International spillovers from U.S. fiscal policy shocks

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Abstract

I estimate the effect of U.S. government spending and tax shocks on Canada and the U.K. from 1975 to 2014, and on Japan from 1979 to 2014. Spending and tax shocks are identified using sign restrictions on the impulse responses from a vector autoregression (VAR). I find that spillover effects of expansionary fiscal shocks are not uniform across countries, though for all three countries they result in economically significant GDP increases in the short run. In addition, government spending shocks have larger effects than net tax shocks. Altogether, the results support the idea that some countries may benefit significantly from expansionary U.S. fiscal policy.

Keywords: Fiscal policy, International Transmission, Spillovers, VAR models, Sign Restriction

JEL Classification Numbers: C32, E62, F42

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1 Introduction

In response to the global recession that began in late 2007, policy makers called for coordinated fiscal responses, expressing a fear that spillover effects would dilute the effectiveness of policies pursued in isolation and, implicitly, that some countries would free ride off of the difficult political decisions of others.[1] Were these policy makers' beliefs consistent with theoretical predictions and empirical evidence? To date there is little empirical evidence on the magnitude of fiscal policy spillovers, particularly for the United States. To the existing evidence I contribute estimates of the spillover effects of U.S. fiscal policy shocks on Canada and the U.K. from 1975 to 2014, and on Japan from 1979 to 2014.

I find that while spillover effects of expansionary fiscal shocks are not uniform across the countries in my sample, for all three countries they result in economically significant GDP increases over some portion of the response horizon. For all three countries, government spending shocks generally have larger effects than net tax shocks. Altogether, the results support the idea that some countries may benefit significantly from expansionary U.S. fiscal policy.

1.1 The Theoretical Basis for Spillovers

> *The United States economy is linked to the rest of the world through goods, factor, and assets markets. The linkages are reflected in the flows of goods and services in international trade; in the relationships between goods and factor prices at home and abroad; and in the asset pricing and capital flow relationships between domestic and foreign assets markets.* Dornbusch and Fischer (1986).

Dornbusch and Fischer's succinct description illustrates the channels through which U.S. fiscal policy can spill over to the rest of the world. In the goods market, changes in government spending can have a direct effect on the trade balance if the government purchases foreign as well as domestic goods. Fiscal policy can have indirect effects on the trade balance if changes in government spending and taxes affect the private sector's consumption decisions as well. To the extent that domestic fiscal policies affect domestic factor prices, such as wages, the relative price levels between the U.S. and other countries should change, driving changes in the real exchange rate and real interest rate differentials. These in turn may drive changes in the trade balance

[1] See, e.g., the speech by Dominique Struass-Kahn, former managing director of the IMF, at Oesterreichische Nationalbank, Vienna, May 15, 2009, http://www.imf.org/external/np/speeches/2009/051509.htm, and the "Declaration of the Summit on Financial Markets and the World Economy" (G20 Washington Summit), November 15, 2008, http://www.g20.utoronto.ca/2008/2008declaration1115.html.

and capital flows between the U.S. and the rest of the world. Real interest rate differentials may also change if fiscal policies have a direct effect on the domestic interest rate.

A number of theoretical models have been developed to investigate the transmission of fiscal policy shocks. The predictions of the models vary, however, based on their particular structures and assumptions. In a basic undergraduate-textbook version of the Mundell-Fleming model,[2] with fixed prices in the short run and flexible exchange rates, a debt-financed increase in government spending or a net tax decrease boosts domestic GDP. The domestic real interest rate increases, leading to a real exchange rate appreciation and, if the Marshall-Lerner condition holds, a deterioration of the trade balance. Increased imports at home imply a boost to GDP abroad. In the version of Frenkel and Razin (1996) — a two-country model — foreign output and the domestic interest rate rise, but the effects on the real exchange rate and trade balance are ambiguous. The responses depend on the relative magnitudes of domestic and foreign saving and import propensities, and the domestic and foreign elasticities of money demand with respect to the interest rate and income.

