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ABSTRACT

In this paper, we estimate the cross-country spillover effects of government purchases on output for a large number of OECD countries. Following the methodology in Auerbach and Gorodnichenko (2012a, b), we allow these multipliers to vary smoothly according to the state of the economy and use real-time forecast data to purge policy innovations of their predictable components. We also consider the responses of other key macroeconomic variables. Our findings suggest that cross-country spillovers have an important impact, and also confirm those of our earlier papers that fiscal shocks have a larger impact when the affected country is in recession.

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1. Introduction

One of the challenges facing a country attempting to maintain economic stability is the economic shocks emanating from abroad, which through trade and other linkages may have important effects on domestic conditions. While such shocks may have many sources, one of particular interest is fiscal policy. Indeed, a common justification for fiscal agreements like the Stability and Growth Pact and successive measures adopted by Eurozone countries is that, having relinquished independent monetary and exchange rate policies, individual countries need some protection from the shocks of uncoordinated fiscal policies. Economic observers long appreciated the importance of fiscal spillovers but it is the current economic environment of ever increasing globalization and of conflicting calls for fiscal austerity and fiscal stimuli that demands clear and robust evidence to navigate policymakers through the Great Recession and its aftermath. Specifically, there are at least three key questions: (1) What is the effect of fiscal austerity/stimulus in one country on economic conditions in another country? (2) Can countries short of fiscal ammunition (e.g., Greece during the Great Recession) be supported by positive fiscal stimulus in other countries? (3) Does the strength of fiscal spillovers vary over the business cycle? If so, what should be the scope of coordinated fiscal policies in recession? In this paper, we try to shed new light on these questions, with results that have a number of immediate policy implications.

Our paper is certainly not the first empirical investigation of fiscal spillovers. For example, Bénassy-Quéré and Cimadomo (2006) estimate the impact of fiscal spillovers from Germany to the remaining G-7 countries using an augmented SVAR model. Beetsma et al. (2005) estimate the spillover impact of shocks via the trade channel by combining panel VAR estimates of the effects of domestic shocks on output and estimates of the effects of output on

imports from abroad. In a recent paper, Hebous and Zimmermann (2012) adopt a panel VAR approach to estimate the effects of domestic and foreign fiscal shocks among Eurozone countries, representing foreign shocks as a common, GDP weighted aggregate of the individual country shocks.[1]

We extend the existing literature in a number of ways. First, we consider fiscal spillovers among OECD countries, a larger and more heterogeneous group than the G-7 or the Eurozone. This allows us to consider, for example, the differences in effects among countries sharing fixed exchange rates versus those that do not. Second, although we allow shocks to depend on trade linkages, we directly estimate the effects of shocks in one country on another country's output. This makes interpretation of estimated coefficients in our econometric specification particularly straightforward and transparent. Third, we allow multipliers to vary across states of the business cycle, thus relaxing standard assumptions that our previous analysis of domestic shocks in the United States and the OECD (Auerbach and Gorodnichenko, 2012a, b, respectively) suggested was important. Fourth, we enhance identification of fiscal shocks by removing predictable innovations in government spending by controlling for information contained not only in the lags of macroeconomic variables but also in professional forecasts. This aspect is important because anticipated and unanticipated fiscal shocks may have different effects and mixing these two types of shocks, which is likely to happen in VAR models (see e.g. Ramey 2011 and Auerbach and Gorodnichenko 2012a, 2012b), can lead to understating estimated effects of fiscal shocks. Finally, we consider the effects of fiscal spillovers not only on output but also on a number of other macroeconomic variables; hence we can paint a more detailed picture of how fiscal shocks propagate across countries.

[1] There have also been a number of papers estimating the impact of fiscal spillovers using DSGE models. See, for example, Bénassy-Quéré (2006) and Corsetti, Meier, and Müller, (2010).

We document that fiscal spillovers are significant in both statistical and economic terms. The effect, however, varies tremendously over the business cycle with the spillovers being particularly high in recessions and quite modest in expansions, with the output multiplier in recessions being even larger than those found in our previous work for domestic shocks, based on what would expect given the strength of trade linkages. We also find that fiscal spillovers are increased further when both recipient and source countries are in recession.

2. Modeling Fiscal Spillovers

To model the effects of fiscal spillovers, we extend the approach taken in Auerbach and Gorodnichenko (2012b) and use data for a panel of OECD countries to estimate fiscal spillover multipliers using direct projections. Specifically, for our baseline model we run a series of regressions for different horizons, h = 0, 1, …, H of the form:

$$(1) \qquad \frac{Y_{i,t+h}-Y_{i,t-1}}{Y_{i,t-1}} = \alpha_h \frac{GShock_{it}}{Y_{i,t-1}} + \sum_{s=1}^{m} \beta_{hs} \frac{\Delta Y_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m} \delta_{hs} \frac{\Delta G_{i,t-s}}{Y_{i,t-s-1}} + \phi_{hi} + \mu_{ht} + error_{iht}$$

where t and i index time and countries, Y is real GDP, and G is real government purchases (both Y and G are measured in terms of local currency in fixed prices of the base year), ϕ and μ are horizon-specific country and time fixed effects, and $GShock$ is the government spending spillover shock emanating from other countries, which we will specify further. The impulse response for H periods is constructed from a sequence of estimated $\{\alpha_h\}_{h=0}^{H}$.

Before we continue, a few observations about equation (1) are useful. First, variables in equation (1) are in differences, scaled by lagged GDP, which follows the approach in Hall (2009) and Barro and Redlick (2011). Estimated $\{\alpha_h\}_{h=0}^{H}$ in this specification directly correspond to multipliers while in our previous work we estimated elasticities of output with respect to a

government spending shock and then converted them into multipliers. Also, scaling by lagged output puts the observations from different dates and countries in similar units.[2] Second, we omit lagged values of taxes from our specification. Experiments with the inclusion of taxes and other potential own-country controls, such as rates of interest, inflation and unemployment, did not have an appreciable impact on the results, and so we omit them in the interest of conserving degrees of freedom. Third, we do not include own-country fiscal shocks in equation (1). While the analysis of the effects of such shocks was the main objective of our previous papers, including them here would require a significant reduction in sample size, for there are many country-years for which we do not have OECD forecasts of government spending. Analysis of models including own-country shocks using this reduced sample suggests that their inclusion has little impact on the estimated effects of fiscal spillovers; given the larger standard errors caused by this reduction in sample size, we omit own-country shocks from the results we report.

