that investment shifting and profit shifting could trigger more significant spillovers on activity and affect fiscal positions. Activity in source countries would be considerably higher—with GDP increasing by almost 4 percent after 10 years—although significantly reduced elsewhere, by about 1 percent. Corresponding changes in trade balances would imply a material deterioration for corporate-tax-reforming countries—as import demand rises significantly—and an improvement for the rest of the world, due to import compression and export growth. Both investment shifting and profit shifting can also have an impact on fiscal positions, improving the primary balance of source countries and undermining the balance of others, above and beyond the direct effects of the corporate income tax reform itself. The marginal impact of profit shifting on public debt stocks can be seen by comparing the red and yellow lines in panels 3 and 4 of Figure 4.15—it is clear that the impact of investment shifting (measured by comparing the blue and the red lines) is much larger than that of profit shifting.[39]

Budget-Neutral Permanent Increase in Public Investment

Compared with corporate income tax reforms that trigger investment and profit shifting, a budget-neutral permanent increase in public investment would have very modest spillovers.[40] The scenario assumes a ½ percent of GDP increase in public investment in the five large economies considered in the empirical exercise—France, Germany, Japan, the United Kingdom, and the United States—which is financed by an increase

[36]This is a simplifying assumption. Countries that currently benefit from a significant corporate income tax gap relative to the source countries, or those with a significant presence of multinational corporations based in countries pursuing corporate income tax reforms, may be more adversely affected by investment shifting.

[37]The assumed impact of investment shifting is derived by applying an estimated semielasticity of the corporate tax base to tax rate changes from De Mooij and Ederveen (2008)—taken to be –3.2—to foreign direct investment inflows and outflow data for France, Germany, and the United States, which proxy the foreign portion of the corporate tax base subject to relocation. Under a large corporate income tax rate reduction, foreign direct investment inflows would increase as foreign multinationals choose to locate more production in the countries pursuing reforms, and outflows would decline as domestic multinationals choose to develop more production capacity domestically. It is important to note that semielasticities in the literature vary widely and that the estimated investment-shifting impact of corporate income tax reform is sensitive to these assumptions.

[38]The assumed impact of profit shifting is derived by applying an estimated semielasticity of profits with respect to the tax rate—a value of 2, taken from De Mooij and Ederveen (2008)—to estimates of the share of multinational firms in each country, which is assumed to be approximately 0.6 in Germany and France and 0.3 in the United States, and to the corporate income tax rate reduction being considered (15 percentage points). The same caveats mentioned for investment shifting regarding elasticities apply.

[39]The impact on public debt in this scenario is only transitory, with all debt-to-GDP ratios returning to baseline in the long term. The speed of adjustment back to baseline depends on assumptions regarding the aggressiveness of the model's fiscal rule—other assumptions would lead to different adjustment dynamics.

[40]This result is broadly consistent with results reported in Bussière and others (2017), who find that most budget-neutral fiscal reforms do not have large cross-border trade spillovers, except in the case of coordinated reforms in periods of accommodative monetary policy.

in consumption taxes. Such a reform would boost the capital stock in source countries, thereby increasing output permanently—the increase in investment resulting from the higher productivity associated with an expansion of the public capital stock outweighs the negative impact on domestic consumption of higher consumption taxes. However, as shown in Figure 4.16, although there would be some modest cross-border impact due to expenditure shifting, the impact would be muted by an exchange rate depreciation in source countries, implying that the expenditure switching channel will eventually offset the positive effect.[41] The impact on recipient countries' trade balances is small, but negative.

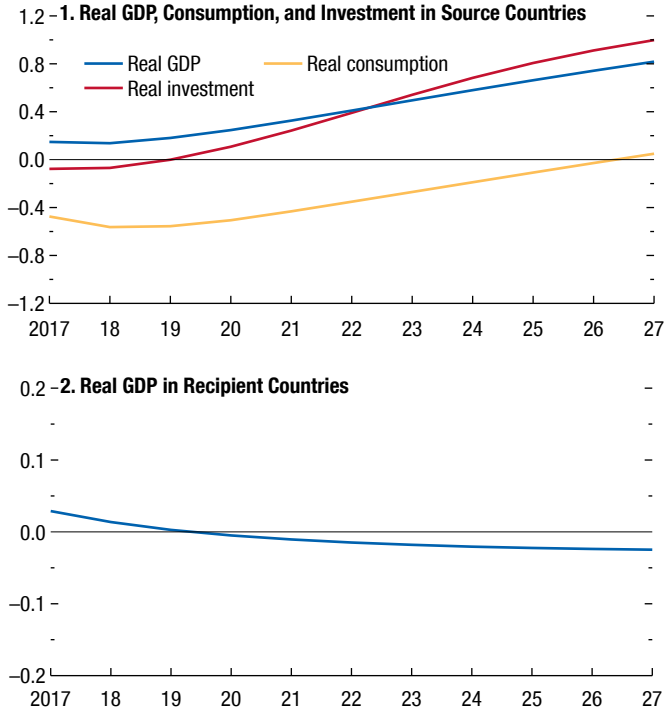
Conclusions

Positive cross-country spillovers from collective fiscal policy actions helped the global economy recover from the global financial crisis, but do fiscal spillovers still matter under much-improved economic conditions today? The chapter finds that spillovers continue to be relevant, but to what extent depends on circumstances in both source and recipient countries. It shows that fiscal spillovers tend to be lower when a fiscal shock originates from a country where GDP is at its potential, but that the impact intensifies when either the source or recipient country is in recession and/or benefiting from accommodative monetary policy. This suggests that spillovers are generally large when domestic multipliers are also large. The chapter also finds that spillovers from government spending shocks are larger than those associated with tax shocks, that the transmission of fiscal shocks may be greater among countries with fixed exchange rates, and that transmission may be dampened if the fiscal impulse at the source tightens global financial conditions.

