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FISCAL STIMULUS AND FISCAL SUSTAINABILITY

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ABSTRACT

The Great Recession and the Global Financial Crisis have left many developed countries with low interest rates and high levels of public debt, thus limiting the ability of policymakers to fight the next recession. Whether new fiscal stimulus programs would be jeopardized by these already heavy public debt burdens is a central question. For a sample of developed countries, we find that government spending shocks do not lead to persistent increases in debt-to-GDP ratios or costs of borrowing, especially during periods of economic weakness. Indeed, fiscal stimulus in a weak economy can improve fiscal sustainability along the metrics we study. Even in countries with high public debt, the penalty for activist discretionary fiscal policy appears to be small.

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I. Introduction

The Great Recession ended more than eight years ago, making the current expansion long by historical standards. But the recession has left many scars and much has changed about the monetary and fiscal policy landscape. For example, despite attempts to set economies on normalization paths after the Great Recession and the Global Financial Crisis, the scope for countercyclical monetary policy remains limited: benchmark interest rates have continued to hover near or even below zero. This constraint on monetary policy coincides with a resurgence in activist fiscal policy (Auerbach and Gale, 2009), which has moved from a focus on automatic stabilizers to a stronger reliance on discretionary measures, reflecting not only necessity but also growing evidence of the effectiveness of such policy to fight recessions (e.g., Auerbach and Gorodnichenko, 2012, 2013). In the current low-interest-rate, low-inflation environment, an even greater reliance on fiscal policy may be needed to address the next recession, whenever it begins.

At the same time, the prolonged recession and the countercyclical fiscal measures adopted to address it have left the United States and other leading economies with substantial increases in public debt (see Figure 1). These elevated debt levels raise several important questions about the conduct of fiscal policy. In particular, to what extent does the increase in public debt limit the "fiscal space" available to fight recession? Do high debt-to-GDP ratios limit the strength of fiscal multipliers (e.g., Perotti, 1999), or alternatively can expansionary policy actually improve the fiscal picture and reduce debt-to-GDP ratios, especially when interest rates are low (DeLong and Summers, 2016)? Should high-debt countries consider fiscal consolidation, even during a period of economic weakness (Alesina et al. 2015)? And how is the scope for fiscal policy altered by the large implicit liabilities from unfunded pension and health care programs in the United States and other economies with rapidly aging populations?

To address these questions, our analysis takes a route that is more direct than much of the existing literature, which has typically concentrated on how fiscal conditions affect fiscal multipliers, how the mix of fiscal policies influences the effects of fiscal consolidations, and the conditions under which expansionary fiscal policy might be adopted without leading to an increase in deficits and debt, relative to GDP. Adapting an approach used in our own previous work on fiscal multipliers (Auerbach and Gorodnichenko 2013), we estimate the effects of fiscal shocks on debt as well as other measures of fiscal pressure, such as benchmark interest rates and CDS spreads. Using CDS spreads may be particularly useful for gauging comprehensive effects on fiscal sustainability, which may be inadequately represented by short-term debt dynamics.

To illustrate our approach, consider the standard law of motion for a country's national debt, $B_t = (1 + r_t)B_{t-1} + PD_t$ where B_t is the stock of national debt in real terms outstanding at the end of year *t*, PD_t is the government's primary deficit during year *t*, and r_t is the real interest rate on national debt in year *t*. A fiscal shock taking the form of an increase in the primary deficit in year *t* can influence the stock of debt B_t in a number of ways, including (1) changing output, leading to further adjustments in taxes and spending (either automatic or discretionary) and hence the primary deficit in year *t*; (2) a change in the nominal interest rate on government debt, which affects r_t; and (3) a change in the inflation rate, which also affects the real interest rate r_t. Rather than estimating the impact on B_t by looking separately at each of these components, we simply estimate the effects of fiscal shocks on B_t directly, as well as on future values, B_{t+1}, B_{t+2}, and so on. While understanding the channels through which fiscal shocks affect public debt is useful, estimating this relationship directly has the advantage of addressing directly the question that is fundamentally of interest, without the need to specify the exact relationships of the intermediate steps, such as how fiscal policy changes in response to fiscal shocks.

We utilize a variety of data sets and measures of fiscal shocks, varying by frequency, sample period, country coverage and the method of identifying fiscal shocks. For example, we use the following approaches to identify unanticipated shocks to government spending: (1) the standard recursive ordering identification as in Blanchard and Perotti (2001); (2) professional forecasts to remove predictable changes in government spending as in Auerbach and Gorodnichenko (2012, 2013); and (3) narrative identification as in Devries et al. (2011).

Consistent with our earlier work, we find that the effects of government spending shocks depend on a country's position in the business cycle. Expansionary fiscal policies adopted when the economy is weak may not only stimulate output but also *reduce* debt-to-GDP ratios as well as interest rates and CDS spreads on government debt, while the outcomes when the economy is strong are more likely to have the conventional effects. When we examine responses of various measures of fiscal stress to government spending shocks across different levels of public debt, we find that these shocks may indeed increase stress when debt levels are high, but the increase is quantitatively modest. The results are broadly similar when we consider interactions of the state of the economy and the level of public debt. These results suggest that fiscal stimulus in a weak economy could be an effective tool to boost the economy and that the penalty from doing so in terms of elevated debt levels and borrowing costs is likely modest for the countries we study.

Our work is related to several strands of previous research. The first strand examines effects of fiscal shocks on macroeconomic aggregates (e.g., Blanchard and Perotti 2002, Ramey 2011, Auerbach and Gorodnichenko 2012, 2013, Jorda and Taylor 2016, Ramey and Zubairy, forthcoming). In agreement with earlier studies, we find that government spending shocks generate expansions and the government spending multiplier is larger when economy is weak than when economy is strong.[1]

The second strand focused on investigating how the level of public debt can influence the ability of government spending shocks to stimulate the economy. Previous studies tend to report mixed results with some (e.g. Ilzetzki et al. 2013) finding a lower fiscal multiplier in high-debt countries and some (e.g., Corsetti 2012) showing no difference across low- and high-debt countries. Consistent with the latter set of results, we find little difference in the responses across low- and high-debt states.

The third strand of research measures sustainability of fiscal policies across time and countries. For example, Auerbach (1994) computes fiscal gaps based on initial debt and projections of different components of government expenditures and tax revenues over extended horizons. Related research examines cyclically adjusted fiscal deficits to establish whether a country is on a sustainable path (see Escolano 2010 and Bornhorst et al. 2011 for more discussion). In contrast to this work, we focus on the dynamics of debt-to-GDP ratio and the cost of borrowing conditional on a government spending shock.

Born et al. (2017) is the paper closest in spirit to our analysis of the effects of fiscal policy changes on fiscal sustainability. Specifically, Born et al. examine how CDS spreads react to fiscal consolidations identified as in Devries et al. (2011) at the annual frequency. In contrast to the sample in our study (effectively, large OECD economies), the Born et al. sample covers 38 countries including such emerging economies as Argentina and South Africa. Another important difference across the studies is that we use the debt-to-GDP ratio as a measure of state (fiscal sustainability) while Born et al. (2017) use the default premium as the state variable (fiscal stress). Born et al. report that a fiscal consolidation (a cut in government spending) *increases* the premium (especially if the

[1] While Ramey and Zubairy (forthcoming) argue that output multipliers are smaller than those found in other studies, they, too, estimate larger multipliers when the economy is weak than when it is strong based on postwar data.

premium is already high, that is, the economy is experiencing fiscal stress) but in the long run the premium declines. This result is consistent with our finding that an increase in government spending does not generate large increases in CDS spreads in the short run.

The rest of the paper is structured as follows. In the next section, we document that many developed economies have strained fiscal positions that might limit their governments' ability to implement discretionary fiscal countercyclical programs. Section 3 describes the data we use to study responses of key macroeconomic variables and fiscal indicators to government spending shocks. Section 4 discusses identification of unanticipated, exogenous government spending shocks. Section 5 lays out our econometric framework to study dynamic responses. In Section 6, we present estimated impulse responses for various identification schemes and time frequencies. Section 7 explores how responses vary with the level of public debt. Section 8 presents concluding remarks.

II. The Growing Challenge of Fiscal Sustainability

Since the beginning of the Great Recession and the Global Financial Crisis, leading economies have accumulated considerable national debt. Based on data from the International Monetary Fund (IMF), Figure 1 shows the evolution of net general government debt-to-GDP ratios for the G-7 countries in recent years, comparing the end of 2007, just as the worldwide recession began, to the end of 2016.[2] With the exception of Germany, all countries experienced an increased debt-to-GDP ratio. For several countries, including the United States, the increase was quite substantial.

These short-term levels and trajectories clearly are relevant. But debt-to-GDP ratios alone typically do not tell us how long countries have before they must make fiscal adjustments or how large these adjustments need to be. Some countries, for example Japan, have maintained relatively high debt-to-GDP ratios for some time. Also, whatever the determinants of short-run budget dynamics, current debt and deficits may provide an inadequate picture of underlying fiscal imbalances. Indeed, the factors contributing to short-term debt accumulation differ substantially from those that will affect debt accumulation over the longer term, which often relate more to the demographic change of population aging and the associated changes in government spending and tax collections.

One method of measuring a country's fiscal imbalance that takes longer-term commitments into account is the fiscal gap associated with them, typically expressed as a share of GDP. As

[2] These data come from the IMF's April, 2017 World Economic Outlook database.

defined, for example, in Auerbach (1994), a fiscal gap, say Δ, over a horizon from the end of the current period, *t*, through a terminal period, *T*, would equal the required increase in the annual primary surplus, as a share of GDP, relative to those projected under current policy that would be needed for the terminal debt-to-GDP ratio to achieve some desired value, or

$$(1) \qquad \Delta = \frac{b_t - \left(\frac{1+g}{1+r}\right)^{(T-t)} b_T + \sum_{s=t+1}^{T} \left(\frac{1+g}{1+r}\right)^{(s-t)} d_s}{\sum_{s=t+1}^{T} \left(\frac{1+g}{1+r}\right)^{(s-t)}}$$

where b_t is the outstanding debt-to-GDP ratio at the end of year *t*, b_T is the target debt-to-GDP ratio at the end of period *T*, d_s is the primary deficit-to-GDP ratio in year *s*, *g* is the GDP growth rate, and *r* is the relevant interest rate, with both growth and interest rates assumed constant for the sake of simplicity. The target debt-to-GDP ratio is often taken to be the current value, although in cases where a country starts with an elevated debt-to-GDP ratio this conventionally assumed target value likely understates the size of the required adjustment, to the extent that long-run stability would be difficult at such a high value of this ratio.

Figure 2 presents estimates of fiscal gaps for the G-7 countries. To form these estimates, we start with the estimated 2016 ratios of net publicly held debt- to-GDP in Figure 1, and then add projections for primary surpluses as a share of GDP from 2017 through 2022 from the IMF April, 2017 World Economic Outlook Database. For years after 2022, it is necessary to make some assumptions as to the further evolution of primary surpluses, and we take an approach that separates “normal” components from those related to aging and health. For shares of GDP accounted for by revenues and non-interest spending in areas excluding health care and public pensions, we set values equal to those in 2022. For the remaining expenditure components, we incorporate recent projections underlying the summary tables in the April, 2017 IMF *Fiscal Monitor*. For these calculations, we assume a real discount rate of 3 percent and a real GDP growth rate of 2 percent. Since these projections run only through 2050, we limit our fiscal gap estimates to a 34-year horizon, i.e., with year *T* = 2050.

In Figure 2, the first bar represents the fiscal gap when the terminal debt-to-GDP ratio is set equal to the 2016 debt-to-GDP ratio. The U.S. estimate is the highest, at over 9 percent of GDP. That is, according to these calculations, the United States would have to reduce non-interest spending or increase revenues by over 9 percent of GDP relative to baseline projections in order to hit its current debt-to-GDP ratio in 2050. The gap for Japan is nearly 5 percent, while those for the other G-7 countries range from 1.3 percent for Germany to 3.3 percent for the United Kingdom. The alternative fiscal gap based on a terminal debt-to-GDP ratio of 60 percent, a figure often used in such calculations (and, for example, used as a target in Europe's original Stability and Growth Pact), indicates a much bigger challenge for Japan, given the required reduction over the period from its current debt-to-GDP ratio.

One can illustrate the relative importance of existing debt and current and future primary surpluses to the fiscal gaps shown in the figure by considering how much of the fiscal gap is due to the initial stock of debt, and how much is due to current and future primary surpluses. The second bar for each country in Figure 2 shows what the fiscal gap would be without any initial debt. In a sense, the difference between these two series represents the share of the fiscal gap attributable to past fiscal policy, in the form of past deficits that together led to the initial level of debt on which the calculation is based. For countries with high initial debt-to-GDP ratios, such as Italy and Japan, the difference between the first and second series is quite large, while for countries, such as Canada, with low initial debt-to-GDP ratios, the difference is small. The third bar in Figure 2 illustrates the importance of the growth in implicit liabilities associated with health care spending and public pensions. For each country, it shows what the fiscal gap would be if, in addition to there being no initial debt, there were also no increase relative to GDP in spending on health care or pensions after 2022. This calculation indicates how much of the fiscal gap comes not from past deficits, just considered, or the present, in the form of current and near-term primary deficits, but the future, in the form of increases in primary deficits, as a share of GDP, relative to their near-term values. For all countries, this assumption reduces the estimated fiscal gaps, and for Germany it eliminates the gap entirely. The incremental effect of this factor is especially large for the United States, for which assumed growth in health care costs is very large in the IMF projections.

These estimates are, of course, sensitive to a variety of assumptions. For example, although real interest and growth rates of 3 and 2 percent may be historically reasonable, the gap between the real interest and growth rates has recently been lower, and assuming a smaller short-term gap would reduce the cost of debt service included in the calculation. In addition, projections of future entitlement costs, especially for health care, are subject to considerable uncertainty. Finally, determining the path of primary deficits under current policy, even through 2022, relies on assumptions regarding short-term policy actions.[3] Thus, the numbers in Figure 2 should not be interpreted as precise, but rather as providing an indication of the relative challenges facing different countries and the relative importance of different components of these countries' fiscal gaps. It should be kept in mind, in particular, that achieving fiscal balance may provide a greater challenge in the future than in the past not only because of higher initial debt-to-GDP ratios but also the added costs associated with demographic change.

III. Data

For our remaining empirical analysis, we use publicly available data on leading economies obtained from a variety of sources. Most of our data come from the Organization for Economic Cooperation and Development (OECD), the IMF, and the Bank for International Settlements (BIS). In this section, we briefly describe and discuss pros and cons of the data. Availability of series is summarized in Appendix Table 1. Appendix Table 2 reports descriptive statistics for select variables.