To construct the fiscal spillover shock $GShock$, we regress real-time one-period-ahead forecast errors for government spending from the OECD's "Outlook and Projections Database" in each country on that country's lagged macroeconomic variables (output, government spending, exchange rate, inflation, investment, and imports) as well as a set of country and period fixed effects. Since the residual from this regression captures innovations in government spending orthogonal to professional forecasts and lags of macroeconomic variables, we take this residual as a measure of unanticipated government spending shocks. Denote this policy shock in source country q with $e_{q,t}$. Then we aggregate $e_{q,t}$ across countries using bilateral trade as a

[2] In principle, if G and Y are cointegrated, their ratio is stable in the long run and a regression based on first differences should include an error correction term reflecting this relationship in levels. However, our estimates are for a relatively short time period (1985-2012), during which there are trends and swings in the G/Y ratio. Moreover, specifications with included levels of G and Y (or their ratio) barely affected the coefficients of interest and therefore are not reported separately here.

measure of inter-country linkages. In particular, our base specification for the fiscal shock affecting country *i* in year *t* is:

$$(2) \qquad \boldsymbol{GShock_{i,t}} = \frac{\sum_{q \neq i}\left(\frac{M_{iq,B}}{G_{q,B}}\right) \times \{e_{q,t} \times G_{q,t-1} \times E_{q,B}\}}{E_{i,B}}$$

where $M_{iq,t}$ is country *q*'s imports from country *i* in year *t*, $E_{j,t}$ is country *j*'s US dollar exchange rate in year *t*, and *B* is a base year. The term in curly brackets in expression (2), $e_{q,t} \times G_{q,t-1} \times E_{q,B}$, equals the dollar value of country *q*'s fiscal shock, calculated using a base-year exchange rate. The first term in the numerator, $M_{iq,B}/G_{q,B}$, scales this shock by the ratio of imports from country *i* to government purchases, and division by the base-year dollar exchange rate of country *i* converts the shock into units of the recipient-country's currency. One may interpret $M_{iq,B}/G_{q,B}$ as a weight which corrects for heterogeneity of countries in the strength of the trade linkage between source country *q* and recipient country *i* and in the size of government in source country *q*. This ratio also captures the idea that a certain factor of government purchases translates (directly or indirectly) into imports from other countries, which stimulate demand in those countries.

It is possible that a dollar increase in government spending in country *q* is going to be converted into less than $M_{iq,B}/G_{q,B}$ dollars of imports from country *i*. Indeed, discretionary government spending shocks are often designed to support the domestic economy. For example, the 2008-2009 fiscal stimulus in the United States had many restrictions, such as that firms receiving federal aid had to hire U.S. citizens or purchase inputs from U.S. suppliers. While examples that go in the other direction are less obvious (military spending abroad would be one instance), indirect effects matter, too; the propensity to import out of induced changes in private

spending in country q must also be taken into account. Our specification in (2) effectively assumes that spillover shocks occur through imports, and that $\theta \frac{M_{iq,B}}{G_{q,B}}$ is imported from country i for each dollar increase in government spending in country q, with θ being constant across countries. Obviously, $\theta = 1$ is an important special case. However, even when $\theta \neq 1$, the estimated α_h in specification (1) will absorb θ and our interpretation of the estimated α_h is not affected. The higher the value of θ, the higher we would expect the estimate of α_h to be.

One can re-write the expression in (2) as follows

$$(2') \qquad GShock_{i,t} = M_{iT,B} \sum_{q \neq i} \left(\frac{M_{iq,B} E_{q,B}}{M_{iT,B} E_{i,B}} \right) \times \left\{ \frac{e_{q,t} \times G_{q,t-1}}{G_{q,B}} \right\} = M_{iT,B} \sum_{q \neq i} \omega_{iq,B} \times \left\{ \frac{e_{q,t} \times G_{q,t-1}}{G_{q,B}} \right\}$$

where $M_{iT,B}$ is the total imports from country i to other countries measured in the currency of country i (i.e., country i's total exports to those countries from which fiscal shocks emanate) and $\omega_{iq,B}$ is the share of these imports from country i going to country q. The last term (curly brackets) can be interpreted as an unanticipated shock to government spending measured in percent terms. Thus, $GShock_{i,t}$ is the weighted average percent shock in government spending in other countries scaled by the level of imports from country i.

Equation (2) uses fixed, base-year exchange rates and import intensity for scaling fiscal shocks. An alternative is to allow these factors to change over time reflecting changing trade patterns and exchange rates. With time-varying weights, we specify country i's fiscal shock in year t as:

$$(3) \qquad \boldsymbol{GShock^*_{i,t}} = \frac{\sum_{q \neq i} \left(\frac{M_{iq,t-1}}{G_{q,t-1}} \right) \times \left\{ e_{q,t} \times G_{q,t-1} \times E_{q,t-1} \times \left(\frac{P_{q,t-1}}{P_{US,t-1}} \right) \right\}}{E_{i,t-1} \times \left(\frac{P_{i,t-1}}{P_{US,t-1}} \right)}$$

where $P_{j,t-1}$ is country j's price index in year $t-1$ and hence $E_{j,t-1} \times \left(\frac{P_{j,t-1}}{P_{US,t-1}}\right)$ is country j's real US dollar exchange rate in year $t-1$. An advantage of using time varying weights is that they will pick up trends in exchange rates and trade linkages and hence more accurately represent current economic conditions. A disadvantage is that imports, government purchases and exchange rates are potentially correlated with the shocks we measure (to the extent that we have not fully purged the shocks of predictable components) and also can exhibit volatility over short periods. To deal with the latter issue, we smooth the time-varying weights in equation (3) by averaging values over two lagged periods.