A number of microfounded, dynamic, general equilibrium models have also been developed that explicitly account for spillovers from fiscal policy. The predictions of these models vary based on assumptions related to, among other things, the financing of government expenditures, the completeness of international asset markets, and substitutability between domestic and foreign goods. As a result, the only common prediction across most of these models is that an increase in domestic government spending increases domestic and foreign output.[3]

Betts and Devereux (2001), for example, develop a model with incomplete markets where the labor supply response to a balanced-budget expansion in domestic government spending leads to an increase in domestic output. Foreign output initially increases as well because of increased demand for foreign products. As prices adjust, however, an improvement in the foreign country's terms of trade generates a wealth effect that lowers foreign labor supply, and the increase in foreign output is reversed. The effect on the real exchange rate depends on whether exports are priced in domestic currency (no effect) or foreign currency (a depreciation).

In more recent work, Corsetti and Müller (2013) specify a model with complete markets where the government can finance consumption through either lump-sum taxes or debt. A government spending shock increases domestic and foreign output relative to their steady-state levels, though in both cases the effect eventually reverses and output moves below the steady

[2] See, e.g., Mankiw (2010), appendix to chapter 12.

[3] For a counterexample, see Taugourdeau (2002) which features a two-country model with monopolistic competition in which expansionary fiscal shocks increase domestic output but decrease foreign output in the short run.

state. The real exchange rate depreciates and the trade balance deteriorates, though again these effects eventually reverse.

1.2 Prior Empirical Evidence

Several recent papers have looked at the effect of U.S. fiscal shocks on the U.S. real exchange rate, terms of trade and the trade balance, though in each case they estimate the effect relative to an aggregate of other countries rather than the effect on individual countries. Enders et al. (2011), Monacelli and Perotti (2010), Kim and Roubini (2008) and Ravn et al. (2007) all find that increases in U.S. government spending or the primary budget deficit lead to real exchange rate depreciation. Enders et al. (2011) and Corsetti and Müller (2006) also find that spending shocks decrease the terms of trade. Kim and Roubini (2008) and Corsetti and Müller (2006) find that increases in the primary deficit have a small but positive effect on the current account or trade balance, while Monacelli and Perotti (2010) and García-Solanes et al. (2011) find a negative effect on the trade balance. Boileau and Normandin (2012), in a multi-country study including the U.S., find that U.S. tax cuts increase the external deficit.

Arin and Koray (2009) and Canzoneri et al. (2003) are the closest to what I do here. Arin and Koray (2009) estimate the effect of U.S. fiscal shocks on Canadian GDP, the bilateral real exchange rate, and Canadian and U.S. real short-term interest rates from 1961 to 2004. They find that U.S. government spending shocks have a negative effect on Canadian GDP, while net tax shocks do not have any significant effects. When their sample is restricted to 1973 through 2004 they find that Canadian GDP first increases in response to U.S. spending shocks, then becomes negative after 16 quarters. The latter finding is consistent with my results, discussed in detail below.

Canzoneri et al. (2003) estimate the effect of U.S. fiscal shocks on GDP and the real effective exchange rate for the U.K., France and Italy from 1975 to 1999. They find that U.S. government spending increases lead to significant and persistent increases in foreign GDP, while an increase in net taxes has little to no effect. Spending increases in the U.S. also cause significant exchange rate depreciations in France and the U.K., with no significant effect for Italy, while net tax increases lead to significant appreciations in the U.K. and Italy, with no significant effect for France.

The introduction of the euro in 1999 and the resulting common monetary policy has motivated work on fiscal policy spillovers among euro-area countries. Beetsma et al. (2006) and Giuliodori and Beetsma (2005) focus on international trade spillovers. Beetsma et al. (2006), using a sample of 14 countries, find that domestic government spending increases and net tax decreases significantly increase imports from other euro area countries, with spending having the larger impact. Giuliodori and Beetsma (2005) likewise find that expansionary fiscal shocks in France, Germany and Italy lead to significant increases in imports from other euro area countries.