Government Debt. We draw series on general government debt (in local currency) from a number of sources, including the Bank for International Settlements (BIS) Credit to the Non-Financial Sector database and the Eurostat Quarterly Government Debt database. The main source of our data is a new BIS dataset on gross general government debt, constructed by BIS researchers (Dembiermont et al. 2015) to facilitate cross-country comparisons of public indebtedness under a consistently defined measure of general government debt. This debt measure is on a consolidated basis and covers loans, debt securities and deposits and is available at a quarterly frequency. Wherever necessary, we seasonally adjust debt series with the U.S. Census Bureau's X-13 algorithm. To convert the BIS data to a semiannual frequency, we use end-of-semester (i.e. the second and fourth quarter) observations. For each country, the database provides nominal (face) and market values of debt.

[3] Using estimates from the most recent long-term and 10-year CBO projections and various assumptions about what constitutes current policy, Auerbach and Gale (2017) estimate a U.S. fiscal gap through 2047 of just 3.4 percent. Some of this is due to smaller assumed primary deficits at the end of the 10-year period – around 3 percent rather than around 6 percent – and most of the remainder is due to a lower assumed growth rate in medical and pension spending. A partial explanation for these differences may be that the IMF data cover all levels of government whereas Auerbach and Gale consider only the federal government. Even the estimates by Auerbach and Gale, however, show much larger fiscal gaps when the horizon is extended, reaching as high as over 9 percent on an infinite-horizon basis.

To increase sample coverage, we also use data from Eurostat, the statistical office of the European Union (EU), which provides quarterly general government debt series for countries in the EU. The public debt series provided by Eurostat is as defined by the Maastricht Treaty: consolidated public debt at face value. The measure of debt reported by Eurostat is directly comparable to the database constructed by the BIS (see Dembiermont et al. 2015, p. 78).

For Germany and Italy, we were able to augment these data with general government debt series obtained directly from the Deutsche Bundesbank and the Banca D'Italia, for the periods 1980-99 and 1986-99, respectively. For both series, the data are on a quarterly basis and the instrument coverage is comparable to the BIS and Eurostat series (Loans, Debt Securities, and Currency and Deposits on a consolidated basis). While these data are somewhat different from the BIS data in terms of definitions, the time series are highly correlated over the period where both sources are available.

In a few cases, the time series for government debt can be extended using the accounting identity relating debt and deficit observations: $Debt_{t+1} = Debt_t + Deficit_t$ where $Deficit$ is taken from the IMF's *International Financial Statistics* (IFS) and is defined as the (seasonally adjusted) net operating balance minus the net acquisition of nonfinancial assets (or the gross operating balance minus the net acquisition of nonfinancial assets that also excludes consumption of fixed capital).

We measure the debt-to-GDP ratio as $Debt_{it}/GDP_{i,t-1}$ where i and t index countries and time. Note that we lag the denominator by one period to ensure that the contemporaneous reaction of the ratio to a government spending shock is driven by changes in debt rather than output.

Interest rates: We collected short- and long-term interest rate series (STI and LTI, respectively) from the OECD Key Short-Term Economic Indicators database. These interest rates measure local-currency returns on short- and long-term government debt.

Credit Default Swaps (CDS): The credit default swap (CDS) spreads data come through Thomson Reuters Datastream, which contains data coming directly from Credit Market Analysis Limited (CMA) and Thomson Reuters. Spreads prior to 2008Q1 are from CMA and spreads after 2010Q2 are from Thomson Reuters. An average of the two series is used for the overlap period to construct a single, continuous series. To eliminate exchange rate risk from CDS series, we use only dollar-valued spreads.

Macroeconomic data: We generally take macroeconomic data from the OECD Economic Outlook (EO) database. We use nominal GDP (value, market prices, OECD mnemonic GDP) measured in local currency to scale debt series. To measure the growth rate of output, we use real GDP (volume, market prices, OECD mnemonic GDPV). The inflation rate is measured as the percent change (semester on the corresponding semester in the preceding year) in the consumer price index (IMF IFS mnemonic PCPI_PC_CP_A_PT). The growth rate of real government consumption is computed using OECD EO data (mnemonic CGV). For a subset of countries, OECD also provides data on real government investment (IGV). Whenever, both CGV and IGV are available, we use CGV=IGV+CGV to measure government spending. In other cases, we use CGV alone. Accordingly, the share of government spending in GDP is computed as either GV/GDPV or CGV/GDPV.

Forecasts for government spending: Each June and December, the OECD releases its *Economic Outlook* which includes forecasts for macroeconomic variables (e.g., GDP, unemployment rate, government spending). While the method used to prepare forecasts varies across countries, the definitions of variables are comparable across countries. The OECD utilizes its regional/country network to obtain feedback from local economists about proposed forecasts. The projections are extensively discussed with local government experts and policy makers. As a result, forecasts incorporate local knowledge and have a significant judgmental component. Vogel (2007) and Lenain (2002) report that OECD forecasts have a number of desirable properties and perform similar to forecasts provided by private forecasters. These forecasts are available since 1987. Unfortunately, forecasts are available only for aggregate government spending and therefore we are not able to study effects of various types of government spending (e.g., military vs. infrastructure) on economic outcomes.

Data filters: To minimize adverse effects of noise and gyrations in the data, we exclude countries that satisfy one of the following criteria: (1) population is less than 2 million (Estonia, Luxembourg, Iceland, Malta, Cyprus); (2) national official statistics are known to be of potentially dubious quality (Greece); and (3) there are too few observations (Slovakia, Slovenia, Turkey). In addition to this filter, we winsorize all variables with significant variation at high frequencies (e.g., CDS, interest rates, GDP growth rate) at the bottom and top two percent. We do not winsorize slow-moving variables such as the debt-to-GDP ratio.

IV. Fiscal Shocks

We employ several approaches to identify government spending shocks.[4] Our first approach is to use the conventional approach of Blanchard and Perotti (2002), which relies on recursive ordering of variables with government spending shocks not responding contemporaneously to macroeconomic variables such as output, inflation, etc. Intuitively, Blanchard and Perotti (2002) argue that fiscal policy has long decision lags and that, given this inertia, it is unlikely that policymakers can use fiscal tools to respond to economic developments at high frequencies. The key advantage of this approach is the minimal data requirement since government spending series are available for a broad spectrum of countries. We refer to shocks identified with this approach as BP shocks.

At the same time, the Blanchard-Perotti approach has several limitations. First, it requires data at high frequencies (and much of our data are at the semiannual frequency). Second, interpretation of government spending shocks at high frequencies may differ from the interpretation of government spending shocks we would like to have. For example, Auerbach and Gorodnichenko (2016) argue that high-frequency shocks may reflect changes in the timing of spending (e.g., a shift in spending from one period to another shortly before or after) rather than changes in the level of government spending. Finally, Ramey (2011), Auerbach and Gorodnichenko (2012, 2013) and others argue that many changes in government spending are anticipated, even if unpredictable based on lagged aggregate variables. As a result the Blanchard-Perotti approach may mix effects of anticipated and unanticipated shocks to government spending, thus potentially attenuating the size of the estimated effects of government spending on output and other macroeconomic aggregates.

In light of these limitations, we follow our previous work (Auerbach and Gorodnichenko, 2013) and use professional forecasts to purge predictable variation from the innovations to government spending. Specifically, we calculate the unpredictable innovation to government

[4] In our analysis, we focus on government spending shocks and omit tax shocks because identification of exogenous, unanticipated shocks to taxes has much higher data requirements (e.g., one needs to remove the component of tax revenues that contemporaneously varies in response to changes in output). In addition, one would expect the effects of tax changes to vary considerably according to their characteristics (e.g., increases in transfer payments versus reductions in corporate tax rates).

spending at time t (forecast error $FE_{t|t-1}$) as the difference between the actual growth rate of government spending at time t and the OECD forecast of the growth rate for time t made at time $t-1$. This forecast error has a number of desirable properties (e.g., FE is serially uncorrelated). The quality of FE shocks can be further improved by projecting it on lags of macroeconomic variables and taking the residual from this projection as a shock. This latter step can be implemented by including lags of macroeconomic variables as controls in a regression where FE is one of the regressors. We take FE shocks as the baseline measure and refer to these shocks as AG shocks.

In contrast to Auerbach and Gorodnichenko (2013), however, we scale forecast errors so that shocks to government spending are measured as a percent of GDP. While in principle it would be preferable to use potential output to scale changes in government spending to avoid scaling by a cyclical measure (Gorodnichenko 2014), available measures of potential output are sensitive to business cycle fluctuations (Coibion, Gorodnichenko, and Ulate 2017). To circumvent this issue, we compute the average share of government spending in GDP, $s_i^g \equiv \overline{\left(\frac{G_{it}}{GDP_{it}}\right)}$, over the sample period for country i and construct our preferred measure of shocks to government spending as $shock_{i,t} \equiv s_i^g \times FE_{i,t|t-1}$. In a similar sprit, we construct $shock_{i,t} \equiv s_i^g \times \frac{G_{it}-G_{i,t-1}}{G_{i,t-1}}$ for the Blanchard-Perotti approach.

To explore the robustness of our results, we also employ fiscal consolidation shocks constructed by Devries et al. (2011) and updated by Alesina et al. (2016). These are narrative shocks identified as in Romer and Romer (2010) and are measured as a percent of GDP. The shocks are available for 17 OECD countries and cover the period between 1980 and 2014. In contrast to other fiscal shocks we use, the fiscal consolidation shocks are available only at the annual frequency. Because fiscal consolidations can include adjustments on both revenue and spending sides, we use only spending consolidations to make the series comparable to the series generated in the Blanchard-Perotti and forecast-error approaches. Given that the initial series of fiscal consolidation shocks was constructed by a team of IMF researchers, we refer to these as IMF shocks.

Because fiscal consolidation shocks for government spending are coded as positive values in Devries et al. (2011) and Alesina et al. (2016), we recode the series so that the sign of the shocks is negative whenever shocks take a non-zero value and thus estimated impulse responses show dynamics after an increase (one percent of GDP) in government spending. This recoding may be problematic since the effects of government spending cuts are not necessarily symmetric to the effects of government spending increases (see Riera-Crichton et al. 2015). Thus, one should bear in mind the caveat that, although we interpret results as showing responses to increases in government spending, the estimated responses are based only on cuts in government spending.

V. Econometric Specification

Following Auerbach and Gorodnichenko (2013), we use the Jorda (2005) local-projections method to estimate effects of fiscal shocks on economic outcomes. There are several key advantages of this approach over more conventional VAR-based approaches. First, this approach allows fast estimation of models with many parameters and imposes no restrictions on the shape of estimated responses. Second, it can be easily extended to estimate potentially nonlinear effects of shocks. Third, it is well-suited to handle error terms correlated across countries and time.

A generic linear specification is

$$(2) \qquad y_{i,t+h} = \sum_{k=0}^{K} \phi_k^{(h)} shock_{i,t-k} + \sum_{k=1}^{K} \psi_k^{(h)} y_{i,t-k} + \sum_{k=1}^{K} \beta_k^{(h)} \boldsymbol{X}_{i,t-k} + \alpha_i^{(h)} + \kappa_t^{(h)} + \epsilon_{ith}$$

where i and t index countries and time (measured in semesters), y is a variable of interest, $shock$ is a measure of a fiscal shock, $\boldsymbol{X}$ is a vector of controls, and α and κ are country and time fixed effects. The vector of controls $\boldsymbol{X}$ includes the GDP growth rate, the inflation rate, the growth rate of government consumption spending, and the short-term interest rate. The interest rate is included to control for the stance of monetary policy. The impulse response of y to $shock$ is constructed as $\left\{\hat{\phi}_0^{(h)}\right\}_{h=0}^{H}$ estimated from a sequence of OLS regressions where horizon h in the regressor $y_{i,t+h}$ is varied from zero to a maximum horizon H. The impact response is given by $\hat{\phi}_0^{(0)}$ and the average response is given by $(1+H)^{-1}\sum_{h=0}^{H}\hat{\phi}_0^{(h)}$.

Note that by using the coefficients on the contemporaneous shocks we effectively impose the Blanchard-Perotti ordering of variables in a VAR (that is, innovations to government spending do not respond to other macroeconomic variables). Given the potentially complex correlation structure of the error term ϵ_{ith} with possible dependence across countries and time, we use the

Driscoll and Kraay (1998) standard errors to make statistical inferences. Here and in what follows, we set the number of lags in expression (2), $K = 3$ to ensure that the error term is approximately uncorrelated at $h = 0$.

Since we control for country and time fixed effects, this approach can attenuate estimated effects of fiscal shocks that influence not only a given country but also the rest of the world. In a similar spirit, estimated responses for interest rates and some other variables can be interpreted as responses of interest rate spreads relative to a benchmark/global interest rate rather than level responses of interest rates.

Recent research documents that the effects of policy shocks (e.g., Auerbach and Gorodnichenko 2012, 2013, Jorda and Taylor 2016, Tenreyro and Thwaites 2016) can vary over the business cycle. This variation is interesting and important to examine because countercyclical fiscal policy is typically about effectiveness of fiscal stimulus programs in recessions rather than "on average." To allow for state dependence in how a fiscal shock may influence fiscal sustainability, we follow our earlier work and consider the following modification to specification (2):

$$(3) \qquad y_{i,t+h} = \sum_{k=0}^{K} \phi_k^{(h)} shock_{i,t-k} + \sum_{k=1}^{K} \psi_k^{(h)} y_{i,t-k} + \sum_{k=1}^{K} \beta_k^{(h)} \boldsymbol{X}_{i,t-k} + \sum_{k=0}^{K} \delta_k^{(h)} shock_{i,t-k} \times F(z_{i,t}) + \sum_{k=1}^{K} \eta_k^{(h)} y_{i,t-k} \times F(z_{i,t}) + \sum_{k=1}^{K} \mu_k^{(h)} \boldsymbol{X}_{i,t-k} \times F(z_{i,t}) + \pi \times F(z_{i,t}) + \alpha_i^{(h)} + \kappa_t^{(h)} + \epsilon_{ith}$$

where $z_{i,t}$ measures the state of the business cycle and $F(z_{it}) = \frac{\exp(-\gamma z_{it})}{1+\exp(-\gamma z_{it})}$, $\gamma > 0$ is a transition function. Under certain conditions, this transition function can be interpreted as a probability of the economy being in a recession/slump. That is, $F(z_{it}) = 1$ can be interpreted as the economy being in a deep slump/recession while $F(z_{it}) = 0$ corresponds to the economy in a strong boom/expansion. Hence, $\left\{\hat{\phi}_0^{(h)}\right\}_{h=0}^{H}$ and $\left\{\hat{\phi}_0^{(h)} + \hat{\delta}_0^{(h)}\right\}_{h=0}^{H}$ give the estimated impulse responses in boom/expansion and slump/recession respectively.