In addition to the standard real GDP series, we will examine responses of other key macroeconomic variables to government spending spillover shocks, following the same general approach as in Auerbach and Gorodnichenko (2012b). As discussed there, a benefit of estimation using direct projections is that consideration of these other variables involves only a small modification to equation (1). For example, equation (1) for a variable of interest X is specified as follows:

(1') $$\frac{X_{i,t+h}-X_{i,t-1}}{X_{i,t-1}} = \alpha_h \frac{GShock_{it}}{X_{i,t-1}} + \sum_{s=1}^{m} \beta_{hs} \frac{\Delta Y_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m} \delta_{hs} \frac{\Delta X_{i,t-s}}{X_{i,t-s-1}} + \phi_{hi} + \mu_{ht} + error_{iht},$$

(1'') $$\frac{X_{i,t+h}-X_{i,t-1}}{X_{i,t-1}} = \alpha_h \frac{GShock_{it}}{Y_{i,t-1}} + \sum_{s=1}^{m} \beta_{hs} \frac{\Delta Y_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m} \delta_{hs} \frac{\Delta X_{i,t-s}}{X_{i,t-s-1}} + \phi_{hi} + \mu_{ht} + error_{iht}.$$

In some instances, we prefer using equation (1'') with $\frac{GShock_{it}}{Y_{i,t-1}}$ rather than $\frac{GShock_{it}}{X_{i,t-1}}$ because X could be measured in units or scale different from $GShock$ (e.g., real exchange rate, hours per worker).[3]

Whichever version of the fiscal shock we use, we also wish to allow the impact of shocks to vary over the business cycle, given the findings in our earlier work that multipliers vary over the cycle and are larger in recessions. Following our earlier approach of allowing smooth transitions between the states we label "recession" and "expansion," we modify specification (1) as follows:

$$(4) \qquad \frac{Y_{i,t+h}-Y_{i,t-1}}{Y_{i,t-1}} = \alpha_{R,h}F\left(z_{i,t-1}\right)\frac{GShock_{i,t}}{Y_{i,t-1}} + \alpha_{E,h}\left(1-F\left(z_{i,t-1}\right)\right)\frac{GShock_{i,t}}{Y_{i,t-1}} + \sum_{s=1}^{m}\beta_{R,hs}F\left(z_{i,t-1}\right)\frac{\Delta Y_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m}\beta_{E,hs}\left(1-F\left(z_{i,t-1}\right)\right)\frac{\Delta Y_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m}\delta_{R,hs}F\left(z_{i,t-1}\right)\frac{\Delta G_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m}\delta_{E,hs}\left(1-F\left(z_{i,t-1}\right)\right)\frac{\Delta G_{i,t-s}}{Y_{i,t-s-1}} + \phi_{hi} + \mu_{ht} + error_{iht}$$

where $F\left(z_{i,t}\right)$ can be interpreted as a measure of probability of being in a recession in country *i* at time *t* based on a measure of the state of the business cycle, $z_{i,t}$. The impulse response for the multiplier in recession is given by $\left\{\alpha_{R,h}\right\}_{h=0}^{H}$, while for expansion it is $\left\{\alpha_{E,h}\right\}_{h=0}^{H}$. We construct $F\left(z_{i,t}\right) = \frac{\exp\left(-\gamma z_{i,t}\right)}{\left[1+\exp\left(-\gamma z_{i,t}\right)\right]}$ and, as before, normalize $z_{i,t}$ to have zero mean and unit variance and fix $\gamma = 1.5$ so that an economy spends about 20 percent of the time in recession. We calculate $z_{i,t}$ after removing very low frequency movements in the data using the Hodrick-Prescott filter (smoothing parameter $\lambda = 10{,}000$), so one can think of z as (normalized) deviations from trend. For our base case, as before, we measure $z_{i,t}$ using the growth rate of real GDP, but we also

[3] We find similar results when in equations (1') and (1'') we control for lags of the government spending growth rate rather than lags of the output growth rate. We prefer the latter specification as it has a better fit and produces smaller standard errors.

consider the logarithm of real GDP and the unemployment rate. When we use the latter two variables, one can use the slump/boom dichotomy rather than the recession/expansion dichotomy. For each variation, we lag $z_{i,t}$ by one period to minimize contemporaneous correlations between fiscal shocks and macroeconomic variables.

3. Data

The macroeconomic series we use in our analyses come from the OECD's Statistics and Projections database. Aside from the benefits these data provide in terms of standardized variable definitions and measurement, we also have available semiannual forecasts prepared by the OECD for key macroeconomic variables such as GDP and government spending in June and December of each year.[4] For further information on these forecasts and their quality, see Auerbach and Gorodnichenko (2012b) or the OECD's website.[5]

The OECD's forecasts are consistently available since 1984 for "old" members of the OECD (e.g., the United States) and since the mid-1990s for newer members (e.g., Poland). A drawback of using the OECD projections is that, for most of the available sample, they are available only semiannually rather than quarterly. Thus, we estimate our equations at this frequency. To avoid a further reduction in sample size, as discussed above, we omit own-country fiscal shocks from our specification, in order to include observations for countries in years for which their own forecasts of government purchases are unavailable. Also, we treat countries for which forecasts are unavailable as having zero weight in the fiscal shock calculations for other countries. This undoubtedly introduces some error to our key variable, but

[4] Consistent with the OECD definitions and the previous literature on fiscal multipliers, our government spending series is the sum of real public consumption expenditure and real government gross capital formation. That is, it excludes imputed rent on the government capital stock, unlike under the current U.S. NIPA convention.

[5] http://www.oecd.org/faq/0,3433,en_2649_33733_1798284_1_1_1_1,00.html

we have complete data for the large leading economies that account for a considerable share of world imports. Finally, we exclude from our analysis all observations from a few small economies—Greece, Estonia, Luxembourg, and Turkey—for which there are large and volatile changes in reported government spending, in at least some cases due to data revisions. In the end, we have 30 countries in our sample.

For all model specifications presented below, we estimate impulse responses for six semiannual periods, starting in the first half of 1985 (because our projections of government spending are available beginning in 1984). That is, we set the maximum horizon $H = 5$ and estimate equations for 0 to 5 periods ahead. Also, we set m, the number of lags of changes in real GDP and government purchases included as control variables, equal to 4. All estimates are reported along with Driscoll and Kraay (1998) standard errors that allow arbitrary correlations of the errors across countries and time.