While the chapter does not offer conclusions about how individual countries should conduct fiscal policy from a domestic perspective, it provides information about potential cross-country effects from such action. The current juncture suggests that positive cross-border effects from stimulus in countries with broadly closed output gaps will generally be smaller than during the crisis, but there could still be benefits. For example, in the euro area, spillovers from a more expansionary fiscal stance in countries with fiscal space—such as higher public investment to raise potential output in Germany—on some trading partners experiencing weak cyclical positions might still be important due to continued accommodative monetary policy and evidence suggesting that spillovers tend to be amplified by currency pegs. More generally, the fiscal instrument also matters: spending on public investment is likely to produce greater cross-border dividends than tax cuts.

The chapter also presents illustrative scenarios of fiscal reforms in which a change in the makeup of the government budget that does not generate a short-term change in the fiscal stance come with small spillovers. However, substantial fiscal reforms, such as large budget-neutral corporate income tax rate reductions—compensated with increases in consumption taxes—that affect the investment-location and

Figure 4.16. Spillovers from Increase in Government Investment in Five Major Economies
(Percent deviation from baseline)



Source: IMF, G20 Model (G20MOD) simulations.
Note: Spillovers from a permanent 0.5 percent of GDP increase in government investment in five major economies (France, Germany, Japan, United Kingdom, United States) financed via value-added tax. No monetary accommodation is assumed for any country.

[41]A permanent productivity shock in source countries increases supply by more than demand, implying that the relative price of source-country goods must fall in equilibrium.

profit-reporting decisions of multinational firms, could have large spillovers.

Finally, and not surprisingly, fiscal actions with economically meaningful cross-border effects can also impact trade balances. For example, the chapter suggests that fiscal stimulus tends to lead to a deterioration in the trade balance of the country where it occurs, with corresponding improvements in the positions of trading partners. This implies that a fiscal expansion in the United States could exacerbate global current account imbalances, while stimulus in Germany would tend to reduce them.

Box 4.1. The Spillover Impact of US Government Spending Shocks on External Positions

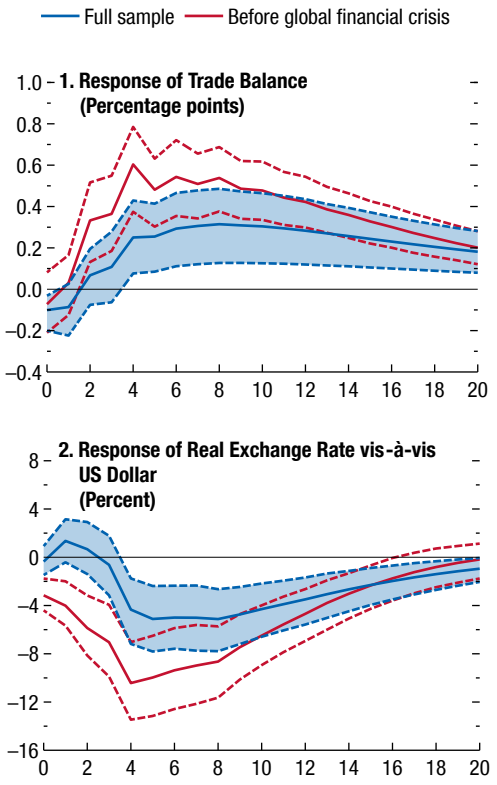
Consensus on the effect of government spending shocks on a country's exchange rate and external balance remains elusive in the empirical literature.[1] This may stem partly from the difficulty of isolating agents' anticipation of fiscal policies, given both legislative and implementation lags, as highlighted by Ramey (2011), among others. This box and a related spillover note (Popescu and Shibata, forthcoming) examine the impact of fiscal spending shocks from the United States on the US trade balance and real exchange rate, from both a multilateral and a bilateral perspective, while carefully taking into consideration the issue of fiscal foresight.

To capture anticipation effects, the approach follows Forni and Gambetti (2016) and relies on professional forecasters' surveys to identify fiscal shocks at the announcement rather than implementation date.[2] Methodologically, the fiscal foresight ("news") shock is identified in a vector autoregression using US data from the first quarter of 1981 through the fourth quarter of 2016.[3] The analysis further extends Forni and Gambetti (2016) to a cross-country perspective to account for recipients' macroeconomic conditions, which is the main unique contribution of this exercise.