We measure $z_{i,t}$ as the deviation of output GDP_{it} from its trend GDP_{it}^{trend}: $z_{i,t} = \log\left(\frac{GDP_{it}}{GDP_{it}^{trend}}\right)/\sigma_i$ where $\sigma_i = std\left(\log\left(\frac{GDP_{it}}{GDP_{it}^{trend}}\right)\right)$. An ideal measure of GDP_{it}^{trend} is a potential output that is insensitive to business cycle fluctuations. Unfortunately, potential output is not available for many countries and, as discussed above, there are a number of issues with the available measures of potential output. Given these constraints, we follow Auerbach and Gorodnichenko (2013) and use the Hodrick-Prescott filter with a high smoothing parameter ($\lambda = 10{,}000$) to ensure that the trend does not follow actual output and large downturns such as the Great Recession. Note that, by construction of the Hodrick-Prescott filter, $z_{i,t}$ has mean zero. We normalize deviations from the trend to have unit variance so that variation in $z_{i,t}$ is comparable across countries and we can apply the same value of γ in the transition function for all countries. Specifically, we use $\gamma = 1.5$, as in Auerbach and Gorodnichenko (2013).

As we discuss below, specification (3) can be further modified to include other nonlinear effects. Our baseline estimation is done at the semiannual frequency. For the narratively identified shocks we aggregate data to the annual frequency and run specifications (2) and (3) on annual data. Given the short time dimension for the annual data, we set $K = 1$ for regressions estimated at the annual frequency.

Our reduced-form approach is aimed to impose as few restrictions as possible on the dynamics of the responses. While this approach can limit our capacity to do counterfactual policy experiments, our findings could be used as inputs to discipline structural models as in Christiano et al. (2011), Coenen et al. (2012), and House and Tesar (2015).

VI. Results

In this section, we study the dynamic responses of key macroeconomic and fiscal variables to identified government spending shocks. We present estimates for the responses using the linear and nonlinear specifications. The main objective of the exercise is to determine whether government spending shocks lead to deterioration of fiscal sustainability.

VI.A. Semiannual data

As a first pass at the data, we examine reactions of standard macroeconomic variables to identified innovations to government spending, using our semiannual data set. Figure 3 shows responses of GDP and the price level (Panels A and B) to our benchmark AG government spending shocks. Table 1 reports point estimates and standard errors for the estimated impact and average (over five years) impulse responses. Consistent with our earlier work, we find that responses vary with the state of the economy and the standard linear response estimated in specification (2) can provide an “average” estimate across states. Specifically, the response of output to a government spending shock is larger in a weak economy than in a strong economy and on “average” (that is, in the linear specification (2)) government spending generally stimulates output. The response of the price level is generally similar in the two regimes but confidence bands are wide. Similar to the AG government spending shocks, BP government spending shocks (Figure 4 and Table 2) generate a stronger response of output in a slump than in a boom. Relative to AG shocks, BP shocks tend to be more inflationary in expansions than in recessions. The weak response of the price level to government spending shocks is consistent with the notion that prices may be rigid in the short run and most of the adjustment in the economy happens via quantities and that, generally, inflationary pressure is stronger when the economy operates at full capacity.

With AG shocks, the response of government spending (Panel C, Figure 3) is stronger and more persistent with the economy at full employment than in a weak economy. By construction, BP shocks have the same unit response on impact in any state of the economy and we find smaller variation in the response of government spending to a shock over the business cycle (Panel C, Figure 4).

Note that in nearly all cases the estimates are imprecise, which contrasts with relatively high precision of estimates in our earlier work which did not include data from the period of the Great Recession and its aftermath. Thus, statistical evidence should be interpreted as tentative because the confidence bands are too wide to allow conclusive inference about the size of the response or its variation with the state of the business cycle. Furthermore, given the bands, we typically cannot rule out that responses obtained with one set of shocks (e.g., AG shocks) are different from the responses obtained with another set of shocks (e.g., BP shocks). This finding reflects limited variation in the data (e.g., we have only a handful of recessions for each country) as well as dramatic size and heterogeneity in shocks hitting economies.

Having established that our baseline government spending shocks produce sensible results for main macroeconomic aggregates, we move to study the behavior of variables measuring sustainability of fiscal policy interventions. Panels D and E in Figure 3 and 4 show impulse responses of short- and long-term interest rates. High interest rates are often interpreted as making public debt less sustainable. For example, during the Global Financial Crisis, a rapid increase in interest rates for countries like Italy and Portugal created a heavier debt servicing burden for these countries, thus raising concerns about whether they had adequate resources to maintain their government spending programs. Therefore, an increase in the level of interest rates in response to a positive government spending shock (fiscal stimulus) may be understood as a sign of reduced fiscal sustainability of the stimulus. We fail to find clear evidence that short- and long-term interest rates increase after an identified shock. If anything, point estimates suggest that the rates may fall. For example, the fall in the long-term interest rate is greater in a weak economy than in a strong economy when we use AG shocks (Panel D, Figure 3). This result suggests that markets may view fiscal stimulus as a way not only to accelerate the economy but also to reduce risks associated with a prolonged slump (e.g., self-defeating austerity policies, populist governments, defaults, etc.). In any case, the estimated impulse responses allow us to rule out extreme hikes in interest rates. These results suggest that effects on fiscal sustainability through the cost of government borrowing may be not particularly important.

While interest rates provide an important metric of how sustainable government spending shocks can be, the responses of interest rates could capture a mixture of policy responses (e.g., monetary policy may accommodate or offset fiscal policy). A more direct measure of sustainability is the CDS spread on sovereign debt. Although this measure may be more useful, one should bear in mind that CDS data are generally available only after the mid-2000s, a period dominated by the Great Recession and the Global Financial Crisis. Therefore, our estimates may be driven by these specific events. With this caveat in mind, we find (Panel F in Figures 3 and Figure 4) that CDS spreads show only weak reaction to government spending shocks in the linear specification: we cannot reject at a 10 percent significance level the null hypothesis of zero response for any horizon. However, this weak response "on average" masks important cyclical heterogeneity.

In particular, we find that after a government spending shock CDS spreads fall in recessions and rise in expansions. The fall could be consistent with the view that by stimulating the economy the government improves business conditions thus averting a larger crisis. In other words, fiscal stimulus in a weak economy may reduce spreads rather raise them. The rise of spreads in expansion may indicate that financial markets perceive spending shocks as wasteful when the economy operates at full capacity. The qualitative patterns are similar but the magnitudes are larger when we use the BP identification. These findings are consistent with the dynamics of interest rates thus indicating a potentially low cost of fiscal stimulus programs when resources in the economy are underutilized.[5]

Panel G in Figures 3 and 4 shows responses of the debt-to-GDP ratio to a government spending shock. As highlighted in our initial discussion, this ratio is widely used to gauge fiscal sustainability. It is also useful in assessing the effectiveness of stimulus programs. In a nutshell, a persistent increase in the debt-to-GDP ratio can be interpreted as signaling limited success of a program even if it stimulates output because, in this case, a series of recessions and fiscal stimulus programs can push public debt to unacceptable levels. On the other hand, if the ratio declines (perhaps after a temporary increase), then fiscal stimulus does not have long-term consequences for the capacity of the government to use countercyclical fiscal policy or increase the need for fiscal consolidation during expansions.

We find that the debt-to-GDP ratio does not rise significantly in response to a government spending shock in the linear specification. Furthermore, we find that, for the AG shock, the ratio falls in slump and rises in boom. As discussed in DeLong and Summers (2012), this pattern is consistent with the view that a fiscal stimulus in recession can pay for itself: when economy is strong, additional government spending is unlikely to increase output considerably and thus a spending shock adds to debt without much improvement in the denominator of the ratio. In contrast, when the economy is weak, a spending shock has a stimulatory effect so strong that the ratio decreases, both as a result of a lower numerator (due to e.g. automatic stabilizers, i.e., less countercyclical spending and higher taxes) and a higher denominator (higher GDP). With the BP identification of spending shocks, the ratio also falls in recession, although in this case the magnitude of the response is much larger and the ratio does not rise in expansion. These results are qualitatively consistent with simulations in Gaspar et al. (2016).

In summary, we find that government spending shocks tend to stimulate the economy and to have little adverse effect on a variety of measures of fiscal sustainability. Specifically, estimated

[5] Another metric we can use is the debt price, measured as the ratio of market value of debt to nominal (face) value of debt. In contrast to CDS spreads, the debt price is harder to interpret because the price can change over time due to variation in investors' perceptions about default probabilities, liquidity conditions, inflation expectations, changes in maturity structure of government debt, etc. Similar to the reaction of CDS spreads, we find that "on average" (that is, in the linear specification) debt prices exhibit weak if any response to government spending shocks. There is also weak evidence that, after a government spending shock, debt prices tend to fall in a slump and rise in a boom, but the differences are not statistically significantly different from zero. The lack of a strong fall in the price of government debt suggests that financial markets do not punish the government implementing a fiscal stimulus with higher borrowing costs

impulse responses show that neither interest rates nor debt-to-GDP ratios increase discernably in response to government spending shocks. Although the estimates are not sufficiently precise to permit clear inference about the magnitude of the response, the evidence is strong enough to exclude the possibility of heavy punishment for fiscal stimulus on average or in weak economy.

VI.B. Annual data

Studies estimating responses of macroeconomic variables to fiscal shocks tend to utilize high-frequency data to sharpen identification of fiscal shocks. However, there could be some benefits in using annual data for our investigation. For instance, governments tend to organize budgets and fiscal plans on an annual basis, and thus identified annual fiscal shocks may have better alignment with the frequency at which governments make decisions. Perhaps more importantly for us, by working with annual data, we can employ narratively identified fiscal consolidation (IMF) shocks. Given that these shocks exploit different sources of information, consistency in the results across identification approaches can provide assurance that our findings are not driven by a particular set of assumptions about what constitutes a government spending shock.

To have a benchmark for comparison across identification approaches at the annual frequency, we aggregate AG shocks by adding up shocks identified for the first and second semesters of a given year to obtain the corresponding annual series. For the BP approach, we use annual series for government spending. Results based on the annual data for AG and BP shocks are reported in Appendix Tables 3 and 4 and Appendix Figures 1 and 2. We generally find that time aggregation does not change the qualitative results.

In the next step, we construct impulse responses to IMF shocks (Figure 5 and Table 3). We find that increased government spending stimulates output, with the response being stronger in a weak economy. The response of prices is somewhat larger in a weak economy but the estimated impulse responses are not statistically different from zero and from each other. Government spending is similarly persistent in the weak- and strong-economy states. While long-term interest rates decline in a weak economy and exhibit no material change in a strong economy, short-term rates tend to increase in a weak economy and fall in a strong economy (although the latter effect is short-lived). CDS spreads go up when the economy operates at full capacity and fall when the economy is not utilizing resources fully. For both states, the price of debt tends to rise while the debt-to-GDP ratio declines (the decline being somewhat stronger in a weak economy).

We view these results as being in general agreement with our findings for the AG and BP identification, at least regarding results for a weak economy. Specifically, macroeconomic responses to *cuts* to government spending (recall that IMF shocks are fiscal consolidations) do not appear to lead to beneficial results in terms of reduced borrowing costs or persistently lower debt burdens. This pattern is similar to our findings for AG and BP shocks that an *increase* in government spending does not yield discernable increases in debt-to-GDP ratio or cost of borrowing.

VII. Public Debt and Fiscal Sustainability

While our analysis of how fiscal sustainability varies with the economy suggests that there could be little cost in pursuing countercyclical fiscal policies, one may expect that the cost could be greater in some circumstances, when one considers other sources of heterogeneity in the data. In particular, recent research (e.g., Ilzetzki et al. 2013) documents that fiscal stimulus may be less effective in economies with a public debt overhang. Intuitively, attempts of the government to jump start the economy with more government spending may backfire in a high-public-debt environment where economic agents are skeptical about the ability of the government to pay back its debt thus raising the cost of funds for the government and potentially private borrowers. Casual inspection of cross-country variation in borrowing costs and the level of public debt (e.g., Japan has large public debt and low CDS spreads costs while Switzerland has moderately high public debt and relatively high CDS spreads) suggests that the relationship between the two may be complex.

To shed more light on how the level of debt may influence sustainability of fiscal stimuli, we consider the following modification of specification (3):

$$(3') \quad y_{i,t+h} = \sum_{k=0}^{K} \phi_k^{(h)} shock_{i,t-k} + \sum_{k=1}^{K} \psi_k^{(h)} y_{i,t-k} + \sum_{k=1}^{K} \beta_k^{(h)} \boldsymbol{X}_{i,t-k} + \sum_{k=0}^{K} \delta_k^{(h)} shock_{i,t-k} \times D_{i,t-1}^{*} + \sum_{k=1}^{K} \eta_k^{(h)} y_{i,t-k} \times D_{i,t-1}^{*} + \sum_{k=1}^{K} \mu_k^{(h)} \boldsymbol{X}_{i,t-k} \times D_{i,t-1}^{*} + \pi \times D_{i,t-1}^{*} + \alpha_i^{(h)} + \kappa_t^{(h)} + \epsilon_{ith}$$

where D^{*} is a measure of debt burden. While a conventional approach in the literature is to use the debt-to-GDP ratio as a measure of debt burden, we use a slight variation of this measure.

Specifically, we note that there is apparent variation in what level of public debt a country may sustain. For example, Japan operates smoothly with a debt-to-GDP ratio greater than 200 percent while a country like Italy would likely not be able to do it. Also, countries vary in the extent to which gross debt (the measure we used based on availability) exceeds net debt (which, by netting out government holdings, may provide a better measure of sustainability). Thus, absolute levels of public debt may provide a distorted sense of a government's capacity to issue and service public debt. To address this concern, we focus on within-country variation in public debt, that is, we compare Japan (Italy) when it had low public debt to Japan (Italy) when it had high debt. We define the debt state as

$$D_{it}^{*} = \frac{D_{it} - D_{i}^{min}}{D_{i}^{max} - D_{i}^{min}}$$

where D_{it} is debt-to-GDP ratio for country i at time t, and D_{i}^{min} and D_{i}^{max} are the minimum and maximum values of the ratio over the sample period. By construction, D_{it}^{*} varies between 0 and 1 for all countries so that units are comparable across countries. Estimates of $\left\{\phi_{0}^{(h)}\right\}_{h=0}^{H}$ and $\left\{\phi_{0}^{(h)} + \delta_{0}^{(h)}\right\}_{h=0}^{H}$ provide impulse responses for variable y in low-debt (min debt) and high-debt (max debt) environments, respectively. The estimated responses to AG government spending shocks (semiannual frequency) are reported in Table 4 and Figure 6.[6]

We find relatively little variation in the size of the output response across low- and high-debt states. Likewise, the response of government spending is similar across states. On the other hand, prices tend to increase more in the high-debt state than in the low-debt state. The cost of borrowing measured by interest rates and CDS spreads generally increases more in the high-debt state but the magnitudes are relatively small. For example, after an AG shock, the change in the CDS spread is 50 to 100 basis points higher at a maximum level of debt than at a minimum level of debt. On average, the difference between the maximum and minimum values of debt-to-GDP ratio across countries is approximately 40 percentage points. Thus, even a dramatic increase in the ratio yields only modest increases in the cost of borrowing for countries in our sample. Finally, a government

[6] We report results for $D_{it}^{*} = D_{it}$ (that is, the burden is measured by the level of debt-to-GDP ratio) in Appendix Table 5 and Appendix Figure 3.

spending shock has no effect on the debt-to-GDP ratio in the low-debt state but it induces a persistent increase in the high-debt state: the point estimate for the average response is a 1.374 percentage point increase, which, however, is not statistically significant at the 10 percent level. In summary, while a fiscal stimulus program in a high-debt country may hurt fiscal sustainability, the estimated effects are generally small. We observe no material effects for the low-debt state.