Figure 1 shows time series of fiscal spillover shocks for selected countries and Table 1 reports basic descriptive statistics. The average (across countries) standard deviation of scaled fiscal spillover shocks $\frac{GShock_{i,t}}{Y_{i,t-1}} \times 100$ is about 0.09 but there is considerable variation across countries from 0.2 for Canada to 0.025 for the USA. The magnitude of these shocks is fairly small for big economies and, given plausible multipliers, they are thus unlikely to explain a large fraction of variation in output and other macroeconomic variables. The correlation of shock series across countries varies between -0.4 to 0.99 with the mean correlation of approximately 0.4. In general, countries that have very different trading partners tend to have low or negative correlation (e.g., Canada and the Czech Republic), while countries sharing the same key trading partners (e.g., Hungary and Slovakia or Canada and Mexico) have highly correlated series. The

average $M_{iq,B}/G_{q,B}$ across countries and trading pairs is 1.6 but again there is dramatic variation across countries from 3.6 in Slovakia to 0.6 in Japan and 0.66 in the United States.

4. Results

A. Basic Results

Table 2 presents results for a variety of specifications based on the approach outlined above. Each entry in the table provides the *average* ($\frac{1}{6}\sum_{h=0}^{5}\alpha_h$) real GDP multiplier of fiscal spillovers over the six-period (i.e., three-year) horizon window, with standard errors in parentheses.

To help in the interpretation of these coefficients, recall that the fiscal shocks are measured in units of real government spending, scaled by the ratio of bilateral imports to government spending in the source country. Thus, if the percent shock to government spending, e_q^G, were uniform across all source countries *q*, this shock would be scaled by the sum of imports from country *i* by all source countries (e.g. $M_{iT,B}$ in (2')) before being included in the regression as the variable $GShock$. In contrast, when using a framework similar to specification (1), the literature estimating domestic government spending multipliers for country *i* scales percent shock e_i^G by the level of government spending $G_{i,t-1}$. Thus, if the impact of spillover shocks is in proportion to the ratio of imports from country *i* to government spending—if $\theta = 1$ in our previous terminology—we should expect the estimated multipliers to be of the same magnitude as those estimated for domestic shocks. Otherwise, as discussed, the estimated spillover multipliers will be larger (if $\theta > 1$) or smaller (if $\theta < 1$).

The first column of Table 2 provides estimates for the linear model, given in (1). The upper panel corresponds to the fiscal shocks in expression (3); those in the lower panel are based on the fiscal shocks as specified in expression (2). For each of these specifications, we present results for three samples: i) our full sample (the base case), ii) our full sample but with fiscal

spillover shocks constructed using only eight relatively large economies for which we have complete data since 1984: the US, UK, France, Italy, Japan, Germany, Canada, and Australia – the G-7 plus Australia – and our full sample of countries, but truncated at the end of 2007, to eliminate the possibly unique effects occurring during the Great Recession. The multipliers for all six variants are similar, given their standard errors, and are statistically significant when the sample is constrained to exclude post-2007 observations.

The remaining columns of Table 2 show estimates of state-dependent multipliers, based on economic conditions in the recipient country, *i*, from expression (4), using our three different measures to represent the state of the business cycle, based on output growth, log output level, and the unemployment rate. Results are again relatively similar across specifications within any column, but are strikingly different across business cycle regimes, with multipliers being much larger in recession, and much smaller in expansion, than for the linear model. Indeed, the multipliers in expansion are generally negative, although not significantly so, while those in recession are considerably larger than those estimated using the linear model. We obtain values in recession of a higher order of magnitude than those found in our earlier work for the United States (Auerbach and Gorodnichenko 2012a), which suggests that fiscal spillovers have a greater impact than would be implied simply by the ratio of imports to government spending. Note that because shocks are fairly correlated across countries by construction, and because we control for many lags of macroeconomic variables as well as country and time fixed effects, the standard errors are relatively large. However, even with this considerable sampling uncertainty, multipliers in recessions are routinely statistically significant at the conventional levels.

Figure 2 presents impulse responses over the six-period horizon, with 90 percent confidence bands, reflecting the estimates in the lower panel and first three columns of Table 2,

which correspond to fixed-weight fiscal shocks for the linear model and states based on lagged output growth rates. Aside from overall differences in magnitude, the impulse responses also differ between recession and expansion in their shape, with the effects in recession growing over time, unlike those in expansion.

Given the similarity of results for different specifications, for the remaining tables we will report results only for this particular specification of fiscal shocks, *GShock* (using fixed weights over time, as in equation (2)) and the business cycle index *z* based on lagged values of real GDP growth.

Table 3 provides multiplier estimates for a variety of other important macroeconomic aggregates. For example, fiscal spillover shocks have a strong, stimulating effect on exports in recessions, while in expansions the effect is negative. In contrast, imports have only weak, statistically insignificant responses to fiscal spillover shocks. These responses are consistent with the notion that trade can be an important channel of how fiscal shocks are propagated across countries. In general, the results confirm those in Auerbach and Gorodnichenko (2012b) where we estimate the effects of own-country fiscal shocks within the OECD, especially when one constrains the sample to large countries or pre-2008 observations. All components of output rise more in recession, as does employment.

B. Exchange rate regimes

As discussed earlier, the issue of fiscal shock transmission within currency areas is of particular interest, given the inability of countries to offset these shocks via monetary and exchange rate policy. More generally, we would expect the transmission of shocks to differ between fixed and floating exchange rate regimes, *ceteris paribus*, because changes in a source country's demand for imports would not have the same effects on its exchange rates vis à vis its trading partners.

In particular, we would expect smaller effects of shocks under a floating exchange rate regime, as an increased demand for imports resulting from a positive shock would cause an appreciation of the recipient country's bilateral exchange rate.