The results suggest that news of future government spending leads to a real appreciation of the US dollar and deterioration of the US trade balance—in line with theory and solving the "depreciation puzzle" found in most previous studies. As discussed in Forni and Gambetti (2016), the key intuition is that the inclusion of additional information on fiscal expectations and forecasts improves the estimation of the effects of fiscal spending shocks by capturing more precisely the timing of the impact. The timing is likely significant in assessing the response of fast-moving variables, such as the exchange rate, which react quickly to perceived changes in future conditions.

Moving on to the analysis of spillovers, a panel vector autoregression analysis makes it possible to take into account the recipient country's macro and policy variables (such as cyclical positions, monetary policy, and domestic fiscal policy). The estimation uses an unbalanced panel of 30 US trading partners (23 advanced economies and 7 emerging market economies representing about 80 percent of US imports) from the fourth quarter of 1982 through the third quarter of 2016. Results suggest that an anticipated increase in US government spending triggers real

Figure 4.1.1. Response of Recipient Countries' Trade Balance and Real Exchange Rate vis-à-vis US Dollar
(Quarters on x-axis)



Source: IMF staff calculations.
Note: $t = 0$ is the quarter of the shock. Dashed lines denote 90 percent confidence bands.

The authors of this box are Adina Popescu and Ippei Shibata.

[1]For example, while the theoretical literature tends to predict that increases in government spending would trigger exchange rate appreciations, the empirical literature often finds the opposite in the case of the United States; this is usually referred to as the "depreciation puzzle."

[2]More specifically, the Survey of Professional Forecasters forecasts of government spending are used to capture preannounced or anticipated (also called "news" or "foresight") fiscal spending by exploiting the change in forecast expectations.

[3]The vector autoregression includes, in this order: real federal government consumption expenditures and gross investment, the fiscal news variable based on Survey of Professional Forecasters forecasts, real GDP, private consumption, the federal surplus divided by GDP, net exports of goods and services divided by GDP, the 10-year Treasury constant maturity rate, and the real effective exchange rate.

Box 4.1 *(continued)*

exchange rate depreciations in other countries and improvements in their trade balances with the United States. More specifically, an announcement of a 1 percent of US GDP increase in government spending will depreciate a trading partner's exchange rate by about 5 percent after one and a half years while improving the partner's net exports vis-à-vis the United States by 0.3 percentage point of its own GDP after two years (Figure 4.1.1, blue lines).

Estimation over subsamples reveals that the impact on exchange rates and trade balances may have diminished following the global financial crisis. The red lines in Figure 4.1.1 plot the response of the trade balance and real exchange rates vis-à-vis the United States before the global financial crisis (before 2007), suggesting that responses were significantly larger before the onset of the crisis. These results may reflect constrained monetary policy in recent years, which could have dampened US exchange rate appreciation (in response to expansionary fiscal shocks), thus also potentially contributing to a smaller trade balance response.

Performing the same analysis for different groups of countries—only advanced economies or only Group of Twenty economies—suggests that the results are quantitatively robust. The results are also robust to variations in the methodology, including different variable ordering and the inclusion of additional variables, as well as to different weighting schemes (including time-varying weights).

Annex Table 4.1.1. Data Sources for Quarterly Fiscal Data by Source Country

Country	Fiscal Data	Data Source	Seasonal Adjustment	Note
France	Government spending	Eurostat[1]	SWDA by source	Sum of government final consumption and GFCF
	Tax revenue	Eurostat[1]	SWDA by source	Current taxes on income and wealth, excluding social contributions
Germany	Government spending	Deutsche Bundesbank	SWDA by source	Sum of government final consumption and GFCF
	Tax revenue	Eurostat[1]	X-12-ARIMA by IMF staff	
Japan	Government spending	Cabinet Office of Japan	SAAR by source	Sum of government final consumption and GFCF
	Government total revenue	Ministry of Finance and Cabinet Office	X-12-ARIMA by IMF staff	Extrapolated using Denton method
United Kingdom	Government spending	Office for National Statistics	Seasonally adjusted by source	Sum of government final consumption and GFCF
	Tax revenue	Eurostat[1]	X-12-ARIMA by IMF staff	
United States	Government spending	US Bureau of Economic Analysis	Seasonally adjusted by source	Sum of government final consumption and GFCF
	Tax revenue	US Bureau of Economic Analysis	Seasonally adjusted by source	

Source: IMF staff compilation.
Note: For government spending, nominal levels are deflated using the GDP deflator when real levels are not directly available from the source. For tax revenue (total revenue for Japan), real levels are calculated by deflating nominal levels using each country's GDP deflator. GFCF = gross fixed capital formation; SAAR = seasonally adjusted and annualized data; SWDA = seasonally and working-day adjusted data; X-12-ARIMA = US Census Bureau software package for seasonal adjustment.
[1]Quarterly nonfinancial accounts for general government database from Eurostat.