These results are reminiscent of our findings for the cyclical variation in the influence of government spending shocks on fiscal sustainability. This pattern is not entirely surprising as the debt-to-GDP ratio (D_{it}) and the weakness of the economy ($F(z_{it})$) are positively correlated (see Appendix Figure 4). However, there are instances when countries pursued aggressive debt (deficit) reduction policies even in weak economic environments (e.g., the U.K. during the Global Financial Crisis). We can exploit this heterogeneity to differentiate variation in the responses due to the state of the economy and the level of public debt. To this end, we use the flexibility of the Jorda (2005) approach and consider another modification of specification (3):

$$
\begin{aligned}
(3'') \quad y_{i,t+h} = {} & \sum_{k=0}^{K} \phi_k^{(h)} shock_{i,t-k} + \sum_{k=1}^{K} \psi_k^{(h)} y_{i,t-k} + \sum_{k=1}^{K} \beta_k^{(h)} \boldsymbol{X}_{i,t-k} + \\
& \sum_{k=0}^{K} \tilde{\delta}_k^{(h)} shock_{i,t-k} \times F(z_{it}) + \sum_{k=1}^{K} \tilde{\eta}_k^{(h)} y_{i,t-k} \times F(z_{it}) + \sum_{k=1}^{K} \tilde{\mu}_k^{(h)} \boldsymbol{X}_{i,t-k} \times F(z_{it}) + \\
& \sum_{k=0}^{K} \delta_k^{(h)} shock_{i,t-k} \times D_{i,t-1}^{*} + \sum_{k=1}^{K} \eta_k^{(h)} y_{i,t-k} \times D_{i,t-1}^{*} + \sum_{k=1}^{K} \mu_k^{(h)} \boldsymbol{X}_{i,t-k} \times D_{i,t-1}^{*} + \\
& \sum_{k=0}^{K} \tau_k^{(h)} shock_{i,t-k} \times D_{i,t-1}^{*} \times F(z_{it}) + \sum_{k=1}^{K} \upsilon_k^{(h)} y_{i,t-k} \times D_{i,t-1}^{*} \times F(z_{it}) + \\
& \sum_{k=1}^{K} \theta_k^{(h)} \boldsymbol{X}_{i,t-k} \times D_{i,t-1}^{*} \times F(z_{it}) + \\
& \pi \times D_{i,t-1}^{*} + \tilde{\pi} \times D_{i,t-1}^{*} \times F(z_{it}) + \breve{\pi} \times F(z_{it}) + \alpha_i^{(h)} + \kappa_t^{(h)} + \epsilon_{ith}
\end{aligned}
$$

Using this specification, we can estimate responses of y to a government spending shock in low/high-debt and boom/slump states. For example, the response in the low-debt/boom state is given by $\left\{\phi_k^{(h)}\right\}_{h=0}^{H}$ while the response in high-debt/slump state is given by $\Big\{\phi_k^{(h)} + \tilde{\delta}_k^{(h)} + \delta_k^{(h)} +$

$\left.\tau_k^{(h)}\right\}_{h=0}^{H}$. Since we now have four combinations of states, we report only average and impact responses, in Panels A and B of Table 5 respectively.[7]

Since this specification is particularly demanding on our data, we estimate few statistically significant responses. With this caveat, we can note, however, that available evidence suggests that, while there is variation in how active fiscal policy can influence fiscal sustainability across states, this variation is not sufficiently strong to suggest considerable adverse effects of fiscal stimulus programs on fiscal sustainability.

VIII. Discussion and Concluding Remarks

Although economists do not believe that expansions die from old age, the prolonged U.S. expansion will end sooner or later and there is serious concern about the ability of policymakers in the United States and other developed countries to fight the next economic downturn. Indeed, the ammunition of central banks is much more limited now than before the Great Recession and it is unlikely that expansionary monetary policy can be as aggressive and effective as it was during the crisis. Available evidence (e.g., Martin and Milas 2012) suggests that additional rounds of quantitative easing may run into diminishing returns. Likewise, it is hard to expect that moderate decreases of interest rates (perhaps breaking zero lower bound on nominal interest rates and even venturing well below zero) can turn the tide.

While fiscal policy had a countercyclical component during the Great Recession, it was not used to full potential, given the depth of the recession (e.g., Coibion et al. 2013). With tight constraints on central banks, one may expect—or maybe hope for—a more active response of fiscal policy when the next recession arrives. This expectation, however, may be too optimistic since governments in developed countries have amassed high levels of debt over the past decade. Whether new fiscal stimulus programs would be jeopardized by these already heavy public debt burdens is a central question. It is certainly conceivable (see e.g. Aguiar et al. 2017) that a significant fiscal stimulus can raise doubts about the ability of a government to repay its debts and, as a result, increase borrowing costs so much that the government may find its debt unsustainable and default. Hence, it is critical to establish how government spending shocks influence not only

[7] We report results for $D_{it}^{*} = D_{it}$ in Appendix Table 6 and Appendix Figure 3.

output and prices but also indicators of fiscal sustainability such as the debt-to-GDP ratio and interest rates on public debt.

We find that in our sample expansionary government spending shocks have not been followed by persistent increases in debt-to-GDP ratios or borrowing costs (interest rates, CDS spreads). This result obtains especially when the economy is weak. In fact, a fiscal stimulus in a weak economy may help improve fiscal sustainability along the metrics we study. There is evidence that this effect is undercut when the debt-to-GDP ratio is elevated, although the penalty for a high debt-to-GDP ratio does not appear to be high at the debt levels experienced historically for developed countries.

Given the nature of the sample analyzed, our results should not be interpreted as an unconditional call for an aggressive government spending in response to a deteriorating economy. Indeed, the experience of Greece and other countries in Southern Europe is a grave warning about the political risks and limits of fiscal policy. Bridges to nowhere, "pet" projects and other wasteful spending can outweigh any benefits of countercyclical fiscal policy. Perhaps more importantly, we face considerable uncertainty about how economies will respond to fiscal stimulus programs given levels of public debt rarely seen in recent history, as well as large unfunded liabilities. In other words, we have to make out-of-sample predictions with data that may not be representative of the future economic environment. It is possible that fiscal institutions that help make government commitments to eventual fiscal adjustments credible will take on even more importance in the future. We hope that further research on the matter will be able to utilize longer and more detailed historical series, covering greater variation in levels of public debt and more disaggregated categories of government spending, and structural models to provide more conclusive inference and clearer policy prescriptions.

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Figure 1. Net General Government Debt, G-7 Countries