2 VAR Specification and Identification

I estimate the effects of fiscal shocks using a vector autoregression (VAR) on quarterly data from 1975:1 through 2014:3 for Canada and the U.K., and from 1979:1 to 2014:3 for Japan. The baseline specification for the VAR is of the form

$$x_t = \sum_{j=1}^{p} A_j x_{t-j} + u_t, \tag{1}$$

where x_t is the vector of endogenous variables, A_j is the coefficient matrix on lag j, u_t is the vector of reduced-form residuals and p is the lag length of the VAR. I start with a baseline specification that includes U.S. real government consumption and investment (g_t), U.S. real net taxes (t_t), U.S. real GDP (y_t), foreign real GDP (y_t^*), and the real bilateral trade balance (tb_t). Alternately, I include as a fifth variable the real bilateral exchange rate (q_t) and the ex-post real short term interest rate differential ($r_t - r_t^*$). U.S. net taxes are current tax and transfer receipts net of transfer, subsidy and interest payments. All variables except the interest rate differential are in natural logs and GDP, spending and net tax variables are per capita. The VAR is estimated in levels, with four lags, a constant and a linear time trend.

2.1 Identification

The residuals from an unrestricted VAR like (1) will, in general, be correlated across equations. As a result, the residuals from the equations for g and t cannot be interpreted as exogenous fiscal shocks — some method must be used to recover the uncorrelated structural shocks from the residuals. The relationship between the VAR residuals (u_t) and the desired structural shocks (ε_t) can be written as

$$u_t = B\,\varepsilon_t, \tag{2}$$

where $E[\varepsilon_t \varepsilon_t'] = I$. Two popular methods for recovering structural shocks require imposing specific restrictions on B.[4]

The first method, originally suggested by Sims (1980), uses the Cholesky factorization of the estimated residual covariance matrix ($\widehat{\Sigma}_u$) for B.[5] This imposes a recursive ordering in which a shock to one variable has a contemporaneous effect on variables following it in the ordering, but no contemporaneous effect on those preceding it. One problem with this approach is technical: the impulse responses it generates may not be robust to alternate orderings of the variables. So the effect of changes in government spending on GDP, for example, may change with the ordering of the variables. The larger the covariance between the residuals of the model the more sensitive the results will be to reordering. Another problem is conceptual: the contemporaneous effects it identifies may conflate discretionary policy responses with automatic changes in government spending or net taxes over the business cycle. For example, government transfers vary systematically over the business cycle by design and do not reflect discretionary policy changes. Since changes in the net taxes variable indirectly capture changes in transfers, the impulse responses to net tax shocks using a recursive identification reflect more than just responses to discretionary policy changes.

The second method, first used by Blanchard and Perotti (2002) in the fiscal policy context, seeks to deal with the conceptual problem of Cholesky identification by using external information to identify the contemporaneous response of government spending and net taxes to changes in output.[6] They use this information to derive restrictions on B that have the effect of isolating discretionary policy responses. For government spending they find no systematic response to changes in output at a quarterly frequency. In addition, they assume that policy makers take at least a quarter to make any discretionary changes in spending in response to changes in output. As a result, unanticipated government spending shocks are just the residuals from the spending equation in a VAR. This is equivalent to a recursive ordering with spending ordered before GDP. For net taxes, they use OECD estimates of the elasticity of taxes and transfers to changes in output to control for non-discretionary changes in net taxes. These estimates indicate a positive

[4]Another approach used in the fiscal policy literature does not identify fiscal policy shocks from measures of total government spending. Instead, narrative measures of federal defense spending or tax changes are used as instruments for government spending and taxes and included in a VAR. See Ramey (2011b) and Romer and Romer (2010). In section 3.2 I compare my results to those obtained using these narrative approaches.

[5]The Cholesky factorization results in a lower triangular matrix P such that $PP' = \widehat{\Sigma}_u$. In this case, then, $B = P^{-1}$. Among the studies cited above, Arin and Koray (2009), Corsetti and Müller (2006) and Kim and Roubini (2008) use this method.