We modify our previous methodology by allowing the effects of shocks to vary according to the recipient country's bilateral exchange rate regime with the source country. That is, we aggregate fiscal shocks into two components, those for countries with a fixed exchange rate with the recipient country, and those for countries with a floating exchange rate with the recipient country.[6] Specifically, for each combination of countries i and q, we create dummy variable $BIFIX_{iq}$ equal to one if countries i and q have a fixed exchange rate (directly or indirectly) and zero otherwise. Then measures of fiscal spillover shocks for countries sharing a fixed exchange rate and countries with floating exchange rates are

$$GShock_{it}^{Fixed} = \frac{\sum_{q\neq i}\left(\frac{M_{iq,B}}{G_{q,B}}\right)\times BIFIX_{iq}\times\{e_{qt}^{G}\times G_{q,t-1}\times E_{qB}\}}{E_{iB}}$$

$$GShock_{it}^{Float} = \frac{\sum_{q\neq i}\left(\frac{M_{iq,B}}{G_{q,B}}\right)\times(1-BIFIX_{iq})\times\{e_{qt}^{G}\times G_{q,t-1}\times E_{qB}\}}{E_{iB}}$$

with $GShock_{it}^{Fixed} + GShock_{it}^{Float} = GShock_{it}$ and the linear specification (1) modified as follows

$$\text{(5)} \qquad \frac{Y_{i,t+h}-Y_{i,t-1}}{Y_{i,t-1}} = \alpha_{h,Fixed}\frac{GShock_{jt}^{Fixed}}{Y_{i,t-1}} + \alpha_{h,Float}\frac{GShock_{jt}^{Float}}{Y_{i,t-1}}$$

$$+\sum_{s=1}^{m}\beta_{hs}\frac{\Delta Y_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m}\delta_{hs}\frac{\Delta G_{i,t-s}}{Y_{i,t-s-1}} + \phi_{hi} + \lambda_{ht} + error_{iht}.$$

The state-dependent version (4) is modified in a similar spirit.

[6] Our categorization of fixed and floating exchange rates is based on Rose (2011). We classify a pair of countries A and B as sharing a fixed exchange rate if one of the countries has a fixed exchange rate with another directly (e.g. A pegs to B) or indirectly (i.e., A pegs to C and C pegs to B or B pegs to C).

Using this modification, we find (Table 4) that while multipliers are broadly similar, the magnitudes of multipliers in countries sharing a floating exchange rate tend to be larger than multipliers in countries sharing a fixed exchange rate, although the differences are not statistically significant. This pattern emerges in both linear and state-dependent models. While these results are somewhat surprising, one should keep in mind that the samples of countries with fixed and floating exchange rate regimes vary in a number of other ways which may affect our estimates. For example, countries having fixed exchange rates are almost exclusively covered by the Eurozone.

C. Cyclical properties by source country

Throughout our discussion thus far, we have allowed impulse responses to differ according to the state of the recipient country's business cycle. This makes sense, as we might expect the effects of a given external shock to vary according to the extent of slack in the recipient economy. But it is also possible that the relationship between the external shock and the source country's fiscal shock might depend on *that* country's economic conditions. For example, if a source country is in recession, a positive fiscal shock there might have a bigger local impact on output and on import demand, and therefore provide a bigger stimulus to recipient country production. According to this logic, multipliers should be bigger if there is a recession in the *source* country as well as if there is one in the recipient country. Whether this prediction is borne out by the data has immediate policy implications in the current economic environment where economic activity is depressed in many countries. Specifically, if a fiscal stimulus in one depressed economy has a more positive effect on another depressed economy, then amplified fiscal spillovers would increase the argument in favor of coordinated fiscal stimulus so that externalities from fiscal shocks are internalized.

We calculate fiscal shocks from sources countries in recession and in expansion as follows

$$GShock_{it}^{R} = \frac{\sum_{q\neq i}\left(\frac{M_{iq,B}}{G_{q,B}}\right)\times F(z_{qt})\times\{e_{qt}^{G}\times G_{q,t-1}\times E_{qB}\}}{E_{iB}}$$

$$GShock_{it}^{E} = \frac{\sum_{q\neq i}\left(\frac{M_{iq,B}}{G_{q,B}}\right)\times\left(1-F(z_{qt})\right)\times\{e_{qt}^{G}\times G_{q,t-1}\times E_{qB}\}}{E_{iB}}$$

where, as in equation (4), $F(z_{qt})$ is a measure of probability of country q being in recession and, by construction, $GShock_{jt}^{R} + GShock_{jt}^{E} = GShock_{jt}$. which is our original measure of fiscal shocks. The linear model is then

(6) $$\frac{Y_{i,t+h}-Y_{i,t-1}}{Y_{i,t-1}} = \alpha_{h,R}\frac{\Delta GShock_{it}^{R}}{Y_{i,t-1}} + \alpha_{h,E}\frac{\Delta GShock_{it}^{E}}{Y_{i,t-1}}$$

$$+\sum_{s=1}^{m}\beta_{hs}\frac{\Delta Y_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m}\delta_{hs}\frac{\Delta G_{i,t-s}}{Y_{i,t-s-1}} + \phi_{hi} + \lambda_{ht} + error_{iht}$$

and the state-dependent version (4) is modified similarly.

Table 5 presents estimates based on expression (6), with a second dimension of distinction between recession and expansion based on the state of the business cycle (measured using the same method) in source countries. Each pair of columns corresponds to one state of the business cycle in the source country (linear; expansion; and recession). For each pair, our previous results hold: multipliers are larger when the recipient country is in recession than when the recipient country is in expansion. Looking across these sets of columns, we see that when the recipient country is in recession, (columns 4 and 6 in the table), the multipliers are generally larger when the source country is also in recession, a result consistent with the reasoning laid out above.

5. Conclusions

In an increasingly globalized world, policies adopted in one country are likely to affect economic outcomes in other countries. To what extent, if at all, fiscal policies spill over into other countries is a key question in the current environment with depressed economies and high or rising levels of public debt in many developed countries. We document that fiscal stimulus in one country is likely to have economically and statistically significant effects on output in other countries. Furthermore, the strength of the spillover varies with the state of the economy in the recipient and source countries, with the output multipliers being large in recessions. These results suggest that fiscal activism may indeed be effective in stimulating demand in economic downturns and that coordination of fiscal policies may be more valuable than previously thought.

The present paper estimates fiscal spillovers based on the historical experience of OECD economies since the mid-1980s and thus it may be difficult to generalize these estimates to different episodes or countries. However, one may reasonably argue that future theoretical and empirical models should allow for non-linear and potentially strong positive responses of economies to domestic and foreign fiscal shocks. This approach is likely to provide a solid, empirically plausible foundation for designing fiscal policies.