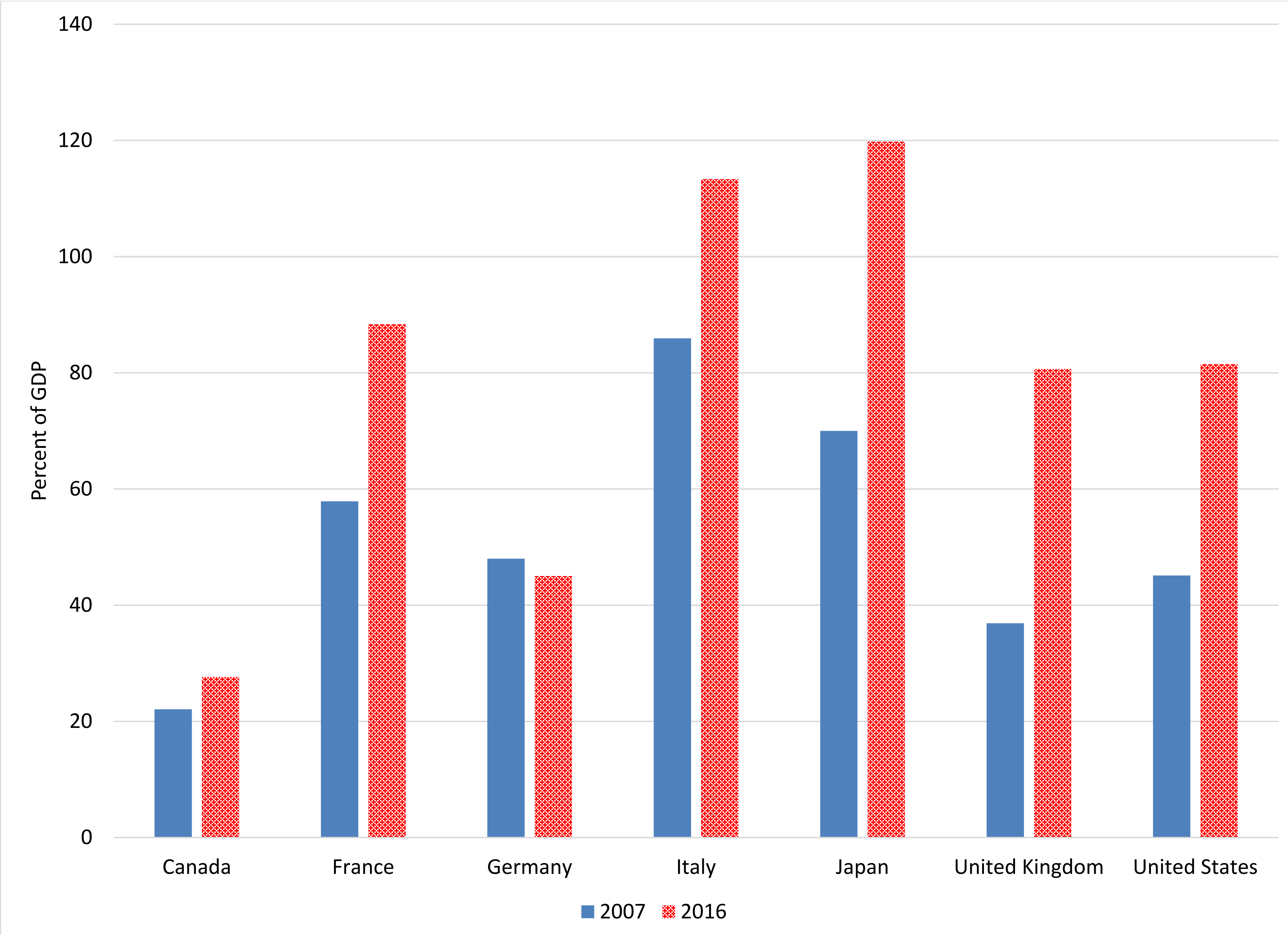


Figure 2. Fiscal Gaps (through 2050), G-7 Countries

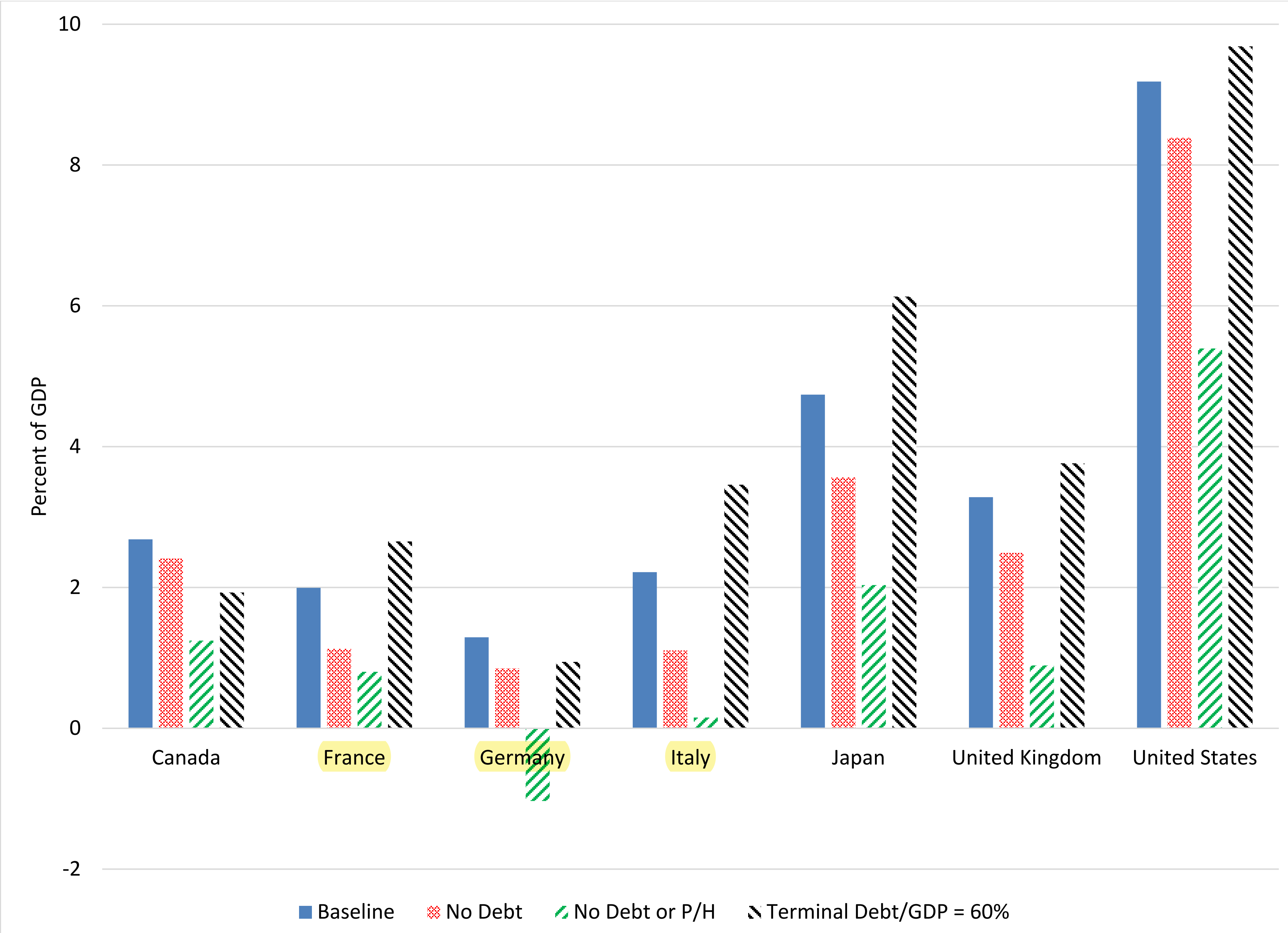
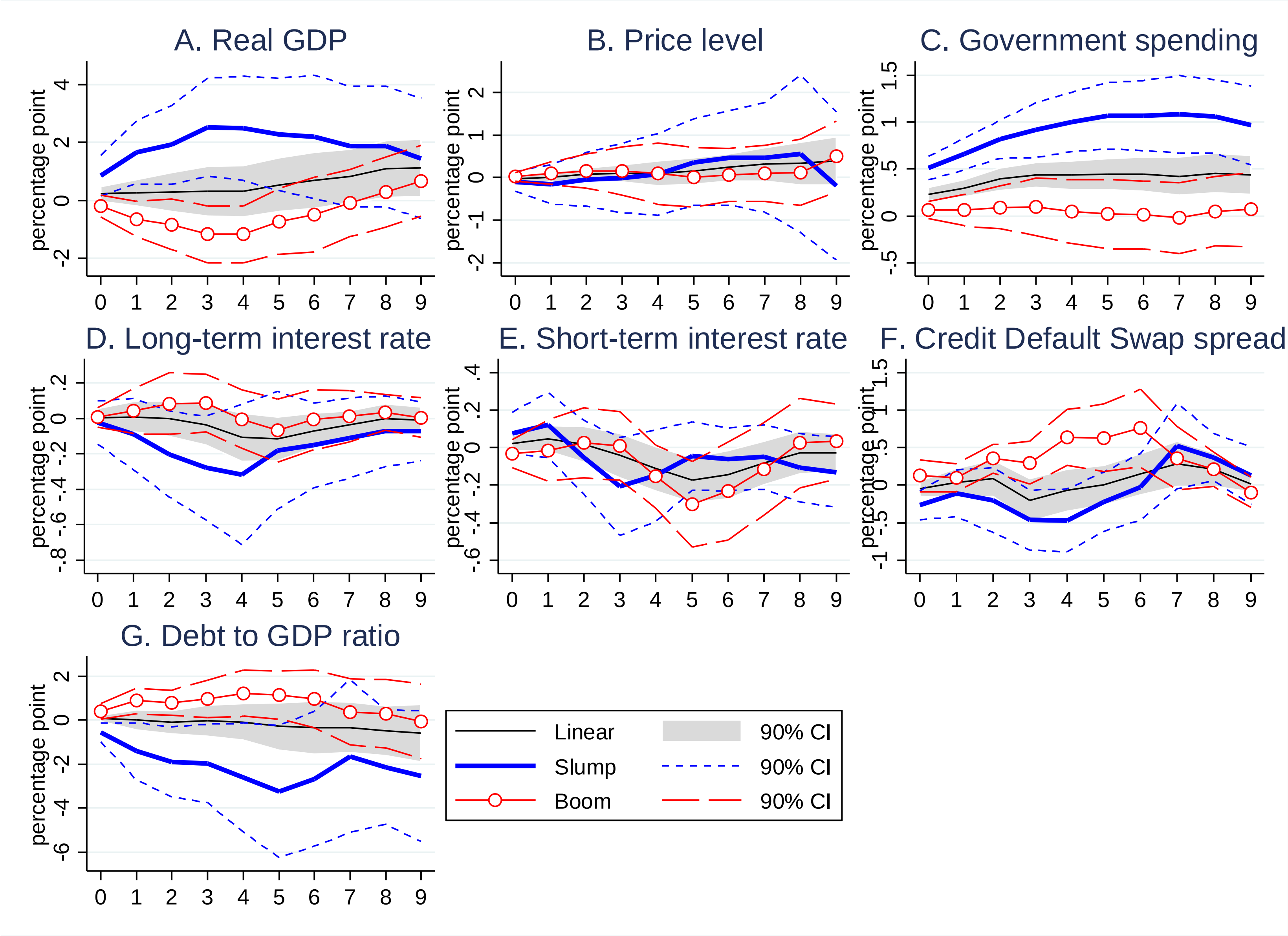
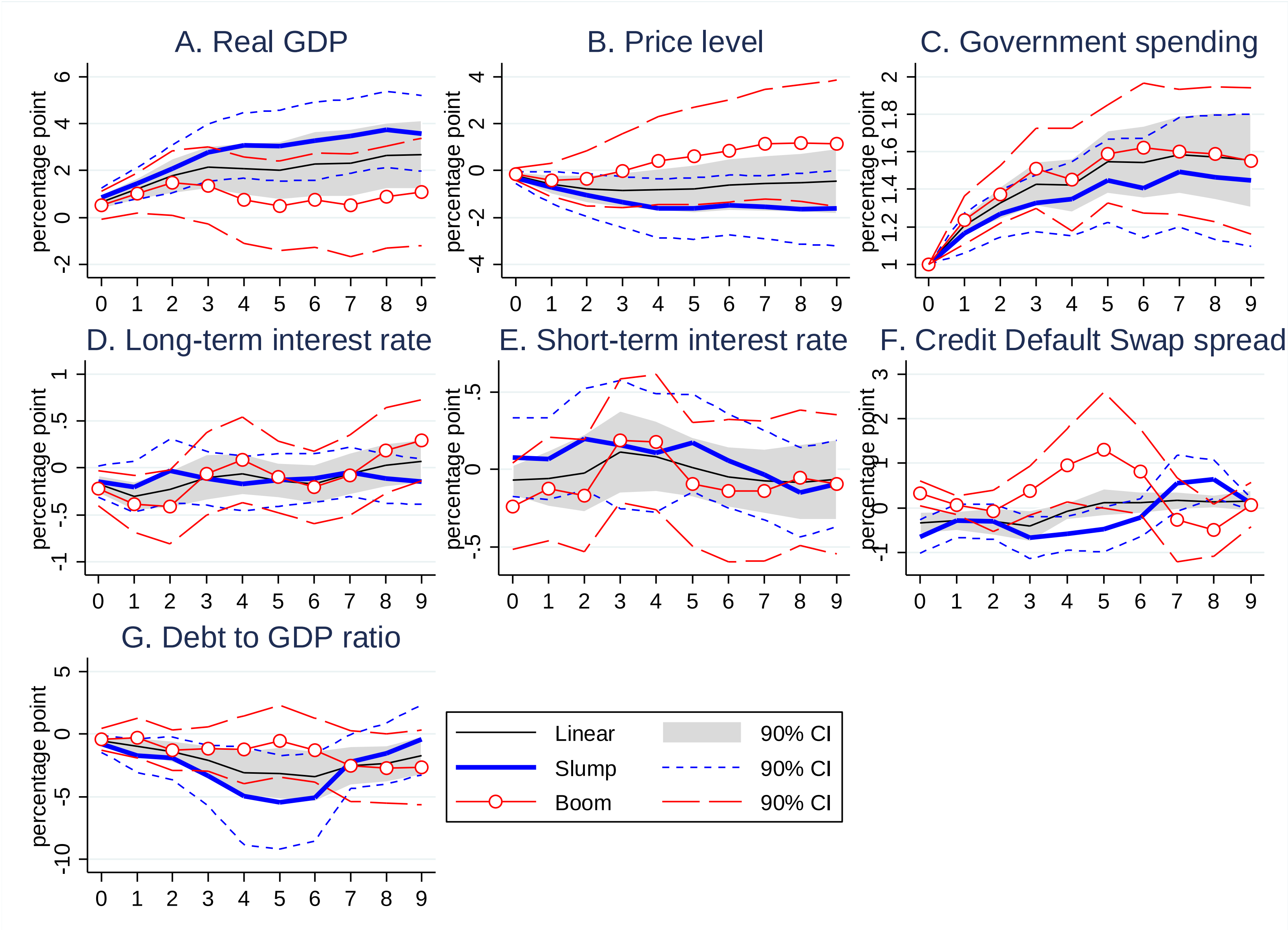


Figure 3. Forecast-error (AG) identification, semiannual frequency



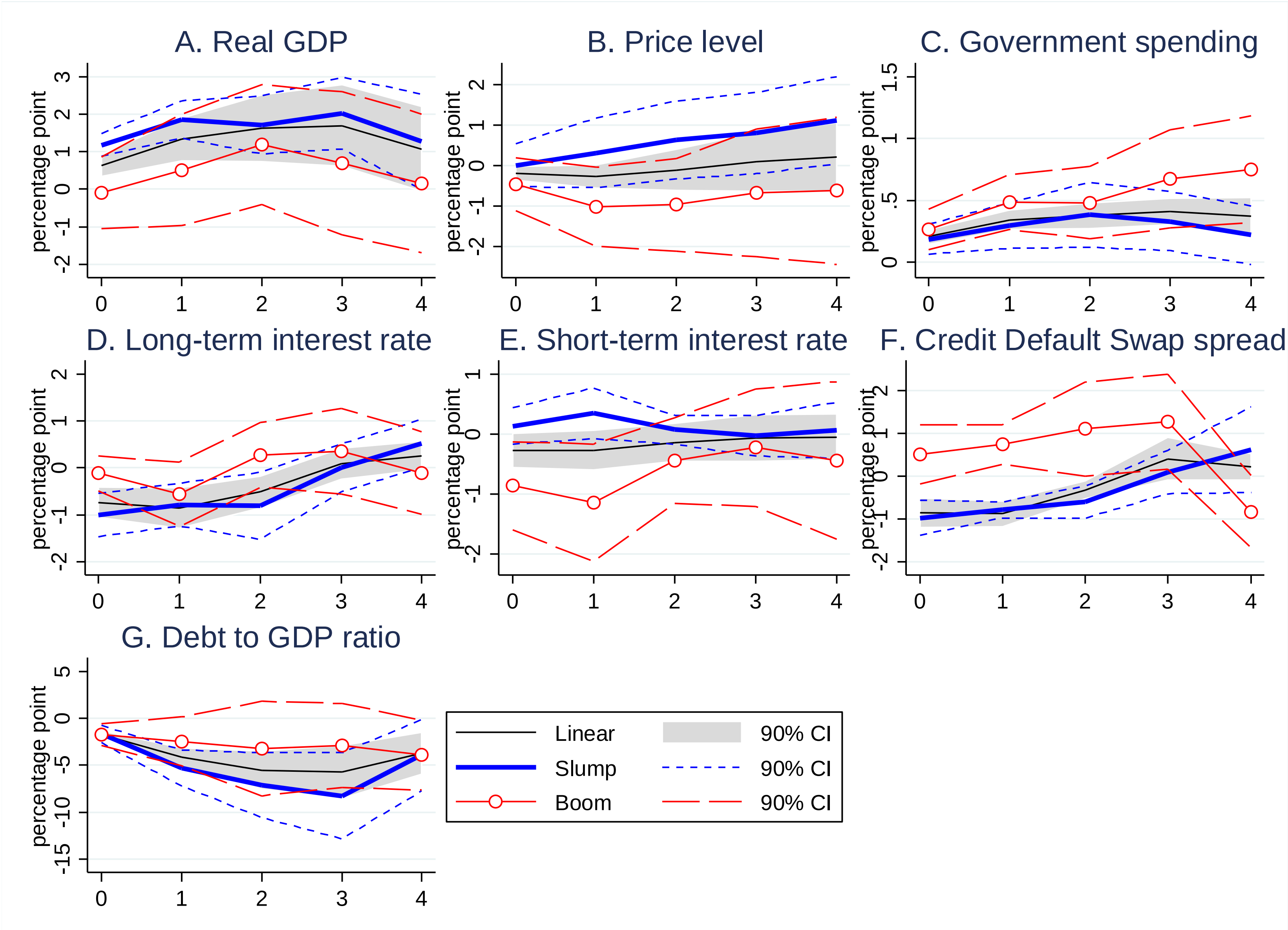
Notes: The figure plots impulse responses to government spending shocks identified as forecast errors (AG shocks) for linear specification (2) and for nonlinear specification (3). 90% confidence bands are constructed using Driscoll-Kraay standard errors. The horizontal axis shows response horizon measured in semesters.

Figure 4. Blanchard-Perotti (BP) identification, semiannual frequency



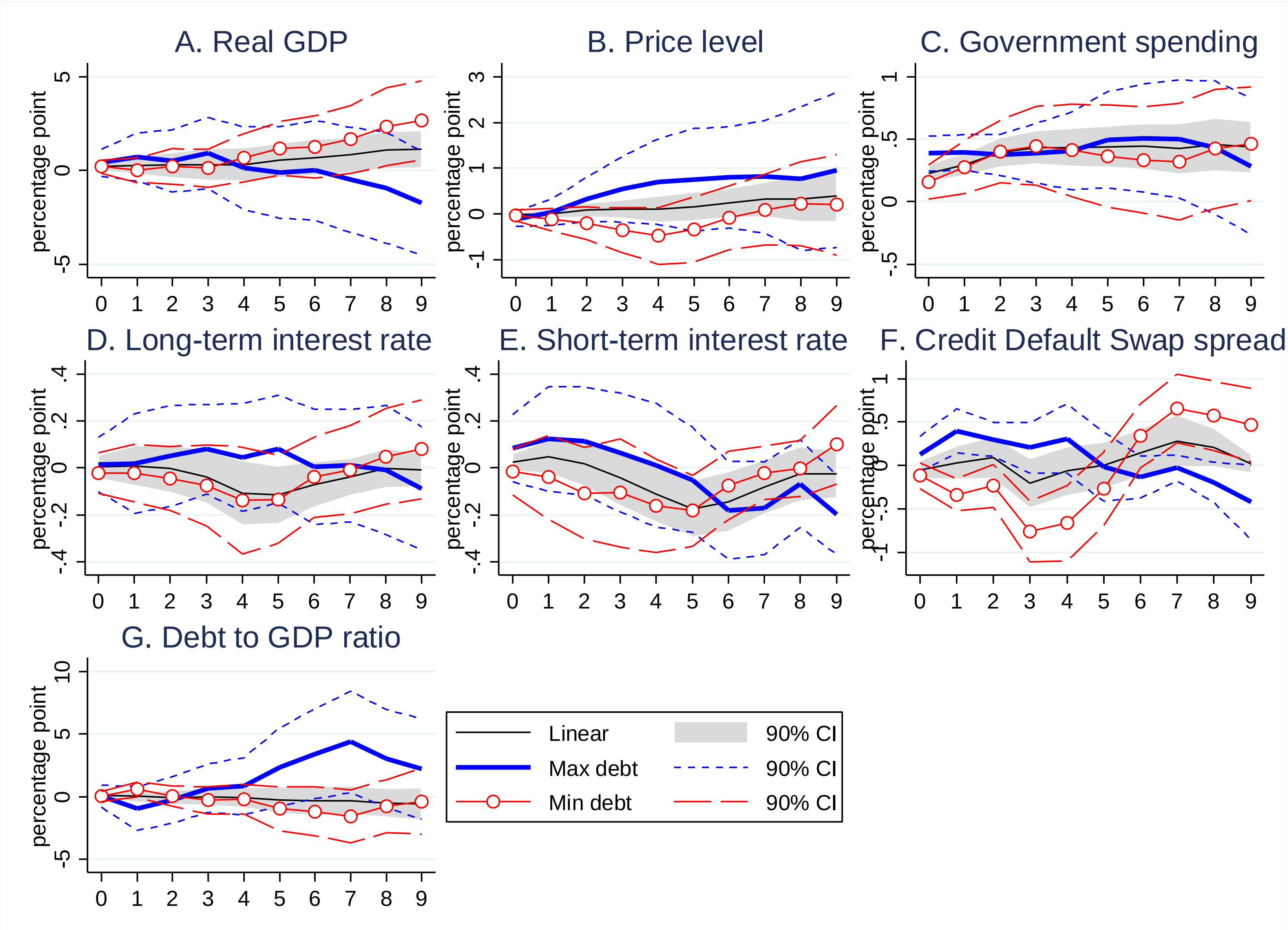
Notes: The figure plots impulse responses to government spending shocks identified as in Blanchard and Perotti (2001) (BP shocks) for linear specification (2) and for nonlinear specification (3). 90% confidence bands are constructed using Driscoll-Kraay standard errors. The horizontal axis shows response horizon measured in semesters.