[6]Among the studies cited above, Canzoneri et al. (2003) and Monacelli and Perotti (2010) use this identification method.

automatic response of net taxes to changes in GDP. Once the automatic response is controlled for, Blanchard and Perotti find a negative relationship between net taxes and GDP. A problem with this approach is that the results may be sensitive to the particular estimates used to control for the automatic responses. These estimates are obtained from regressions and therefore subject to estimation uncertainty which is not reflected in the resulting impulse responses.

2.2 Sign Restriction Methodology

In this paper I use the sign restriction approach of Mountford and Uhlig (2009) which avoids the problems associated with the identification methods above. The idea is to specify a minimal number of assumptions on what the impulse responses should look like, find a large number of candidate B matrices that produce impulse responses that satisfy the restrictions, and calculate point estimates as the median of the resulting distribution of impulse responses. The advantage of this methodology over the recursive approach is that, like Blanchard and Perotti, I can specify the restrictions in a way that isolates discretionary policy shocks. In addition, the results are not dependent on the ordering of the variables. The advantage of this method over the Blanchard and Perotti approach is that it allows me to deal with the same problems they were addressing but in a more general way. Rather than specify a particular quantitative structural relationship *a priori* based on uncertain estimates of contemporaneous correlations, I generate many candidate structural relationships that share qualitative implications. This better accounts for the inherent uncertainty of the estimates.

2.2.1 Specifying the Restrictions

As mentioned above, the key to identifying discretionary policy shocks is controlling for the automatic response of spending and net taxes to changes in GDP. I accomplish this by following Mountford and Uhlig (2009) and first identifying a “business cycle shock” which captures these automatic responses and requiring government spending and net tax shocks to be orthogonal to the business cycle shock. To identify a business cycle shock I make one critical assumption: increases in U.S. net taxes do not cause increases in U.S. GDP; if output and tax revenue are both increasing it must be the result of an improvement in the business cycle. Specifically, I define a business cycle shock as a positive co-movement in the impulse responses of U.S. net taxes and GDP for quarters zero through four. In addition, I require that the increase in net taxes be greater than any change in government spending over the same time period. This additional restriction is imposed to eliminate situations where the increase in GDP is itself the

Table 1: Identifying Sign Restrictions

	Business Cycle Shock	Gov't Spending Shock	Net Tax Shock
U.S. GDP (y_t)	+		
Gov't Spending (g_t)	$g_t < t_t$	+	$g_t < t_t$
Net Taxes (t_t)	+	$t_t < g_t$	+

Notes: This table shows the restrictions on the sign and relative magnitude of impulse responses for each identified shock. The restrictions are imposed for impact and the following four quarters.

result of an increase in government spending.

A "government spending shock" is defined as increase in the impulse response of government spending for quarters zero through four that is also orthogonal to a business cycle shock. In certain draws that meet this restriction, it may also be the case that net taxes are decreasing over the same horizon. This is a fiscal change that should have similar qualitative results as an increase in government spending. As a result, for government spending shocks I also require that the increase in government spending be greater in magnitude than any change in net taxes over the same horizon. I define "net tax shocks" analogously: an increase in the impulse response of net taxes for quarters zero through four that is orthogonal to a business cycle shock and which is greater than any change in government spending over the same horizon. Government spending and net tax shocks must also be mutually orthogonal. No restrictions are placed on the impulse responses of any of the other variables in the system. A summary of the identifying sign restrictions is provided in Table 1.

2.2.2 Potential Problems with the Methodology

Fry and Pagan (2007) and Fry and Pagan (2011) identify and discuss two potential problems when using the sign restriction methodology: the "multiple shocks problem" and the "multiple models problem." The multiple shocks problem arises when a set of responses could have been generated by more than one potential shock; not enough information is specified to discriminate between the potential shocks. An example of this in my case is a shock which produces an increase in all of GDP, net taxes, and government spending. With only restrictions on the sign of the impulse responses this could be identified as either a business cycle or government spending shock. As described above, I impose additional restrictions on the relative magnitude of the responses to deal with this problem.