Annex 4.1. Data

Data for Shock Identification

Quarterly fiscal data used in shock identification for five shock-emitting (source) countries stem from national statistical bureaus, either directly or via Haver Analytics.[42] Quarterly real government spending and tax revenue data used in constructing fiscal shocks are expressed in local currency units, seasonally adjusted, and annualized for the sample period of 2000:Q1–2016:Q2. Government spending is calculated as the sum of quarterly general government consumption and general government gross fixed capital formation from national accounts. For tax revenue, quarterly general government total tax income is used, except for Japan. Data sources for each country are listed in Annex Table 4.1.1. See Blagrave and others, forthcoming, for more details on the data, as well as a discussion of data limitations and construction of fiscal shocks.

[42]France, Germany, Japan, United Kingdom, United States.

Data for Spillover Analysis

Quarterly data from 55 recipient countries for 2000:Q1–2016:Q2 include series on real output, consumption, investment, exports/imports, bilateral good exports/imports, external demand, short-term interest rates, output gaps, and exchange rate regimes, collected from multiple data sources. Data sources for each series are listed in detail in Annex Table 4.1.2, followed by a list of all the countries in the sample in Annex Table 4.1.3.

Data Description

- *Real GDP, consumption, investment:* Quarterly real levels are rebased to 2010 prices, expressed in local currency units, seasonally adjusted and annualized. Investment data refer to gross fixed capital formation.
- *Exports/imports:* Quarterly real levels are rebased to 2010 prices, expressed in local currency units, seasonally adjusted and annualized. Data from national accounts stem from Haver Analytics and refer to total exports/imports of goods and services.

Annex Table 4.1.2. Data Sources for Recipient Countries

Series	Data Sources	Estimation	Countries Missing Data	Note
Real Output	WEO; Haver Analytics	Rebased to 2010; deflated using GDP deflator	None in the sample	Seasonally adjusted, annualized, in national currency
Real Consumption, Investment, Exports, Imports	Haver Analytics	Rebased to 2010; deflated using respective deflators for each country and variable	Vietnam	Seasonally adjusted, annualized, in national currency; data from national accounts
Bilateral Goods Exports/Imports	DOTS	Average of values reported by the reporter and partner countries	None in the sample	Original data at monthly frequency, aggregated by sum
External Demand	WEO; DOTS; Haver Analytics	Export-weighted sum of partner countries' real GDP growth	None in the sample	Seasonally adjusted, quarter over quarter growth, log difference, percent
Short-Term Monetary Policy Rate	Bloomberg Finance L.P.; Haver Analytics	Three-month LIBOR, three-month Treasury bill rate, where available	Cyprus, Estonia, Luxembourg, Slovak Republic, Uruguay	Policy rate, deposit rate, target rate used where LIBOR and treasury bill rates were not available
Output Gap	WEO; Haver Analytics	Gap between real output and potential output estimated by HP filter	None in the sample	Denton method used to match annual output gap numbers in WEO

Source: IMF staff compilation.
Note: DOTS = IMF, *Direction of Trade Statistics*; HP = Hodrick-Prescott; LIBOR = London interbank offered rate; WEO = *World Economic Outlook*.

- *Bilateral goods exports/imports:* Bilateral weights are calculated using bilateral exports/imports of goods between 55 countries in the sample and five source countries (5 x 55 = 275 pairs). For each country pair, the average is that of reported values of both countries.
- *External demand:* This is calculated as a weighted sum of partner countries' real growth based on bilateral export weights.
- *Short-term interest rate:* The three-month London interbank offered rate (LIBOR) and three-month Treasury bill rate are used. For more comprehensive country and historical coverage, policy, deposit, and target rates are used where three-month LIBOR and Treasury bill data are not available.
- *Output gap:* The quarterly output gap is first calculated as the gap between real output and potential output, estimated by the Hodrick-Prescott filter. Then, to reconcile any potential difference between the estimated output gap and the annual output gap numbers published in the IMF's *World Economic Outlook* (WEO), the Denton proportional benchmarking method is used. This method both preserves the seasonality observed from quarterly estimated output gap series and matches the data published in the WEO when converted to annual basis.

Variables with notable trends over the sample period are detrended using country-specific linear

Annex Table 4.1.3. Recipient Countries in Sample

Region	Countries (55 total)
Africa	South Africa
Americas	Argentina, Brazil, Canada, Chile, Colombia, Costa Rica, Mexico, Peru, United States,* Uruguay
Asia	Australia, China, India, Indonesia, Japan,* Korea, Malaysia, New Zealand, Philippines, Thailand, Vietnam
Europe	Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France,* Germany,* Greece, Hungary, Ireland, Israel, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom*

Source: IMF staff compilation.
*Shock-emitting (source) country. Source country is excluded from the set of recipient countries when analyzing fiscal shocks from the same source.

trends. In addition, outliers—observations with quarter-over-quarter GDP growth rates higher than 10 percent or lower than –10 percent in any given quarter (very few observations)—are excluded.

Exchange Rate Regime Classification

A measure of bilateral exchange rate arrangement vis-à-vis the US dollar is constructed to estimate spillovers for different exchange rate regimes.