Figure 5. IMF spending (fiscal consolidation) shock, annual frequency



Notes: The figure plots impulse responses to government spending shocks identified narratively in Devries et al. (2011) and Alesina et al (2016) for linear specification (2) and for nonlinear specification (3). 90% confidence bands are constructed using Driscoll-Kraay standard errors. The horizontal axis shows response horizon measured in years.

Figure 6. Forecast-error (AG) identification, responses by normalized level of public debt, semiannual frequency



Notes: The figure plots impulse responses to government spending shocks identified as forecast errors (AG shocks) for linear specification (2) and for nonlinear specification (3'). 90% confidence bands are constructed using Driscoll-Kraay standard errors. The horizontal axis shows response horizon measured in semesters.

Table 1. Responses to AG government spending shock, semiannual frequency

Variable	Average response				Impact response			
	Linear	Boom	Slump	p-value	Linear	Boom	Slump	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Long-term interest rate	-0.040	0.053	-0.197*	0.117	0.005	0.007	-0.022	0.756
	(0.044)	(0.067)	(0.109)		(0.030)	(0.034)	(0.074)	
Short-term interest rate	-0.055	-0.038	-0.099	0.648	0.023	-0.033	0.076	0.270
	(0.046)	(0.090)	(0.076)		(0.023)	(0.046)	(0.068)	
CDS spread	0.145*	0.308***	0.087	0.366	-0.047	0.125	-0.266**	0.099
	(0.082)	(0.092)	(0.187)		(0.065)	(0.127)	(0.117)	
Real GDP	0.529	-0.421	1.875*	0.135	0.228	-0.186	0.858*	0.098
	(0.443)	(0.564)	(1.019)		(0.151)	(0.230)	(0.427)	
Price level	0.161	0.069	0.110	0.958	-0.027	0.018	-0.093	0.574
	(0.158)	(0.271)	(0.564)		(0.030)	(0.064)	(0.137)	
Debt/GDP ratio	-0.228	0.617	-2.123**	0.047	0.071	0.400*	-0.550*	0.038
	(0.424)	(0.506)	(0.934)		(0.089)	(0.217)	(0.264)	
Government spending	0.402***	0.045	0.928***	0.014	0.230***	0.064	0.508***	0.002
	(0.087)	(0.177)	(0.171)		(0.043)	(0.057)	(0.076)	

Notes: The table reports estimated responses of macroeconomic and fiscal variables to government spending shocks identified as in Auerbach and Gorodnichenko (2013), that is, forecast-error shocks. The average response is calculated over five years (10 semesters). The impact response is calculated for horizon $h = 0$. Standard errors are constructed using Driscoll and Kraay (1998). P-value in columns (4) and (8) shows p-values for the test that responses are the same in slump and boom.

Table 2. Responses to BP government spending shock, semiannual frequency

Variable	Average response				Impact response			
	Linear	Boom	Slump	p-value	Linear	Boom	Slump	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Long-term interest rate	-0.131	-0.090	-0.157	0.797	-0.174***	-0.219*	-0.146	0.694
	(0.099)	(0.170)	(0.150)		(0.058)	(0.113)	(0.103)	
Short-term interest rate	-0.030	-0.092	0.061	0.537	-0.069	-0.236	0.080	0.300
	(0.092)	(0.164)	(0.143)		(0.060)	(0.168)	(0.153)	
CDS spread	-0.011	0.165	0.032	0.708	-0.336**	0.324*	-0.646**	0.017
	(0.082)	(0.217)	(0.158)		(0.150)	(0.172)	(0.230)	
Real GDP	2.013***	0.812	2.926***	0.117	0.655***	0.512	0.841***	0.494
	(0.609)	(0.933)	(0.653)		(0.196)	(0.369)	(0.248)	
Price level	-0.634	0.394	-1.205	0.298	-0.235**	-0.159	-0.307*	0.565
	(0.529)	(1.011)	(0.736)		(0.101)	(0.158)	(0.157)	
Debt/GDP ratio	-1.420**	-2.230**	-0.643	0.410	-0.535**	-0.418	-0.793*	0.658
	(0.500)	(1.050)	(1.038)		(0.198)	(0.531)	(0.394)	
Government spending	1.400***	1.405***	1.352***	0.793	1.000	1.000	1.000	-
	(0.083)	(0.149)	(0.109)		-	-	-	

Notes: The table reports estimated responses of macroeconomic and fiscal variables to government spending shocks identified as in Blanchard and Perotti (2001), that is, an innovation to government spending not predicted by standard macroeconomic variables. The average response is calculated over five years (10 semesters). The impact response is calculated for horizon $h = 0$. Standard errors are constructed using Driscoll and Kraay (1998). P-value in columns (4) and (8) shows p-values for the test that responses are the same in slump and boom.

Table 3. Responses to IMF spending (fiscal consolidation) shock, annual frequency

Variable	Average response				Impact response			
	Linear	Boom	Slump	p-value	Linear	Boom	Slump	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Long-term interest rate	-0.352**	-0.030	-0.415**	0.384	-0.733***	-0.112	-1.003***	0.082
	(0.136)	(0.274)	(0.183)		(0.193)	(0.225)	(0.280)	
Short-term interest rate	-0.158	-0.621	0.119	0.247	-0.273	-0.861*	0.134	0.099
	(0.193)	(0.506)	(0.161)		(0.177)	(0.444)	(0.183)	
CDS spread	-0.269	0.732**	-0.383	0.040	-0.857***	0.517	-0.974***	0.036
	(0.212)	(0.291)	(0.299)		(0.209)	(0.422)	(0.249)	
Real GDP	1.273**	0.493	1.610***	0.299	0.632***	-0.090	1.176***	0.106
	(0.463)	(0.876)	(0.352)		(0.171)	(0.581)	(0.186)	
Price level	-0.031	-0.878	0.869	0.106	-0.194*	-0.457	0.009	0.502
	(0.300)	(0.671)	(0.525)		(0.107)	(0.397)	(0.320)	
Debt/GDP ratio	-3.309***	-2.809	-3.707**	0.780	-1.704***	-1.749**	-1.678***	0.952
	(0.820)	(2.076)	(1.555)		(0.217)	(0.708)	(0.554)	
Government spending	0.340***	0.532***	0.283**	0.341	0.205***	0.266**	0.186**	0.602
	(0.046)	(0.160)	(0.108)		(0.036)	(0.100)	(0.073)	

Notes: The table reports estimated responses of macroeconomic and fiscal variables to government spending shocks identified as in Devries et al. (2011). The average response is calculated over five years. The impact response is calculated for horizon $h = 0$. Standard errors are constructed using Driscoll and Kraay (1998). P-value in columns (4) and (8) shows p-values for the test that responses are the same in slump and boom.

Table 4. Responses to AG government spending shock by normalized level of debt, semiannual frequency

Variable	Average response				Impact response			
	Linear	Low debt	High debt	p-value	Linear	Low debt	High debt	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Long-term interest rate	-0.040	-0.026	0.014	0.808	0.005	-0.022	0.014	0.738
	(0.044)	(0.077)	(0.099)		(0.030)	(0.052)	(0.070)	
Short-term interest rate	-0.055	-0.051	-0.041	0.946	0.023	-0.017	0.084	0.481
	(0.046)	(0.074)	(0.094)		(0.023)	(0.059)	(0.087)	
CDS spread	0.145*	0.056	0.232**	0.188	-0.047	-0.118	0.132	0.134
	(0.082)	(0.110)	(0.102)		(0.065)	(0.091)	(0.123)	
Real GDP	0.529	1.101	-0.380	0.409	0.228	0.212	0.415	0.722
	(0.443)	(0.736)	(1.203)		(0.151)	(0.210)	(0.434)	
Price level	0.161	0.037	0.315	0.758	-0.027	-0.033	-0.113	0.627
	(0.158)	(0.372)	(0.570)		(0.030)	(0.073)	(0.099)	
Debt/GDP ratio	-0.228	-0.296	1.374	0.459	0.071	0.012	0.039	0.972
	(0.424)	(0.736)	(1.553)		(0.089)	(0.248)	(0.538)	
Government spending	0.402***	0.367*	0.394*	0.943	0.230***	0.158*	0.386***	0.140
	(0.087)	(0.209)	(0.191)		(0.043)	(0.082)	(0.085)	

Notes: The table reports estimated responses of macroeconomic and fiscal variables to government spending shocks identified as in Auerbach and Gorodnichenko (2013), that is, an innovation to government spending not predicted by standard macroeconomic variables. The average response is calculated over five years (10 semesters). The impact response is calculated for horizon $h = 0$. Low (high) debt corresponds to the minimum (maximum) level of debt for a given country in the sample. Standard errors are constructed using Driscoll and Kraay (1998). P-value in columns (4) and (8) shows p-values for the test that responses are the same in high- and low-debt environments.

Table 5. Average response by state of normalized level of debt and economic conditions, semiannual frequency

Variable	Linear	Low debt			High debt		
		Boom	Slump	p-value	Boom	Slump	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Average response							
Long-term interest rate	-0.040	0.036	-0.364*	0.103	0.006	-0.001	0.987
	(0.044)	(0.097)	(0.198)		(0.265)	(0.206)	
Short-term interest rate	-0.055	-0.035	-0.400	0.302	-0.095	0.102	0.611
	(0.046)	(0.127)	(0.266)		(0.248)	(0.174)	
CDS spread	0.145*	0.155	0.863	0.314	0.207	-0.410***	0.132
	(0.082)	(0.230)	(0.533)		(0.297)	(0.137)	
GDP	0.529	1.425	1.551	0.960	-5.334**	3.482*	0.030
	(0.443)	(1.372)	(1.424)		(2.330)	(1.845)	
Price level	0.161	0.732	-1.138	0.158	-1.424	2.032**	0.013
	(0.158)	(0.562)	(0.923)		(0.946)	(0.711)	
Debt/GDP ratio	-0.228	1.269	-2.643**	0.055	1.013	0.375	0.884
	(0.424)	(1.153)	(1.093)		(2.636)	(2.304)	
Government spending	2.191***	-0.167	6.356***	0.039	-1.187	4.420***	0.151
	(0.505)	(1.611)	(1.643)		(2.758)	(1.476)	
Panel B. Impact response							
Long-term interest rate	0.005	0.010	-0.188	0.330	-0.038	0.116	0.492
	(0.030)	(0.046)	(0.162)		(0.114)	(0.137)	
Short-term interest rate	0.023	0.054	-0.218	0.152	-0.186	0.350*	0.110
	(0.023)	(0.057)	(0.149)		(0.162)	(0.187)	
CDS spread	-0.047	0.286	-0.258	0.326	-0.069	0.126	0.747
	(0.065)	(0.308)	(0.277)		(0.439)	(0.178)	
GDP	0.228	0.455	0.515	0.942	-1.805**	1.730***	0.006
	(0.151)	(0.321)	(0.614)		(0.766)	(0.479)	
Price level	-0.027	0.035	-0.199	0.433	-0.001	-0.119	0.777
	(0.030)	(0.100)	(0.247)		(0.290)	(0.172)	
Debt/GDP ratio	0.071	-0.590	0.030	0.469	2.556	-1.725**	0.057
	(0.089)	(0.489)	(0.610)		(1.604)	(0.692)	
Government spending	1.271***	0.158	2.649***	0.015	1.008	2.653***	0.216
	(0.251)	(0.482)	(0.587)		(0.785)	(0.731)	

Notes: The table reports estimated responses of macroeconomic and fiscal variables to government spending shocks identified as in Auerbach and Gorodnichenko (2013), that is, an innovation to government spending not predicted by standard macroeconomic variables. Column (1) presents estimates for specification (1). Columns (2)-(3) and (5)-(6) present estimations for specification (3''). The average response is calculated over 5 years (10 semesters). The impact response is calculated for horizon $h = 0$. Low (high) debt corresponds to the minimum (maximum) level of debt for a given country in the sample. Standard errors are constructed using Driscoll and Kraay (1998). P-value in columns (4) and (8) shows p-values for the test that responses are the same in boom and slump.

APPENDIX TABLES AND FIGURES

Appendix Table 1. Availability of key fiscal variables.

County		Government spending forecast error		Credit Default Swap (CDS) Spread		Government debt		Short-term interest rates		Narrative identification of fiscal consolidations	
Name	Code	first	last	first	last	first	last	first	last	first	last
Australia	AUS	1998	2014	2003	2017	1988	2016	1980	2017	1980	2014
Austria	AUT	1998	2014	2004	2017	2000	2016	1980	2017	1980	2014
Belgium	BEL	1998	2013	2004	2017	1995	2016	1980	2017	1980	2014
Canada	CAN	1987	2014	2012	2017	1990	2016	1980	2017	1980	2014
Czech Republic	CZE	1998	2009	2004	2017	1999	2016	1993	2017		
Denmark	DNK	1998	2010	2003	2017	1999	2016	1980	2017	1980	2014
Finland	FIN	1998	2014	2008	2017	1999	2016	1980	2017	1980	2014
France	FRA	1987	2014	2005	2017	1980	2016	1980	2017	1980	2014
Germany	DEU	1987	2014	2004	2017	1980	2016	1991	2017	1980	2014
Hungary	HUN	1998	2003	2004	2017	1995	2016	1991	2017		
Ireland	IRL	1998	2014	2006	2017	2000	2016	1990	2017	1980	2014
Italy	ITA	1987	2014	2004	2017	1986	2016	1980	2017	1980	2014
Japan	JPN	1987	2014	2004	2017	1997	2016	1980	2017	1980	2014
Korea	KOR	1999	2014	2004	2017			1991	2017		
Netherlands	NLD	1998	2014	2006	2017	1999	2016	1980	2017	1980	2009
New Zealand	NZL	1998	2014	2006	2017	1989	2016	1980	2017		
Norway	NOR	1998	2014	2003	2010	2000	2016	1980	2017		
Poland	POL	1998	2011	2004	2017	1999	2016	1991	2017		
Portugal	PRT	1998	2014	2004	2017	1999	2016	1980	2017	1980	2014
Slovak Republic	SVK	2008	2009	2004	2017	1999	2016	1995	2017		
Spain	ESP	1998	2012	2006	2017	1995	2016	1980	2017	1980	2014
Sweden	SWE	1998	2014	2003	2017	1995	2016	1982	2017	1980	2014
Switzerland	CHE	1998	2014	2008	2017	1995	2016	1980	2017		
United Kingdom	GBR	1987	2014	2007	2017	1987	2016	1980	2017	1980	2014
United States	USA	1987	2014	2008	2017	1980	2016	1980	2017	1980	2014

Notes: the table shows the first and last year of data available for a given country and a given variable.