The multiple models problem arises from the fact that each set of impulse responses represents a different model of the relationship between the variables in the VAR. One way to present my results would be, for example, to provide the median response of foreign GDP to an identified net tax shock, calculating the median with reference to the range of responses of foreign GDP only. Then I could give the median response of the interest rate differential, calculating the median with reference to the range of responses of the interest rate differential only, and so on for the other variables. The problem with this approach is that if I consider the response of each variable in isolation, there is no reason to expect that all of the median responses are generated by the same matrix B. The result for each variable will likely be coming from a different model. To deal with this, Fry and Pagan (2007) suggest presenting the set of median responses that are "closest" to the median calculated across all candidate responses that meet the restrictions.

I generated candidate matrices as described in Appendix A, below, until I had 1000 that each contained a business cycle, government spending and net tax shock identified using the restrictions discussed above. To deal with the multiple models problem, for each set of responses that met the criteria I summed the squared, standardized difference of each variable's response from the median response of that variable across all candidates. The candidate matrix B whose responses had the lowest overall deviation from the median was used to generate the results I present here.

3 Results

Graphs of the impulse responses to a positive government spending shock and a positive net tax shock are given in Figures 1 through 3. Tables 2 and 3 provide more detailed numerical results for the spillover variables. The solid-line point estimates are the median values across the identified responses. The dashed lines in the figures are 90% bootstrap confidence intervals constructed using the structural matrix that resulted in the median responses.

3.1 Results for the Foreign and Domestic Variables

Figure 1 shows the estimated shocks and the response of U.S. GDP to each. The identified shocks are normalized to equal a 1% increase in government spending or net taxes, respectively, at the time of the shock. The effect of spending shocks on the level of spending and net tax

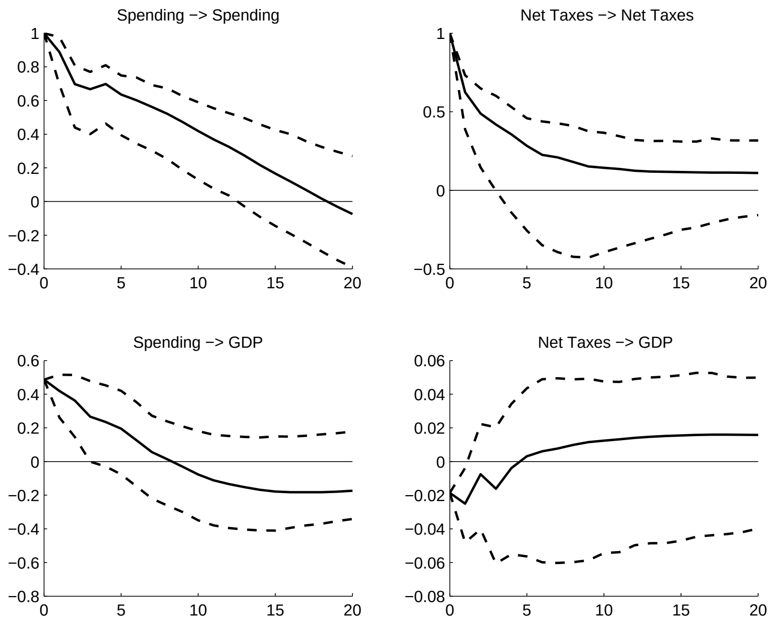

Figure 1: Response of U.S. variables to a positive 1% shock to Spending and Net Taxes.

shocks on the level of net taxes are both persistent, with each remaining positive for most of the response horizon. Government spending shows a reversal around 18 quarters after the shock.