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Table 1. Descriptive statistics

Country	Trade linkage to government spending $M_{iq,B}/G_{q,B}$		Standard deviation of spillover fiscal shocks $\frac{GShock_{it}}{Y_{i,t-1}} \times 100$					
			Time-varying weights			Fixed weights		
	Mean	St. Dev.	base	Only old/large OECD economies in construction of spillover shocks	Constrain the sample to pre-2008	base	Only old/large OECD economies in construction of spillover shocks	Constrain the sample to pre-2008
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AUS	0.85	0.32	0.056	0.048	0.056	0.062	0.053	0.061
AUT	1.96	0.54	0.089	0.086	0.091	0.073	0.071	0.076
BEL	2.58	0.66	0.141	0.111	0.146	0.155	0.144	0.160
CAN	1.30	0.41	0.204	0.206	0.209	0.162	0.162	0.162
CHE	2.84	0.65	0.068	0.064	0.068	0.058	0.052	0.059
CHL	2.72	0.59	0.058	0.040	0.054	0.053	0.036	0.051
CZE	2.67	0.75	0.152	0.142	0.170	0.174	0.161	0.195
DEU	1.36	0.51	0.051	0.039	0.045	0.045	0.036	0.042
DNK	1.25	0.36	0.059	0.057	0.060	0.059	0.058	0.059
ESP	1.17	0.43	0.032	0.029	0.031	0.021	0.020	0.021
FIN	1.18	0.41	0.059	0.053	0.060	0.059	0.055	0.061
FRA	0.84	0.24	0.042	0.039	0.043	0.037	0.034	0.038
GBR	0.99	0.34	0.036	0.030	0.036	0.028	0.022	0.027
HUN	2.79	1.07	0.141	0.138	0.150	0.071	0.066	0.076
IRL	2.76	1.30	0.190	0.182	0.198	0.149	0.153	0.155
ISL	1.40	0.26	0.062	0.053	0.067	0.054	0.053	0.056
ISR	1.56	0.18	0.073	0.071	0.075	0.046	0.043	0.046
ITA	1.00	0.29	0.039	0.036	0.040	0.031	0.029	0.032
JPN	0.60	0.10	0.032	0.029	0.032	0.026	0.024	0.025
KOR	1.77	0.77	0.084	0.081	0.087	0.059	0.057	0.061
MEX	1.53	0.95	0.128	0.132	0.127	0.089	0.088	0.089
NLD	1.88	0.53	0.126	0.123	0.129	0.114	0.112	0.119
NOR	1.23	0.18	0.084	0.085	0.084	0.064	0.064	0.066
NZL	1.17	0.29	0.068	0.062	0.069	0.061	0.057	0.062
POL	1.95	0.46	0.056	0.058	0.054	0.032	0.031	0.033
PRT	1.44	0.36	0.060	0.058	0.062	0.035	0.034	0.036
SVK	3.58	1.05	0.171	0.132	0.159	0.204	0.162	0.202
SVN	3.09	0.54	0.098	0.099	0.097	0.114	0.105	0.119
SWE	1.13	0.39	0.050	0.044	0.047	0.058	0.055	0.054
USA	0.66	0.28	0.025	0.014	0.025	0.023	0.013	0.023
Total	1.60	0.93	0.094	0.089	0.095	0.085	0.080	0.087

Notes: columns (1) and (2) show time-series standard deviation and mean of import to government spending ratio by country. Columns (3) through (8) show the time-series standard deviation of fiscal spillover shocks.

Table 2. Average output multipliers over 3 years

Shock series	Linear	State-dependent multipliers where state measured as deviation from trend					
		Output growth rate		Output		Unemployment rate	
		Expansion	Recession	Expansion	Recession	Expansion	Recession
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Time-varying weights							
Base	1.34	-0.46	3.38	-0.49	3.16**	-1.14	3.45***
	(0.91)	(1.32)	(2.30)	(0.98)	(1.63)	(1.15)	(1.35)
Only old/large OECD economies in	1.25	-1.37	4.41	-0.60	2.97	-1.68	3.48**
construction of spillover shocks	(0.97)	(1.92)	(2.77)	(1.29)	(1.87)	(1.15)	(1.55)
Constrain the sample to pre-2008	1.63**	-0.92	4.64*	-0.58	3.51**	-0.94	3.20***
	(0.85)	(1.44)	(2.69)	(1.06)	(1.59)	(1.33)	(1.16)
Fixed weights							
Base	1.60	-1.10	4.63*	0.33	3.30**	-1.50	4.06***
	(1.00)	(1.59)	(2.54)	(1.45)	(1.63)	(1.53)	(1.05)
Only old/large OECD economies in	1.96*	-2.56	6.72***	0.74	3.19*	-0.76	3.90***
construction of spillover shocks	(1.16)	(2.13)	(2.72)	(1.64)	(1.84)	(1.46)	(1.26)
Constrain the sample to pre-2008	2.05**	-0.93	5.36**	1.19	3.27*	-0.95	3.94***
	(1.00)	(1.63)	(2.73)	(1.68)	(1.71)	(2.05)	(1.05)

Notes: the table reports average output multipliers from fiscal spillovers. The estimated specifications are given by equation (1) in column (1) and equation (4) in columns (2) through (7). Driscoll and Kraay (1998) standard errors are in parentheses. ***, **, * denote significance at 0.01, 0.05, and 0.10 levels.

Table 3. Additional macroeconomic variables: average multipliers over 3 years

	base			Only old/large OECD economies in construction of spillover shocks			Constrain the sample to pre-2008		
	Linear	Recession	Expansion	Linear	Recession	Expansion	Linear	Recession	Expansion
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Consumption	0.58	1.95	-0.77	0.24	3.13***	-2.44***	0.47	2.24	-1.13
	(0.47)	(1.30)	(1.12)	(0.54)	(1.29)	(1.05)	(0.53)	(1.62)	(1.07)
Investment	0.39	0.78	0.25	0.41	1.49	-0.57	0.46	1.54	-0.49
	(0.64)	(1.42)	(1.09)	(0.63)	(1.47)	(1.08)	(0.61)	(1.55)	(1.10)
Export	0.26	3.33***	-2.41*	0.50	3.37***	-2.79*	0.51	4.01***	-2.77**
	(0.56)	(1.39)	(1.32)	(0.62)	(1.35)	(1.51)	(0.56)	(1.43)	(1.42)
Import	0.67	1.41	2.04	0.86	1.84	0.10	0.75	2.07	1.34
	(0.70)	(1.87)	(1.73)	(0.74)	(2.00)	(1.75)	(0.69)	(2.00)	(1.99)
Real exchange rate	1.85	12.06	-4.40	2.55	7.52	1.93	2.63	12.30	-1.99
	(5.13)	(10.11)	(11.01)	(7.16)	(10.78)	(11.38)	(6.01)	(12.83)	(12.11)
Hours per worker	0.24	-1.70**	2.25***	0.48	-1.40	2.53***	0.17	-2.16**	2.38***
	(0.48)	(0.82)	(0.78)	(0.57)	(0.94)	(0.81)	(0.48)	(0.98)	(0.67)
Employment	1.21*	1.34	0.79	1.40*	1.90	-0.18	1.09	2.73	-0.46
	(0.73)	(2.19)	(1.60)	(0.84)	(2.55)	(1.44)	(0.70)	(1.74)	(1.07)
Real wage rate	1.10	0.11	1.91	1.97	3.03	1.02	2.10	0.60	1.24
	(1.15)	(2.88)	(2.43)	(1.55)	(3.07)	(2.00)	(1.49)	(3.15)	(2.30)