Appendix Table 2. Descriptive statistics

Country	ISO	Long-term interest rate		Short-term interest rate		CDS spread		Growth rate of real GDP		Inflation		Debt-to-GDP ratio		AG government spending shock		IMF fiscal consolidation shock to government spending	
		mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
Australia	AUS	7.86	4.03	7.67	4.75	0.35	0.23	3.08	2.04	4.23	3.10	0.22	0.09	0.00	0.54	-0.10	0.22
Austria	AUT	5.31	2.76	4.25	3.29	0.45	0.53	1.91	1.74	2.58	1.53	0.76	0.07	0.00	0.26	-0.21	0.39
Belgium	BEL	6.15	3.66	5.12	4.35	0.62	0.78	1.75	1.76	2.82	2.14	1.09	0.12	0.00	0.39	-0.41	0.63
Canada	CAN	6.58	3.77	5.69	4.48	0.32	0.02	2.35	2.37	3.24	2.79	0.70	0.11	0.00	0.38	-0.16	0.24
Czech Republic	CZE	3.39	1.92	4.64	4.86	0.59	0.49	2.54	2.56	3.77	3.44	0.32	0.09	0.00	0.69		
Finland	FIN	6.32	3.92	5.95	5.26	0.32	0.19	2.11	3.00	3.31	3.17	0.46	0.09	0.00	0.45	-0.36	0.87
France	FRA	6.40	4.33	5.36	4.49	0.51	0.54	1.73	1.57	3.17	3.51	0.60	0.19	0.00	0.27	-0.14	0.33
Germany	DEU	3.91	2.34	2.97	2.65	0.24	0.26	1.44	1.95	1.72	1.15	0.63	0.12	0.00	0.33	-0.22	0.34
Ireland	IRL	5.21	2.76	3.84	3.83	2.01	2.46	4.36	4.33	4.24	4.90	0.62	0.36	0.00	0.74	-0.45	0.90
Italy	ITA	8.19	5.13	7.19	6.35	1.31	1.36	1.17	1.99	5.04	5.19	1.09	0.14	0.00	0.31	-0.49	0.70
Japan	JPN	3.22	2.69	2.48	3.09	0.44	0.35	1.94	2.73	1.06	1.78	1.59	0.38	0.00	0.66	-0.08	0.16
Netherlands	NLD	5.25	2.89	4.17	3.20	0.37	0.32	2.04	2.02	2.30	1.58	0.57	0.08	0.00	0.42	-0.48	0.76
New Zealand	NZL	8.12	4.05	8.53	5.39	0.41	0.27	2.70	2.87	4.80	5.18	0.29	0.06	0.00	0.78		
Norway	NOR	6.89	3.96	6.88	4.71	0.11	0.11	2.27	2.62	3.87	3.24	0.37	0.08	0.00	0.50		
Portugal	PRT	10.07	6.50	7.99	7.29	2.45	3.19	1.77	2.76	7.34	7.79	0.85	0.31	0.00	0.44	-0.38	0.82
Spain	ESP	7.97	4.99	7.05	6.19	1.51	1.46	2.22	2.35	4.93	4.14	0.64	0.20	0.00	0.29	-0.30	0.52
Sweden	SWE	6.83	4.38	5.78	4.71	0.25	0.28	2.20	2.29	3.60	3.80	0.49	0.11	0.00	0.41	-0.21	0.49
Switzerland	CHE	3.26	1.80	2.83	2.78	1.02	0.40	1.71	2.00	1.75	1.94	0.42	0.07	0.00	0.23		
United Kingdom	GBR	6.71	3.78	6.42	4.66	0.46	0.30	2.15	2.09	2.58	1.79	0.48	0.22	0.00	0.93	-0.10	0.20
United States	USA	6.15	3.27	5.06	4.08	0.25	0.12	2.61	2.16	3.32	2.51	0.63	0.17	0.00	0.26	-0.10	0.15

Notes: The table reports mean and standard deviation (SD) for select macroeconomic and fiscal variables. AG government spending shock is the unanticipated, exogenous innovation to government spending identified as in Auerbach and Gorodnichenko (2013). IMF fiscal consolidation shocks are narratively identified cuts in government spending and are taken from Devries et al. (2011).

Appendix Table 3. Responses to AG government spending shock, annual frequency

Variable	Average response				Impact response			
	Linear	Boom	Slump	p-value	Linear	Boom	Slump	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Long-term interest rate	-0.160	0.063	-0.494***	0.015	-0.077	0.170	-0.455*	0.073
	(0.110)	(0.135)	(0.161)		(0.098)	(0.141)	(0.234)	
Short-term interest rate	-0.043	-0.013	-0.152	0.693	0.106	0.007	0.082	0.807
	(0.095)	(0.224)	(0.189)		(0.104)	(0.196)	(0.207)	
CDS spread	0.063	0.187	-0.095	0.410	-0.110	0.474	-0.833***	0.056
	(0.153)	(0.138)	(0.241)		(0.162)	(0.395)	(0.277)	
GDP	0.931*	-0.355	2.666***	0.039	0.663**	-0.096	1.583***	0.037
	(0.492)	(0.691)	(0.806)		(0.265)	(0.371)	(0.488)	
Price level	0.408	0.419	0.302	0.891	0.081	0.409**	-0.268	0.056
	(0.242)	(0.376)	(0.594)		(0.098)	(0.158)	(0.228)	
Debt/GDP ratio	-1.929***	-0.143	-4.130***	0.075	-1.010**	0.651	-2.848**	0.137
	(0.589)	(1.163)	(1.206)		(0.416)	(1.006)	(1.324)	
Government spending	0.596***	0.226	1.000***	0.019	0.403***	0.217***	0.608***	0.012
	(0.077)	(0.179)	(0.160)		(0.027)	(0.075)	(0.083)	

Notes: The table reports estimated responses of macroeconomic and fiscal variables to government spending shocks identified as in Auerbach and Gorodnichenko (2013), that is, forecast-error shocks. The average response is calculated over five years. The impact response is calculated for horizon $h = 0$. Standard errors are constructed using Driscoll and Kraay (1998). P-value in columns (4) and (8) shows p-values for the test that responses are the same in slump and boom.

Appendix Table 4. Responses to BP government spending shock, annual frequency

Variable	Average response				Impact response			
	Linear	Boom	Slump	p-value	Linear	Boom	Slump	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Long-term interest rate	-0.334	-0.300	-0.370	0.861	-0.410***	-0.285	-0.517***	0.510
	(0.196)	(0.274)	(0.255)		(0.127)	(0.243)	(0.168)	
Short-term interest rate	-0.075	-0.192	0.085	0.507	-0.127	0.013	-0.188	0.682
	(0.188)	(0.311)	(0.248)		(0.212)	(0.360)	(0.271)	
CDS spread	-0.297***	0.380	-0.722***	0.051	-0.515**	0.085	-0.883*	0.278
	(0.079)	(0.326)	(0.222)		(0.197)	(0.418)	(0.463)	
GDP	2.173***	0.203	3.884***	0.000	1.047***	0.033	1.965***	0.006
	(0.610)	(0.685)	(0.513)		(0.272)	(0.367)	(0.414)	
Price level	-0.811	0.655	-1.835*	0.071	-0.632*	0.021	-1.155*	0.176
	(0.742)	(0.711)	(1.055)		(0.322)	(0.268)	(0.648)	
Debt/GDP ratio	-3.673***	-1.975	-5.600***	0.103	-1.674***	-0.892	-2.603**	0.285
	(0.997)	(1.448)	(1.322)		(0.467)	(0.695)	(1.093)	
Government spending	1.280***	1.204***	1.321***	0.414	1.000	1.000	1.000	-
	(0.054)	(0.100)	(0.074)		-	-	-	

Notes: The table reports estimated responses of macroeconomic and fiscal variables to government spending shocks identified as in Blanchard and Perotti (2001), that is, an innovation to government spending not predicted by standard macroeconomic variables. The average response is calculated over five years. The impact response is calculated for horizon $h = 0$. Standard errors are constructed using Driscoll and Kraay (1998). P-value in columns (4) and (8) shows p-values for the test that responses are the same in slump and boom.

Appendix Table 5. Responses to AG government spending shock by level of debt, semiannual frequency

Variable	Average response				Impact response			
	Linear	0% Debt/GDP ratio	100% Debt/GDP ratio	p-value	Linear	0% Debt/GDP ratio	100% Debt/GDP ratio	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Long-term interest rate	-0.040	-0.111	0.063	0.217	0.005	-0.022	0.016	0.665
	(0.044)	(0.082)	(0.079)		(0.030)	(0.039)	(0.059)	
Short-term interest rate	-0.055	-0.090	-0.016	0.750	0.023	-0.068	0.126*	0.091
	(0.046)	(0.134)	(0.112)		(0.023)	(0.056)	(0.061)	
CDS spread	0.145*	-0.327***	0.393***	0.006	-0.047	-0.049	0.038	0.602
	(0.082)	(0.109)	(0.136)		(0.065)	(0.107)	(0.107)	
GDP	0.529	0.538	0.146	0.619	0.228	-0.220	0.688***	0.017
	(0.443)	(0.629)	(0.426)		(0.151)	(0.225)	(0.225)	
Price level	0.161	0.199	-0.029	0.702	-0.027	-0.154**	0.034	0.081
	(0.158)	(0.340)	(0.311)		(0.030)	(0.073)	(0.050)	
Debt/GDP ratio	-0.228	-0.176	0.158	0.823	0.071	-0.061	0.133	0.701
	(0.424)	(0.908)	(0.737)		(0.089)	(0.257)	(0.262)	
Government spending	0.402***	0.496***	0.313**	0.415	0.230***	0.228**	0.277***	0.632
	(0.087)	(0.169)	(0.112)		(0.043)	(0.082)	(0.059)	

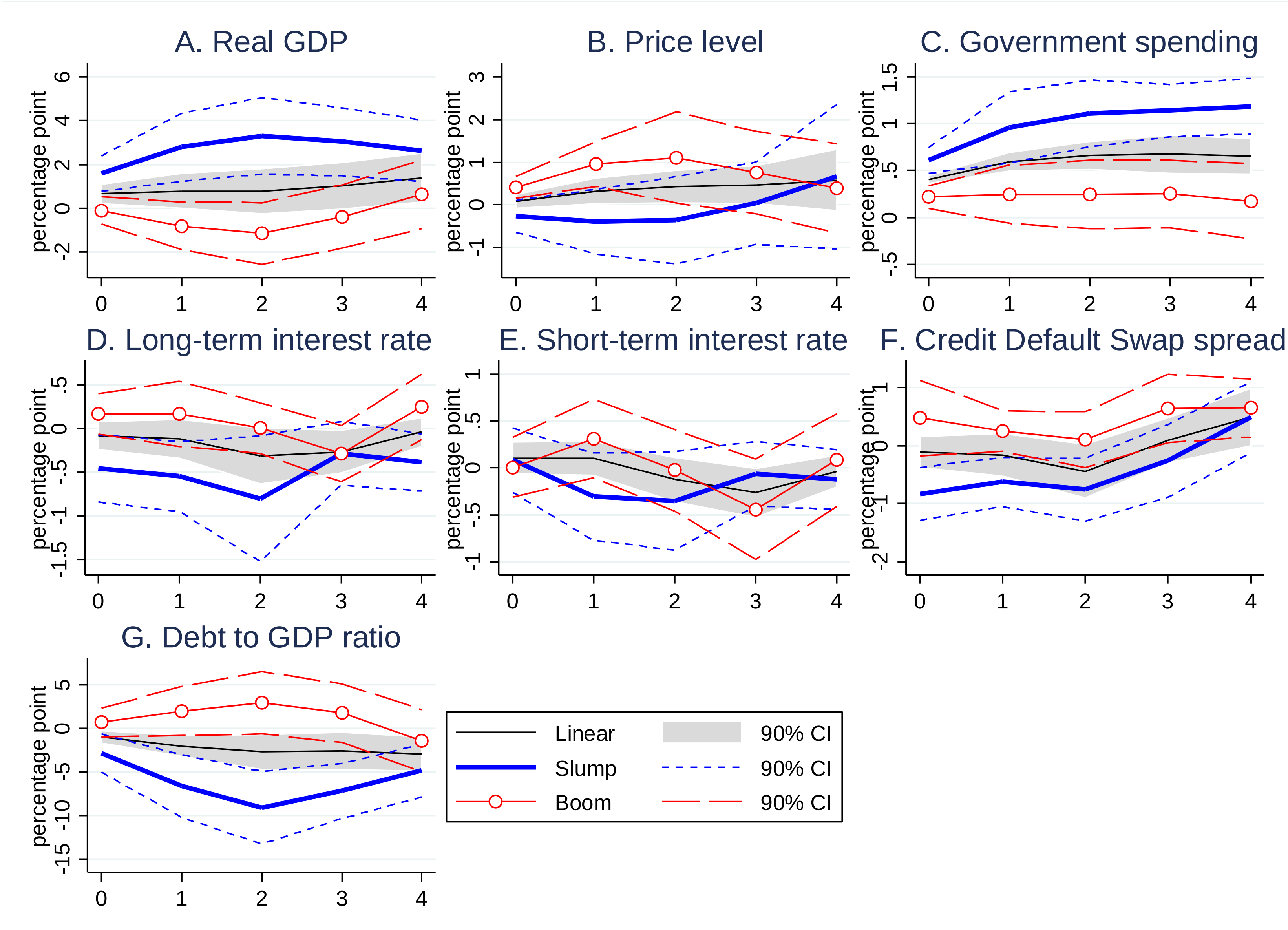
Notes: The table reports estimated responses of macroeconomic and fiscal variables to government spending shocks identified as in Auerbach and Gorodnichenko (2013), that is, forecast-error shocks. The average response is calculated over five years (10 semesters). The impact response is calculated for horizon $h = 0$. Standard errors are constructed using Driscoll and Kraay (1998). P-value in columns (4) and (8) shows p-values for the test that responses are the same in high- and low-debt environments.