For the Reinhart-Rogoff classification, the exchange rate regime is expressed as a time-varying index based on the annual coarse de facto classification from Ilzetzki, Reinhart, and Rogoff (2017a, 2017b), ranging from 1 (most rigid) to 6 (most flexible). For each period, if a country is assigned a value of 1 (de facto peg) or 2 (de facto crawling peg), it is deemed a "fixed regime." The quarterly index is interpolated from annual data, assigning the same value for all four quarters within a year. For example, in 2015, this classification yields seven "fixed" rate countries (Argentina, China, Costa Rica, India, Peru, Philippines, Vietnam) out of the sample of 55 countries.[43]

The IMF pre-2008 classification (coarse) consists of six categories, with 1 being the most rigid and 6 the most flexible.[44] The classification changed in 2008, and post-2008 data are obtained from the IMF's website. As under the Reinhart-Rogoff classification, a country is generally classified as having a fixed exchange rate vis-à-vis the US dollar if it is assigned a value of 1 (de facto peg) or 2 (de facto crawling peg or crawling band narrower than or equal to ±2 percent). Again, the quarterly index is interpolated from annual data. For example, for 2015, this classification yields two fixed-rate countries (China, Vietnam) out of the sample of 55 countries, although there are more fixed-rate countries in earlier periods.

Annex 4.2. Empirical Strategy

Baseline Specification

As in Auerbach and Gorodnichenko (2013), the response of output in the recipient country to a fiscal shock abroad is estimated using the local projections method. This approach is particularly well suited to accommodate nonlinearity; that is, it allows estimation of spillovers under different states of the economy. Moreover, the method is more robust to misspecification of the data-generating process than a vector autoregression, for which the misspecification error is compounded at each horizon of the impulse response.

The following baseline linear model at time horizon h (for $h = 0, \ldots, H$) is estimated using a panel ordinary least squares estimator:

$$\frac{Z_{i,t+h} - Z_{i,t-1}}{Y_{i,t-1}} = \alpha_h \frac{Shock_{it}}{Y_{i,t-1}} + \sum_{l=1}^{L} \beta_{hl} X_{i,t-l} + \theta_{hi} + \mu_{ht} + \varepsilon_{iht}, \quad (4.1)$$

in which Z_{it} is the variable of interest (real GDP, consumption, investment, and the like) in recipient country i at quarter t, Y_{it} is real GDP in recipient country i at quarter t, $Shock_{it}$ is the foreign fiscal shock facing country i at time t (see below), and X_{it} is a vector of control variables including lags of the fiscal shock, lags of GDP growth, and lags of external demand, measured as a weighted average of trading partner growth rates (the number of lags $L = 4$ was chosen). Variables θ_{hi} and μ_{ht} capture the country and time fixed effects. Given that the foreign fiscal shock is expressed in units of recipient-country GDP ($Shock_{it}$ is scaled by lagged GDP Y_{it-1}), the coefficient α_h is analogous to a domestic multiplier of an external shock (Hall 2009; Barro and Redlick 2011). The impulse response for H periods is constructed from a sequence of estimates $\{\alpha_h\}_{h=0}^{H}$.

The baseline fiscal shock combines country-specific shocks from the five source countries (France, Germany, Japan, United Kingdom, United States) and weights them using trade links with recipient countries. The assumption behind the weighting system is that fiscal policy is transmitted mainly through trade—countries with tighter trade links to the source would be expected to receive larger shocks in the form of larger changes in export demand, and therefore larger spillovers. However, the estimated spillovers capture those from all transmission channels, including the financial channel. The external fiscal shock facing recipient country i in time t is given by

$$Shock_{it} = \sum_{j=1}^{5} \frac{M_{ij,t-1}}{M_{j,t-1}} \frac{s_{jt} E_{j,t-1}}{E_{i,t-1}}, \quad (4.2)$$

in which j denotes source country, M_{ijt} is country j's goods imports from country i at time t, M_{jt} is

[43]The number of countries classified as "fixed" can generally vary over time given that the exchange rate regime classification is time varying.

[44]Data for regime classification before 2008 is from Carmen Reinhart's website, http://www.carmenreinhart.com.

total goods imports by country j, s_{jt} is the identified fiscal shock in country j expressed in real terms in country j's currency, and E_{jt} is country j's US dollar real exchange rate. Therefore, the second term on the right side $\left(s_{jt}E_{j,t-1}/E_{i,t-1}\right)$ equals the real monetary value of the fiscal shock coming from country j converted into units of recipient country i's currency. This term is then scaled by the import share $\left(M_{ij,t-1}/M_{j,t-1}\right)$, which captures the relative importance of recipient country i as a supplier of the source country's imports.[45] Finally, the weighted shocks are added up across the five source countries.[46] The combined shocks are relatively small: for example, spending (tax) shocks average about 0.06 (0.1) percent of recipient-country GDP over the sample period.

Nonlinear Specifications

Role of Cyclical Conditions and Monetary Policy Constraints

To study the state-dependent effects for *recipient* countries, a nonlinear version of the baseline specification is estimated. Regression coefficients on the shock and the control variables are allowed to vary with different states. The state is defined with respect to the economic cycle ("slack/no slack") or with respect to monetary policy stance ("effective lower bound/no effective lower bound"). Slack corresponds to a negative output gap. Effective lower bound corresponds to short-term interest rate below the 25th percentile value of the cross-country distribution, which is about 0.57 percent for advanced economies and 3.0 percent for emerging market economies.