Notes: the table reports average multipliers from fiscal spillovers for variables indicated in the left column. A positive coefficient for the real exchange rate means that the real exchange rate appreciates. State-dependent multipliers are for the case where the state of the business cycle is measured as deviation of the output growth rate from trend. The estimated specification is given by equation (1') for consumption, investment, exports, and imports, and by equation (1'') for the real exchange rate, hours per worker, employment and the real wage rate.

Table 4. Average output multipliers over 3 years by exchange rate regime

	Linear model		State-dependent multipliers where state measured as deviation from trend (output growth rate)			
			Fixed		Float	
	Fixed	Float	Expansion	Recession	Expansion	Recession
	(1)	(2)	(3)	(4)	(5)	(6)
Base	1.46	2.51	0.80	2.06	-1.38	4.29
	(1.13)	(1.93)	(1.92)	(2.61)	(2.40)	(2.75)
Only old/large OECD economies in construction of spillover shocks	2.08*	3.77*	-1.15	4.53	-1.27	5.89*
	(1.16)	(2.12)	(1.96)	(2.85)	(2.56)	(3.22)
Constrain the sample to pre-2008	1.73	2.98	-0.69	4.16	-1.23	5.86*
	(1.17)	(1.91)	(1.98)	(2.90)	(2.16)	(3.39)

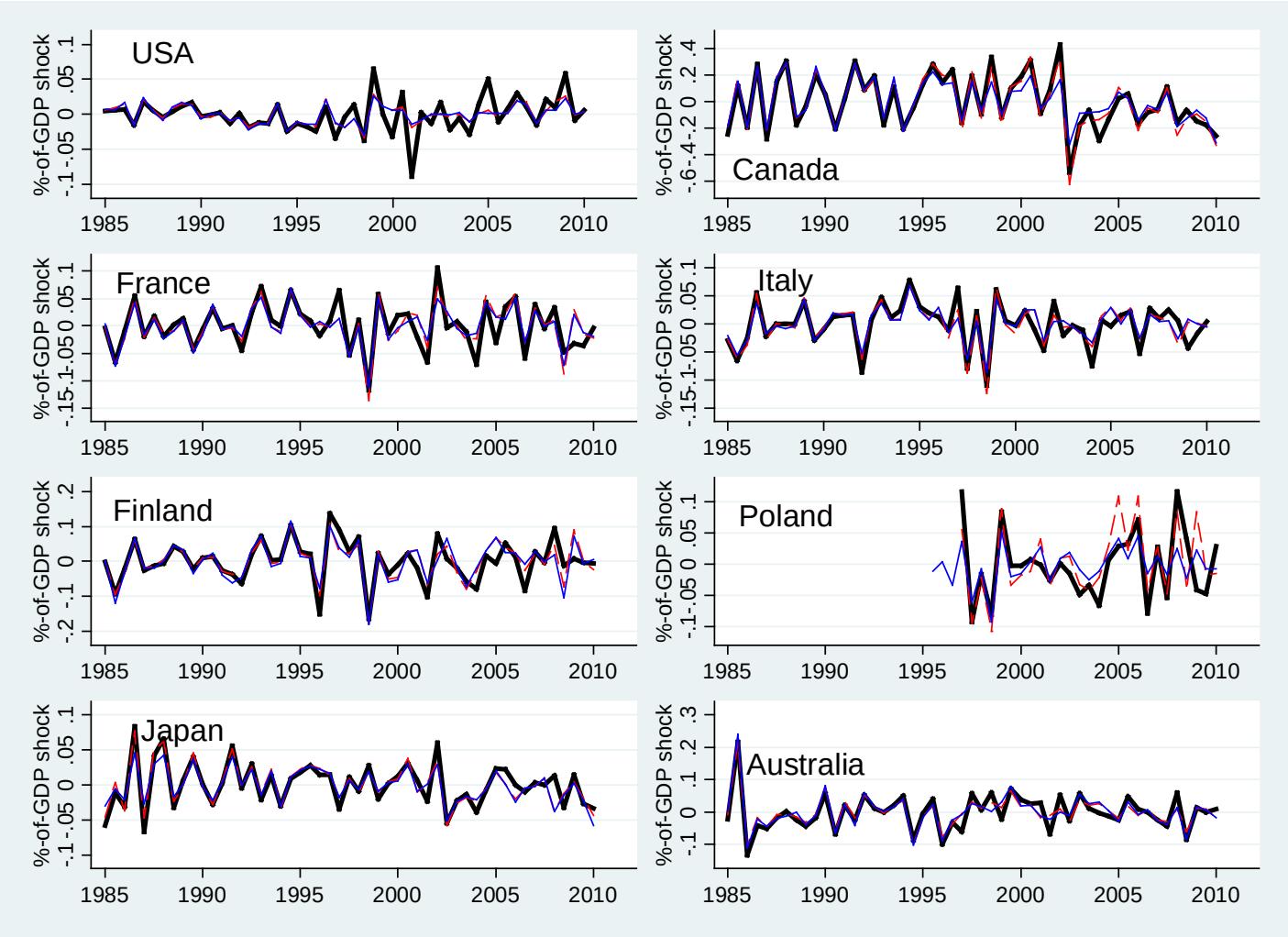
Notes: the table reports average output multipliers from fiscal spillovers. The estimated specifications are given by equation (5) in columns (1) and (2) and the corresponding modification of equation (4) in columns (3) through (6). Driscoll and Kraay (1998) standard errors are in parentheses. ***, **, * denote significance at 0.01, 0.05, and 0.10 levels.