Appendix Table 6. Responses by state of level of debt and economic conditions, semiannual frequency

Variable	Linear	0% Debt/GDP ratio			100% Debt/GDP ratio		
		Boom	Slump	p-value	Boom	Slump	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Average response							
Long-term interest rate	-0.040	-0.028	-0.528**	0.060	0.144	-0.048	0.333
	(0.044)	(0.071)	(0.249)		(0.115)	(0.185)	
Short-term interest rate	-0.055	-0.113	-0.359	0.359	-0.000	-0.115	0.647
	(0.046)	(0.117)	(0.268)		(0.182)	(0.100)	
CDS spread	0.145*	0.023	0.328	0.314	0.117	-0.017	0.332
	(0.082)	(0.108)	(0.244)		(0.131)	(0.078)	
GDP	0.529	-1.227	3.108**	0.036	-0.607	0.035	0.727
	(0.443)	(0.775)	(1.353)		(0.650)	(1.416)	
Price level	0.161	0.230	0.117	0.929	-0.387	-0.140	0.848
	(0.158)	(0.409)	(1.082)		(0.525)	(0.988)	
Debt/GDP ratio	-0.228	0.799	-4.181***	0.008	1.119	2.811	0.579
	(0.424)	(0.734)	(1.324)		(0.954)	(2.306)	
Government spending	2.191***	0.683	6.913***	0.020	-1.292	4.234**	0.023
	(0.505)	(1.006)	(1.854)		(1.096)	(1.640)	
Panel B. Impact response							
Long-term interest rate	0.005	-0.011	-0.187*	0.168	0.084	-0.086	0.124
	(0.030)	(0.052)	(0.104)		(0.070)	(0.075)	
Short-term interest rate	0.023	-0.028	-0.202	0.256	0.072	0.193	0.436
	(0.023)	(0.049)	(0.140)		(0.081)	(0.135)	
CDS spread	-0.047	0.320**	-0.387	0.090	-0.089	0.050	0.564
	(0.065)	(0.141)	(0.329)		(0.120)	(0.172)	
GDP	0.228	-0.478	0.727	0.218	0.030	0.840*	0.277
	(0.151)	(0.320)	(0.727)		(0.390)	(0.448)	
Price level	-0.027	-0.208**	-0.313	0.750	0.410***	-0.324**	0.001
	(0.030)	(0.075)	(0.273)		(0.100)	(0.138)	
Debt/GDP ratio	0.071	0.037	-0.753	0.366	0.614*	-0.670	0.173
	(0.089)	(0.266)	(0.716)		(0.305)	(0.710)	
Government spending	1.271***	0.606	2.592***	0.019	0.255	3.144***	0.007
	(0.251)	(0.368)	(0.588)		(0.378)	(0.774)	

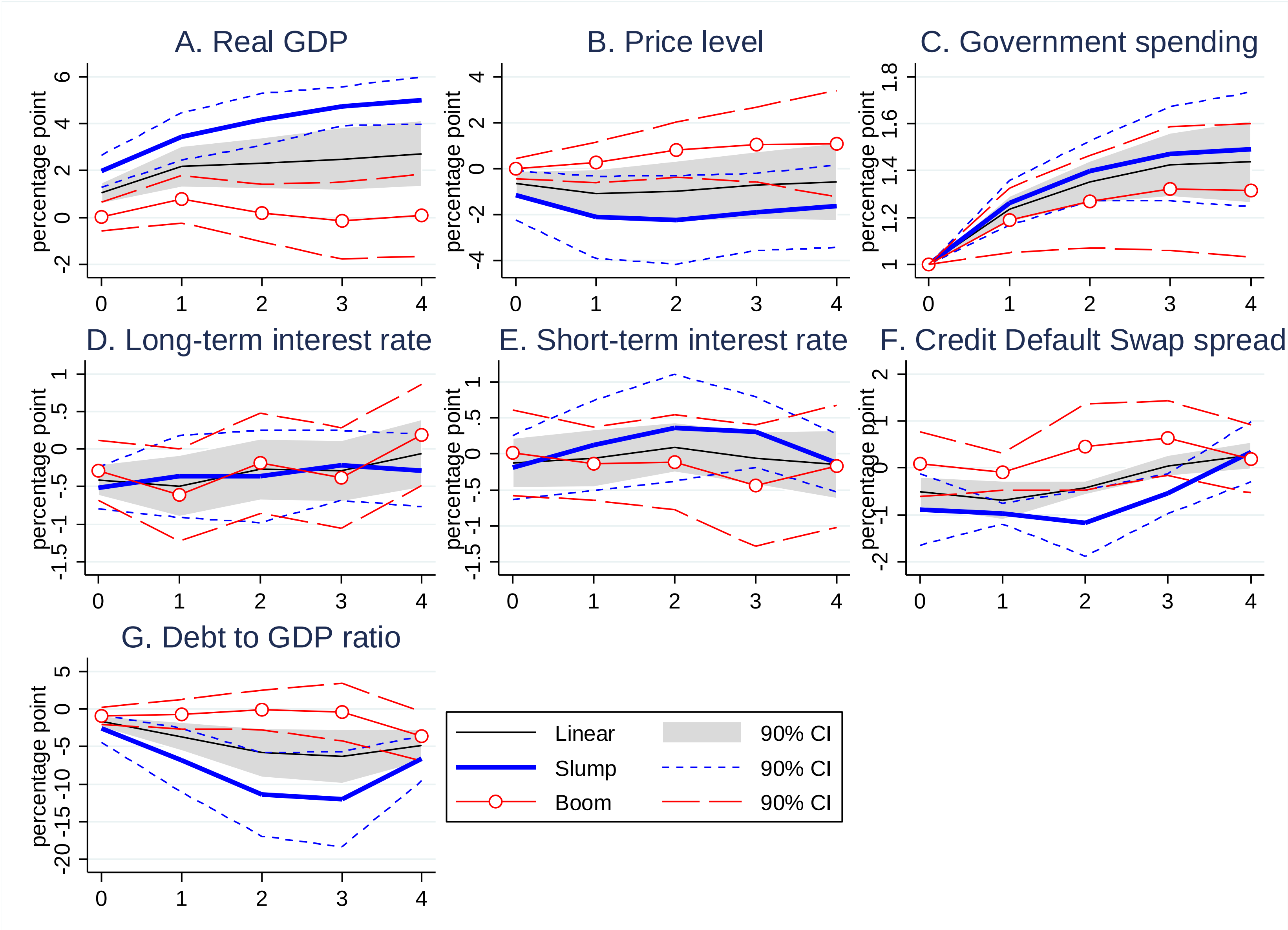
Notes: The table reports estimated responses of macroeconomic and fiscal variables to government spending shocks identified as in Auerbach and Gorodnichenko (2013), that is, an innovation to government spending not predicted by standard macroeconomic variables. The average response is calculated over five years (10 semesters). The impact response is calculated for horizon $h = 0$. Column (1) presents estimates for specification (1). Columns (2)-(3) and (5)-(6) present estimations for specification (3''). In contrast to **Error! Reference source not found.**, this table uses the absolute (rather than normalized) level of debt. Standard errors are constructed using Driscoll and Kraay (1998). P-value in columns (4) and (8) shows p-values for the test that responses are the same in high- and low-debt environments.

Appendix Figure 1. AG government spending shocks, annual frequency.



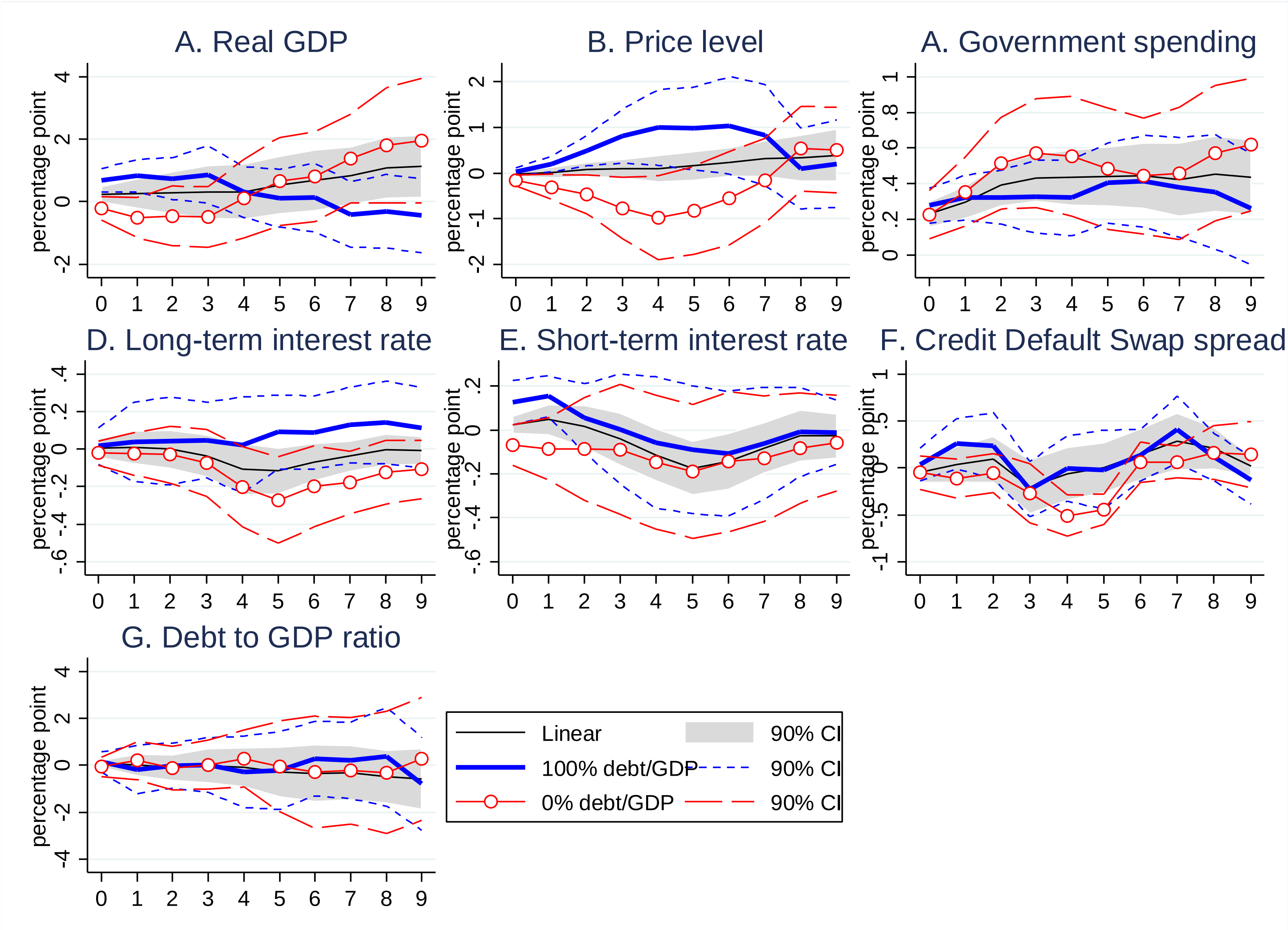
Notes: The figure plots impulse responses to government spending shocks identified as forecast errors (AG shocks) for linear specification (1) and for nonlinear specification (2). 90% confidence bands are constructed using Driscoll-Kraay standard errors. The horizontal axis shows response horizon measured in years.

Appendix Figure 2. Blanchard-Perotti identification, annual frequency



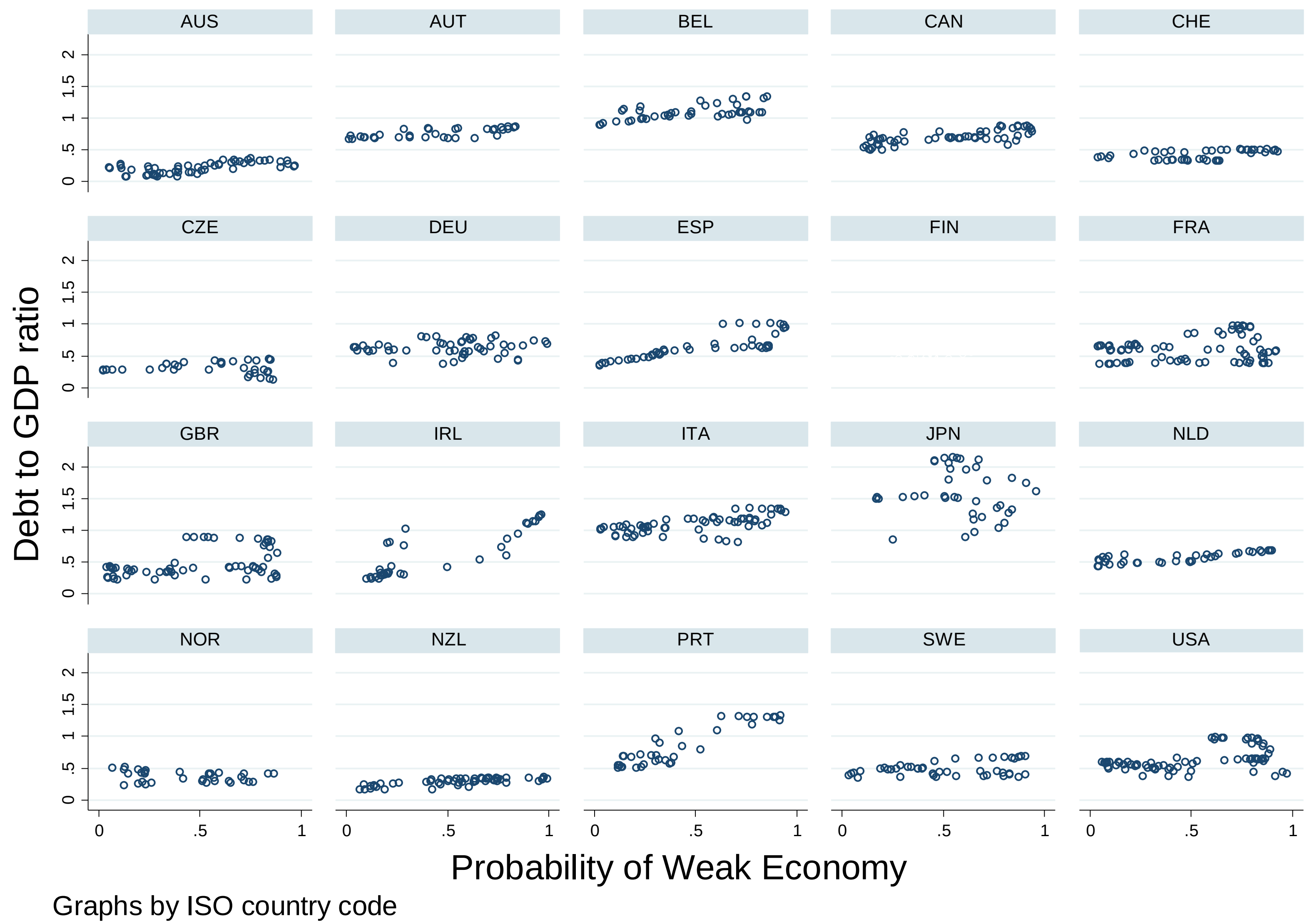
Notes: The figure plots impulse responses to government spending shocks identified as in Blanchard and Perotti (2001) (BP shocks) for linear specification (1) and for nonlinear specification (2). 90% confidence bands are constructed using Driscoll-Kraay standard errors. The horizontal axis shows response horizon measured in semesters.

Appendix Figure 3. Forecast-error (AG) identification, responses by level of public debt, semiannual frequency



Notes: The figure plots impulse responses to government spending shocks identified as forecast errors (AG shocks) for linear specification (2) and for nonlinear specification (3'). 90% confidence bands are constructed using Driscoll-Kraay standard errors. The horizontal axis shows response horizon measured in semesters. In contrast to Figure 6, debt burden is measured as the raw debt-to-GDP ratio.

Appendix Figure 4. Gross debt to GDP ratio vs. Probability of weak economy



Note: Probability of weak economy is calculated as $F(z)$ where $F(\cdot)$ is the transition function in specification (3).