Following Auerbach and Gorodnichenko (2013), the baseline specification is modified in the following way:

$$\begin{aligned}\frac{Z_{i,t+h}-Z_{i,t-1}}{Y_{i,t-1}} &= \alpha_{1h}I_{i,t-1}\frac{Shock_{it}}{Y_{i,t-1}} \\ &+ \alpha_{2h}\left(1-I_{i,t-1}\right)\frac{Shock_{it}}{Y_{i,t-1}} \\ &+ \sum_{l=1}^{4}\beta'_{1hl}I_{i,t-1}X_{i,t-l} \\ &+ \sum_{l=1}^{4}\beta'_{2hl}\left(1-I_{i,t-1}\right)X_{i,t-l} \\ &+ \theta_{hi}+\mu_{ht}+\varepsilon_{iht}. \qquad (4.3)\end{aligned}$$

in which $I_{i,t}$ takes the values of either 1 or 0, indicating the state in recipient country i in period t. Spillovers in the two different states can then be analyzed by comparing the estimated parameters α_{1h} and α_{2h}.

For the *source* country, only the shock is partitioned according to the state of the economy, which can be again either the cyclical position or monetary policy near the effective lower bound. The states are defined in the same way as in the specification for recipient countries. The source-country shock therefore becomes

$$Shock^{j}_{it} : I^{j}_{t-1}Shock^{j}_{it} + \left(1-I^{j}_{t-1}\right)Shock^{j}_{it}, \qquad (4.4)$$

in which I^{j}_{t} is a {0;1} dummy variable indicating the state in the shock-emitting country. The assumption behind interacting only the shock with the state dummy is that although shocks in the source country and its domestic response might be regime dependent, their propagation to recipient countries is not.

Spillovers to Recipients with Different Exchange Rate Regimes

Similar to the nonlinear specification in which the shock is partitioned based on the source country's state, the shock is decomposed into two components according to the bilateral exchange rate arrangement between recipient i and the United States:

$$Shock^{US}_{it} : Fix^{US}_{i,t-1}Shock^{US}_{it} + \left(1-Fix^{US}_{i,t-1}\right)Shock^{US}_{it}, \qquad (4.5)$$

in which $Fix^{US}_{it} = 1$ if country i and the United States share a fixed regime in period t.

Spillover Estimates Expressed in Terms of Source-Country GDP

While the baseline specification expresses fiscal shocks in terms of *recipient-country GDP*—given the decision to combine shocks from different sources and following standard practice in the literature—this transformation might complicate the interpretation of the magnitude of spillovers. To facilitate the interpretation, the estimates presented in the chapter are rescaled as spillovers in response to a 1 percent of *source country GDP* fiscal shock. This is done by normalizing the estimated spillover coefficient α in the following way:

$$Spill_{i,j} = S_j\frac{M_{i,j}}{M_j}\frac{Y_j}{Y_i}\alpha, \qquad (4.6)$$

in which S_j is the source-country shock as a percent of its own GDP (assumed to be 1); $\left(M_{i,j}/M_j\right)$ is the recipient country's share in the source country's total imports (the weighting factor in the baseline model);

[45]See Blagrave and others, forthcoming, for a discussion of alternative weighting systems.

[46]Estimated fiscal shocks are not correlated across countries.

and (Y_j/Y_i) is the ratio of source to recipient-country GDP—both measured in US dollars.[47]

Annex 4.3. Robustness Tests

To ensure that the baseline results are not driven by the selected shock identification scheme or econometric approach, this section performs several robustness checks. The results are robust to (1) estimation of spillovers using a panel vector autoregression, which accounts for the endogenous response of exchange rates and monetary policy in recipient countries; and (2) the use of alternative fiscal shocks based on forecast error and narrative approaches.

Estimation with a Panel Vector Autoregression

Analysis in a panel vector autoregression is conducted to ensure that the results are not driven by the choice of the local projections method. A panel vector autoregression explicitly takes into account the endogenous response of key macro variables when estimating spillovers from a fiscal shock. The following six-variable panel vector autoregression model is estimated:

$$Y_{i,t} = c_i + \sum_{p=0}^{1} A_p Y_{i,t-p} + \mu_{i,t}, \qquad (4.7)$$

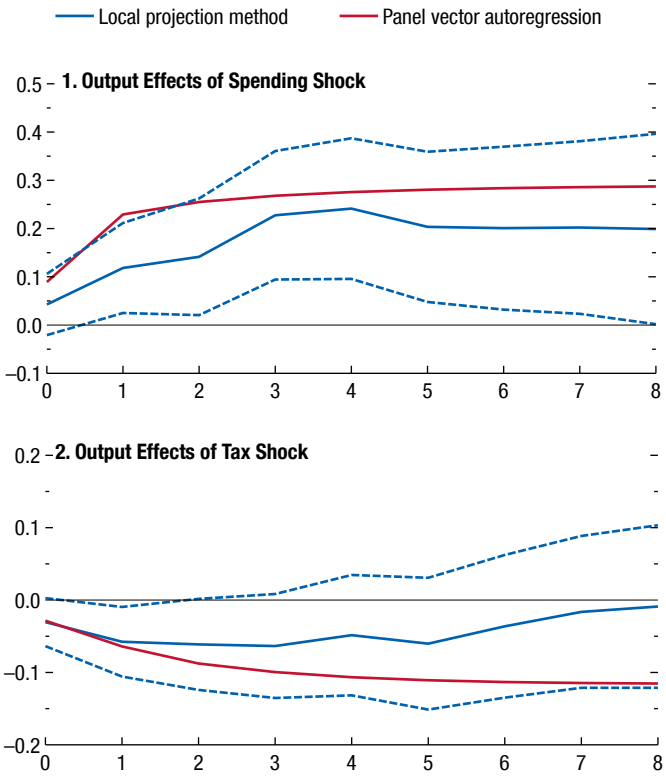
in which c_i is a vector of country-specific fixed effects, A_p is a reduced-form coefficient matrix, $\mu_{i,t}$ is a vector of shock terms, and $Y_{i,t}$ is a vector of six endogenous variables:

$$Y = \{Gshock; Tshock; effective\ ext.\ demand; GDP\ growth; interest\ rate; REER\}.$$

With the exceptions of *Gshock* and *Tshock*, which are identical to the weighted shocks used in the baseline analysis presented in equation 4.1, each variable is in (detrended) quarter-over-quarter growth rates and relates to the recipient country *i*'s domestic economy.[48] The sample period is the same as in the baseline local projections analysis.

Panel vector autoregression analysis confirms the findings from the baseline regression model estimated with the local projections method. The results, expressed in terms of the cumulative impulse response following a 1 percent of source-country GDP shock to government spending (tax revenue), are presented in Annex Figure 4.3.1 (red line). Spillovers from an increase in government spending at the source are larger than spillovers from a tax cut. The results are statistically different from zero at the 5 percent level, based on simulations conducted using standard (Monte Carlo) resampling methods.

Annex Figure 4.3.1. Effects of Spending and Tax Shock on Recipient Countries' Output: Comparison with Panel Vector Autoregression
(Percent; quarters on x-axis)



Source: IMF staff calculations.
Note: $t = 0$ is the quarter of respective shocks. Solid blue lines denote the baseline response to respective shocks using local projection method; dashed lines denote 90 percent confidence bands; and solid red lines represent the response to respective shocks using panel vector autoregressions. Shocks are normalized to an average of 1 percent of GDP across source countries.

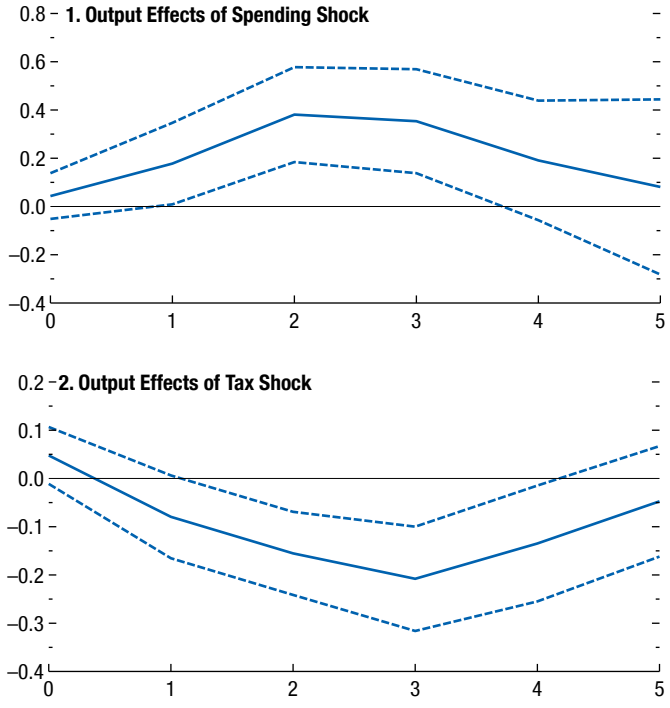
Identification Using Forecast Errors

The second robustness check focuses on the identification of fiscal shocks. The alternative methodology identifies shocks as forecast errors (the difference

[47]Plausible alternative weighting systems of the source-country shock would deliver the same results in terms of source-country GDP. Alternative weighting systems would also require recalculating the spillover coefficient estimated in the baseline (α), resulting in an equal and offsetting adjustment of this coefficient, given that any transformation applied to the *source* shock would be constant across all *recipient* countries.

[48]Results from the panel vector autoregression are robust to several alternative specifications, including not detrending the data.

Annex Figure 4.3.2. Effects of Spending and Tax Shock on Recipient Countries' Output: Forecast Errors
(Percent; years on x-axis)



Source: IMF staff calculations.
Note: $t = 0$ is the year of respective shocks. Solid lines denote the response to respective shocks, and dashed lines denote 90 percent confidence bands. Effects are estimated based on shocks derived from forecast errors. Shocks are normalized to an average of 1 percent of GDP across source countries.

between actual variable and its forecast from the previous period) in the growth rates of government spending or tax revenues, this way capturing only unanticipated fiscal changes. This differs from the structural shocks used in the baseline analysis, which are based on actual changes in fiscal variables and can be anticipated by agents if they were announced earlier. The presence of such anticipated shocks could bias the estimates because the information set of the econometrician is different from the information set of the agents. Because forecast errors capture unexpected changes, the problem with fiscal foresight is reduced under this approach, as the information set of the econometrician and private agents is more aligned.

