OUTPUT SPILLOVERS FROM FISCAL POLICY

Alan J. Auerbach and Yuriy Gorodnichenko
University of California, Berkeley

January 2013

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. 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.

This paper was presented at the American Economic Association meetings, San Diego, January 2013. We thank Olivier Coibion and Harald Uhlig for comments on an earlier version of the paper. We are grateful to Kyle Kennelly for research assistance. Gorodnichenko thanks NSF for financial support.

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, 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 shed new light on these questions, with results that have immediate policy implications.

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. 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.

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, $h = 0, 1, \ldots, H$ 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 $\{\alpha_h\}_{h=0}^{H}$, which directly correspond to multipliers. Note that variables in equation (1) are in differences, scaled by lagged GDP, which follows the approach in Hall (2009) and Barro and Redlick (2011).

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 $e_{q,t}$, which is measured in percent. Then we aggregate $e_{q,t}$ across countries using bilateral trade as a measure of inter-country linkages. In particular, our base specification for the fiscal shock affecting country i in year t is $GShock_{i,t} = \frac{\sum_{q \neq i}(M_{iq,B}/G_{q,B}) \times \{e_{q,t} \times G_{q,t-1} \times E_{q,B}\}}{E_{i,B}}$

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, $e_{q,t} \times G_{q,t-1} \times E_{q,B}$, 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.[1]

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

[1] Results are similar when weights are allowed to vary over time. See Auerbach and Gorodnichenko (2012c).

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 for *GShock* 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.

Following our earlier approach with smooth transitions between the "recession" and "expansion" states, we modify specification (1) as follows:

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

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 $\{\alpha_{R,h}\}_{h=0}^{H}$, while for expansion it is $\{\alpha_{E,h}\}_{h=0}^{H}$. We construct $F\left(z_{i,t}\right) = \frac{\exp(-\gamma z_{i,t})}{[1+\exp(-\gamma z_{i,t})]}$ 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.[2] For our base case, as before, we measure $z_{i,t}$ using the growth rate of real GDP, but we also 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.[3] 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). Since the OECD projections are available only semiannually, we estimate our equations at this frequency. We exclude from our analysis 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.

[2] Using a two-sided filter may be problematic as it uses information that is not available in agents' real-time information set. However, the large value of the smoothing parameter makes these concerns quantitatively negligible because the filter removes very low frequency variation while we focus on business cycle frequencies.

[3] 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. For further information on these forecasts and their quality, see Auerbach and Gorodnichenko (2012b).

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 four. All estimates are reported along with Driscoll and Kraay (1998) standard errors that allow arbitrary correlations of the errors across countries and time.

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, while countries sharing the same key trading partners 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 1 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, were uniform across all source countries *q*, this shock would be scaled by the sum of imports from country *i* by all source countries 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 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 1 provides estimates for the linear model, given in (1). 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 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 1 show estimates of state-dependent multipliers, based on economic conditions in the recipient country, *i*, from expression (2), 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 significant and considerably larger than those estimated using the linear model. We obtain values in recession larger 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.[4]

B. 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. 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. Hence, 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.

[4] Auerbach and Gorodnichenko (2012c) present multipliers for a variety of other important macroeconomic aggregates. In short, all components of output (including private consumption) rise more in recession, as does employment.

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

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

where, as in equation (2), $F(z_{qt})$ 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

$$(3) \qquad \frac{Y_{i,t+h}-Y_{i,t-1}}{Y_{i,t-1}} = \alpha_{h,R}\frac{\Delta GShock_{it}^{R}}{Y_{i,t-1}} + \alpha_{h,E}\frac{\Delta GShock_{it}^{E}}{Y_{i,t-1}} + \sum_{s=1}^{m}\beta_{hs}\frac{\Delta Y_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m}\delta_{hs}\frac{\Delta G_{i,t-s}}{Y_{i,t-s-1}} + \phi_{hi} + \lambda_{ht} + error_{iht}$$

and the state-dependent version (2) is modified similarly.

Table 2 presents estimates based on expression (3), with a second dimension of distinction between recession and expansion based on the state of the business cycle (also measured using the output growth rate) 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), 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.

References

Auerbach, Alan, and Yuriy Gorodnichenko, 2012a. "Measuring the Output Responses to Fiscal Policy," *American Economic Journal: Economic Policy* 4(2), May, 1-27.

Auerbach, Alan, and Yuriy Gorodnichenko, 2012b. "Fiscal Multipliers in Recession and Expansion," in A. Alesina and F. Giavazzi, eds. *Fiscal Policy after the Financial Crisis*, Chicago: University of Chicago Press, forthcoming.

Auerbach, Alan, and Yuriy Gorodnichenko, 2012c. "Output Spillovers from Fiscal Policy," NBER working Paper # 18578.

Barro, Robert, and Charles Redlick, 2011. "Macroeconomic Effects of Government Purchases and Taxes," *Quarterly Journal of Economics* 126(1), February, 51-102.

Driscoll, John C., Aart C. Kraay, 1998. "Consistent Covariance Matrix Estimation With Spatially Dependent Panel Data," *Review of Economics and Statistics* 80(4), 549-560.

Hall, Robert E., 2009. "By How Much Does GDP Rise if the Government Buys More Output? *Brookings Papers on Economic Activity* 2009(2), 183-231.

Table 1. 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)
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 construction of spillover shocks	1.96*	-2.56	6.72***	0.74	3.19*	-0.76	3.90***
	(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 2. Average output multipliers over 3 years by business cycle regime in source and recipient countries

	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.