Increases in government spending have a positive effect on U.S. GDP, with a 1% increase in spending leading to a peak effect of 0.49% of GDP on impact. In dollar terms, measured at the mean of each series, this implies a multiplier of around 2.2. In a recent review of the literature on fiscal policy multipliers, Ramey (2011a) reports a range of estimates between 0.3 and 3.8, varying by specification, sample, and identification method. My result is on the high side of most estimates from linear VARs, although the studies Ramey surveys all have samples ending no later than 2008. They therefore do not include the effects of the 2009 stimulus package in the U.S. as my sample does. The effect on GDP reverses around eight quarters after the shock, eventually decreasing by around 0.18%.

Because my sign restrictions identify a simultaneous increase in net taxes and GDP as a business cycle shock, net tax shocks are restricted to having negative effects on GDP on impact and the following four quarters. With this qualification in mind, a 1% increase in net taxes has a peak effect of a 0.025% decrease in GDP, occurring in the quarter after the shock. The effect on GDP reverses after about 5 quarters, leading eventually to an increase of around 0.016%. In

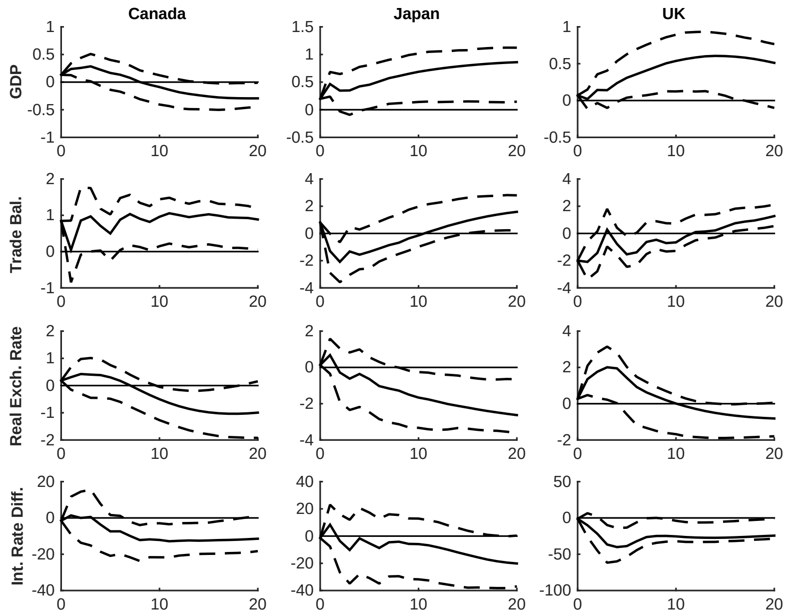

Figure 2: Response of foreign variables to a 1% increase in Spending

dollar terms, measured at the mean of each series, the peak effect implies a net tax multiplier of around -0.24, significantly smaller in magnitude than the spending multiplier. This is a pattern that continues in the responses of the other variables.

3.1.1 Spending Shocks

A spending shock has a positive spillover effect on all three countries' GDP; for Canada the peak effect is an increase of 0.29%, for Japan 0.86%, and for the U.K. 0.61%. Similar to the response of U.S. GDP, the effect on Canada's GDP eventually turns negative, leading to a decrease of 0.29%. Interestingly, while the effect on Canada is about 60% of that for the U.S., the effect on Japan and the U.K. is significantly larger than for U.S. GDP, though the peaks take three to four years to materialize.

The effect on bilateral trade balances is mixed. The U.S.-Canada trade balance improves by around 1%, and remains close to that level for the entire response horizon. The U.S.-Japan and U.S.-U.K. balances initially decline between 1.5-2%, but both eventually improve to levels close to 2% above where they were prior to the shock. The timing of the reversal in the Japan and U.K. responses is consistent with the initial increase and then decrease in U.S. GDP in response