The approach uses real-time fiscal projections by the Organisation for Economic Co-operation and Development and real-time actual data to construct the forecast error shocks at annual frequency on the sample from 2000 to 2012.[49] The forecast error for each variable $X = \{G, T, Y\}$ is constructed as

$$FE_t^X = X_t - X_{t|t-1}^f, \tag{4.8}$$

in which X_t is the growth rate of the variable from the contemporaneous data release and $X_{t|t-1}^f$ is the forecast one period earlier. A positive forecast error means an expansionary spending shock and a contractionary tax shock. Following Auerbach and Gorodnichenko (2013), the forecast errors of spending and taxes are regressed on the forecast errors of output to take into account any changes as a result of surprises in the business cycle. They are also regressed on lagged macroeconomic variables' growth rates (GDP, deflator, investment, government spending or tax revenues) to account for the portion of the innovation that can be predicted from past observations. The forecast error shocks for each source country are then constructed as residuals from this regression, converted to levels using base year (2010) expenditures or revenue, and replaced in equations (4.1) and (4.2).

Spillover analysis using forecast error shocks confirms the baseline results—that spending shocks have larger spillovers than tax shocks (Annex Figure 4.3.2)—and provides a strong robustness check. These shocks are constructed using an entirely different methodology, a different database and estimated at a different frequency than the shocks used in the baseline specification. The size of spillovers is somewhat larger compared with the baseline, which can be explained, in part, by a stronger response of source-country spending and revenues to forecast error shocks compared with structural shocks (although these impulse responses are imprecisely estimated because of the small sample).

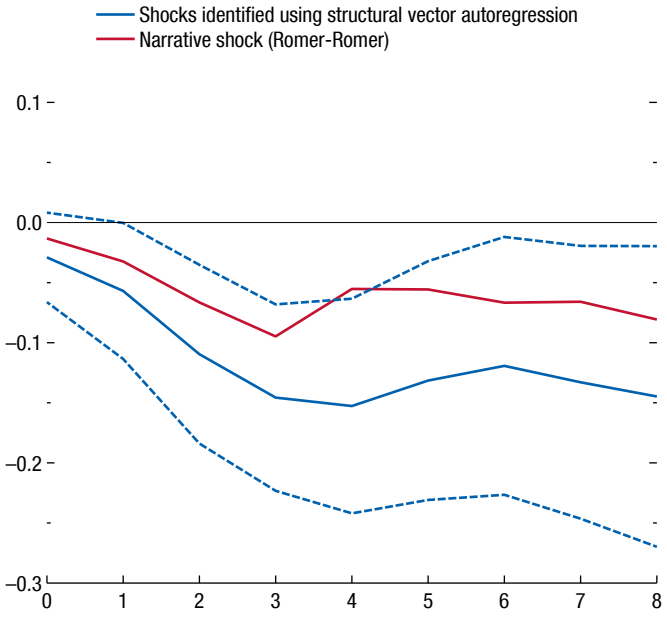
Identification Using Narrative Approach

To further confirm that the baseline results are not driven by the shock identification scheme, a robustness check using the narrative tax shocks of Romer and Romer (2010) is conducted. Several studies in the literature present narrative fiscal shocks (for example, DeVries and others 2011), but the data set of Romer and Romer (2010) is the most suitable for comparison with the baseline analysis of the chapter given that it covers both expansion and consolidation episodes.[50]

[49]After 2012 the forecast data are not continuous.

[50]Narrative shock databases for government spending are much less common in the literature, which precludes a robustness check of spillovers from spending shocks based on narrative shocks.

Annex Figure 4.3.3. Effects of US Tax Shock on Recipient Countries' Output: Comparison with US Narrative Tax Shock, 1995–2007
(Percent; quarters on x-axis)



Sources: Romer and Romer (2010); and IMF staff calculations.
Note: $t = 0$ is the quarter of the US tax shock. Solid blue line denotes the response to US tax shock using structural vector autoregression; dashed lines denote 90 percent confidence bands; and solid red line represents the response to US narrative tax shock based on Romer and Romer (2010). Shocks are normalized to an average of 1 percent of GDP across source countries (note that this will represent a less than 1 percent of US GDP shock).

The shock is simply replaced in equations (4.1) and (4.2), with analysis conducted only for the United States over the period 1995:Q1–2007:Q4 (2007:Q4 is last period for which the narrative shock is available). A comparable set of time-sample-modified baseline results is obtained by estimating spillovers from the United States on the same sample.

Results presented in Annex Figure 4.3.3 show similar spillovers from US tax shocks for shocks identified using a structural vector autoregression and those coming from the narrative approach. Although the spillovers identified using the narrative approach are somewhat smaller compared with the (time-sample-modified) baseline, they fall comfortably within the confidence bands of the baseline estimates. Given that the narrative shocks are based on a completely different identification scheme, these results provide another strong robustness check.

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