Table 5. Average output multipliers over 3 years by exchange rate regime and by business cycle regime

	Linear model		State-dependent multipliers where state measured as deviation from trend (output growth rate)			
			Expansion in source country		Recession in source country	
	Expansion in source country	Recession in source country	Expansion in recipient country	Recession in recipient country	Expansion in recipient country	Recession in recipient country
	(1)	(2)	(3)	(4)	(5)	(6)
Base	-0.58	2.50	0.54	0.38	-2.21	5.34
	(2.28)	(2.29)	(4.51)	(4.83)	(6.90)	(3.69)
Only old/large OECD economies in construction of spillover shocks	1.26	2.86	-0.65	6.92	-5.21	5.21
	(2.74)	(2.40)	(4.36)	(4.87)	(5.80)	(4.29)
Constrain the sample to pre-2008	-2.08	4.19**	-2.49	-0.80	3.46	8.05**
	(2.02)	(2.10)	(3.84)	(4.29)	(5.53)	(3.92)

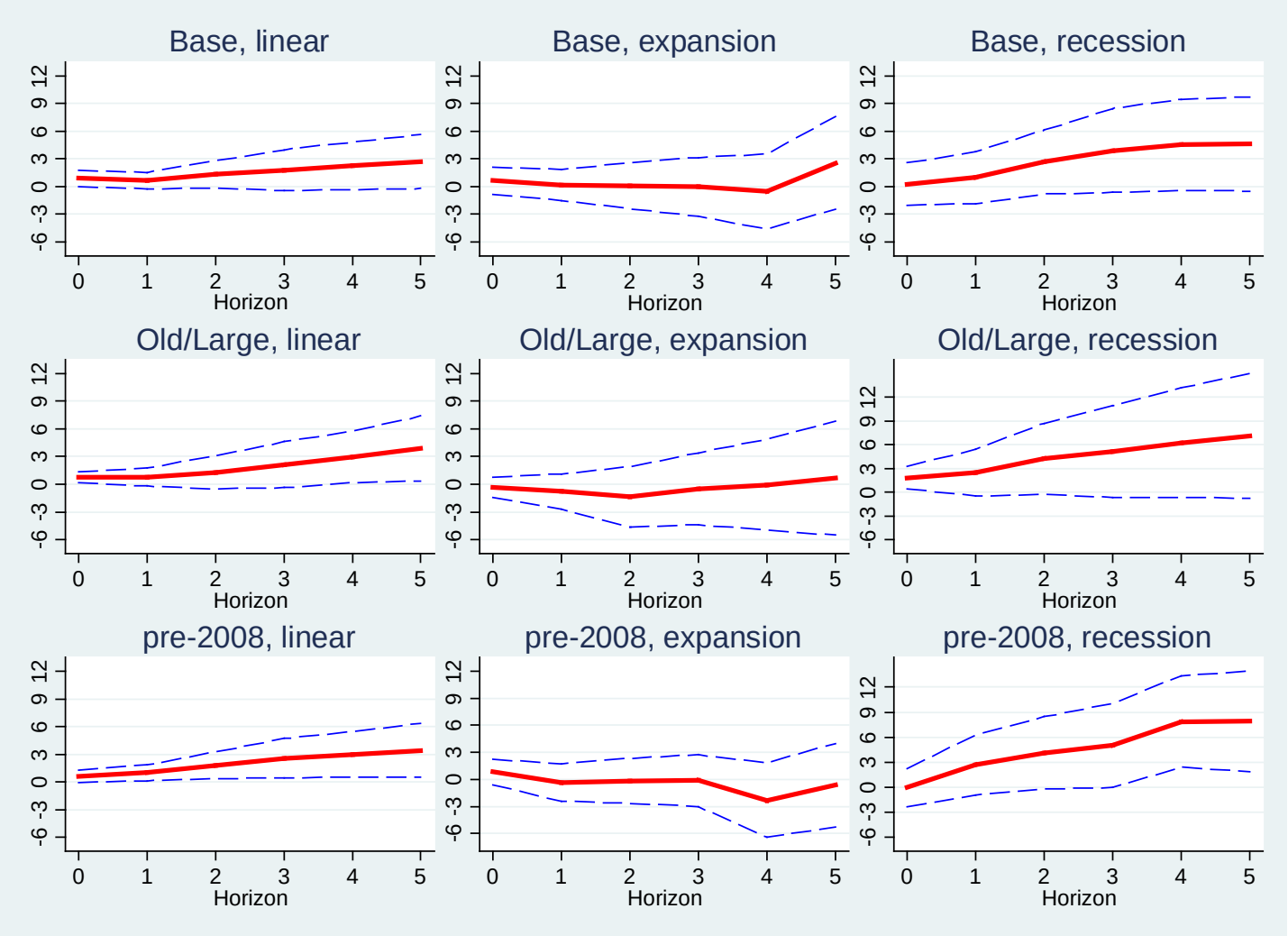
Notes: the table reports average output multipliers from fiscal spillovers. The estimated specifications are given by equation (6) in columns (1) and (2) and the corresponding modification of equation (4) in columns (3) through (6). Driscoll and Kraay (1998) standard errors are in parentheses. ***, **, * denote significance at 0.01, 0.05, and 0.10 levels.

Figure 1. Time series of fiscal spillover shocks for selected countries



Notes: The figure shows time series of spillover shocks as percent of GDP of the corresponding country in the previous period, i.e. $\frac{GShock_{it}}{Y_{i,t-1}} * 100$.The thick, solid black line is constructed as in equation (3) using government spending innovations in all countries. The red, thin, dashed line is constructed as in equation (3) using government spending innovations in only large OECD economies. The solid, thin, blue line is constructed as in equation (2) with fixed weights using government spending innovations in only large OECD economies.

Figure 2. Impulse response functions (fixed weights)



Notes: the figure reports impulse response of output to a GSshock with fixed weights (equation (2)). The left column reports impulse responses in the linear specification (1) while the right two columns show responses in the non-linear specification (4). Each row corresponds to the sample of countries and construction of shocks described in section 4.A. Solid, thick, red lines are point estimates. Dashed, blue, thin lines are 95% confidence intervals constructed using Driscoll and Kraay (1998) standard errors.