Table 2: Responses to Government Spending shock

	impact	4 qrtrs	12 qrtrs	peak	
Real GDP (%)					
Canada	0.13	0.22	-0.18	-0.29*	(19)
Japan	0.20	0.42	0.74*	0.86*	(20)
U.K.	0.07	0.24	0.58*	0.61*	(14)
Trade Balance (%)					
Canada	0.85	0.71*	1.00*	1.06*	(11)
Japan	0.80	-1.56	0.33	-2.09*	(2)
U.K	-2.00	-0.77	0.10	-2.09*	(1)
Real Exchange Rate (%)					
Canada	0.18	0.38	-0.76*	-1.04*	(18)
Japan	0.13	-0.36	-1.89*	-2.63*	(20)
U.K.	0.27	1.95*	-0.29	2.01*	(3)
Interest Rate Differential (basis points)					
Canada	-1.52	-3.65	-12.60*	-12.85*	(11)
Japan	-1.41	-1.67	-8.30	-20.13	(20)
U.K.	-1.15	-40.16*	-26.99*	-40.16*	(4)

Notes: Response to a one-period, 1% increase in the level of real U.S. government spending per capita. An asterisk indicates that zero falls outside 90% bootstrap confidence intervals. The number in parentheses is the quarter in which the peak effect occurs.

to the shock.

With Canada and the U.K. the bilateral real exchange rate appreciates for the first eight to ten quarters after the shock; about 0.4% for the U.S.-Canada rate and about 2% for the U.S.-U.K. rate. Thereafter the exchange rate depreciates by about 1% and 2%, respectively, relative to its level before the shock. For the U.S.-Japan exchange rate the depreciation happens much earlier; after a quick appreciation of about 0.7% by the second quarter after the shock, the exchange rate starts to depreciate, eventually decreasing by 2.63% relative to its pre-shock level.

The short-term interest rate differential decreases for all three countries, with a peak decrease of around 13 basis points for Canada, 20 basis points for Japan, and 40 basis points for the U.K. While this response could be caused by either a decrease in the U.S. interest rate or an increase in the foreign rate, it seems likely that the direct effect of an increase in U.S. government spending would fall on the U.S. rate.

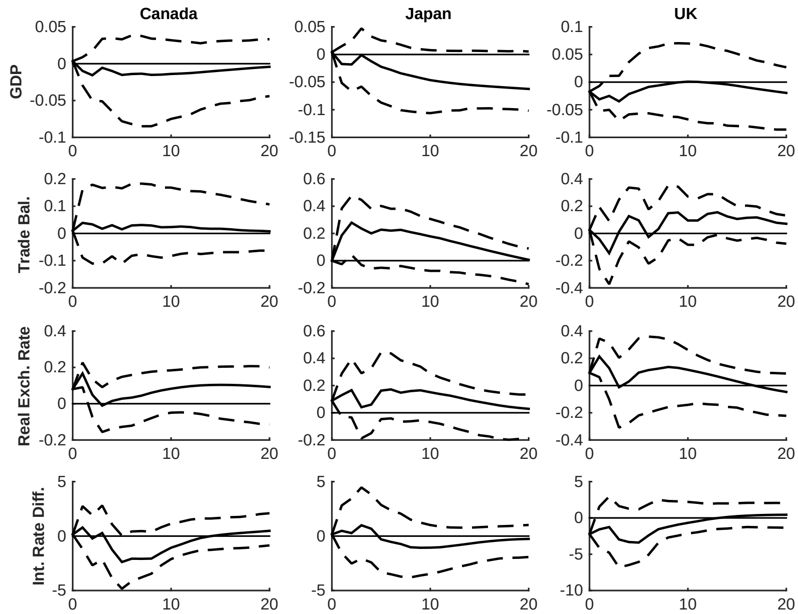

Figure 3: Response of foreign variables to a 1% increase in Net Taxes

3.1.2 Net Tax Shocks

The responses to net tax shocks are very consistent across countries. An increase in U.S. net taxes decreases foreign GDP, improves the U.S. trade balance, causes an appreciation of the real exchange rate, and decreases the interest rate differential. The magnitudes of the responses, however, are much smaller than those for spending shocks and not economically significant. Peak effects for range from 0.02% to 0.06% for GDP, from 0.04% to 0.28% for the trade balance, from 0.17% to 0.21% for the exchange rate, and from 1 basis point to 3.4 basis points for the interest rate differential. Moreover, for almost all of the responses, zero falls within the 90% confidence bands for most of the response horizon.

3.2 Comparison to Other Identification Methods

In this section I compare the results generated using sign restrictions to the other identification methods discussed previously, as well as the "narrative" identification methods of Ramey (2011b) for government spending and Romer and Romer (2010) for taxes. The methods discussed above in Section 2.1 all share the common feature that they rely on the same measure of total government spending or net taxes. The narrative measures instead identify shocks from

Table 3: Responses to Net Tax shock

	impact	4 qrtrs	12 qrtrs	peak	
Real GDP (%)					
Canada	0.00	-0.01	-0.01	-0.02	(2)
Japan	0.00	-0.01	-0.05	-0.06	(20)
U.K	-0.02	-0.02	0.00	-0.03	(3)
Trade Balance (%)					
Canada	0.01	0.03	0.02	0.04	(1)
Japan	0.00	0.20	0.14	0.28*	(2)
U.K	0.03	0.13	0.14	0.16	(13)
Real Exchange Rate (%)					
Canada	0.08	0.02	0.10	0.17*	(1)
Japan	0.09	0.06	0.13	0.17	(6)
U.K	0.09	0.03	0.08	0.21*	(1)
Interest Rate Differential (basis points)					
Canada	0.15	-1.24	-0.44	-2.38	(5)
Japan	0.16	0.68	-0.92	-1.07	(9)
U.K	-2.23	-3.32	-0.21	-3.40	(5)

Notes: Response to a one-period, 1% increase in the level of real U.S. net taxes per capita. An asterisk indicates that zero falls outside 90% bootstrap confidence intervals. The number in parentheses is the quarter in which the peak effect occurs.

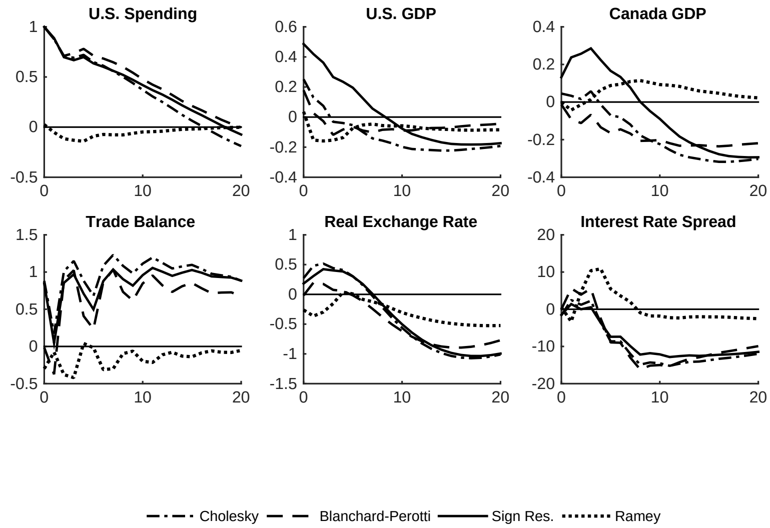

Figure 4: Effect of 1% increase in Spending.

a variable that measures news about future changes in government spending or taxes and are intended to account for anticipation effects.

For the recursive and Blanchard and Perotti identifications, the U.S. variables were ordered government spending, net taxes, then GDP. For the Blanchard and Perotti methodology I used the output elasticities for taxes reported in their paper to estimate a VAR using my data sample. Figure 4 shows the results for government spending shocks and Figures 5 and 6 show the results for net tax shocks. Since there is no reason to think that the relative difference in identifications should vary by country, I only report results for the U.S.–Canada specifications.

From Figure 4 it is clear that the shape and persistence of the government spending shock identified using sign restrictions is nearly identical to that identified by a recursive ordering or the Blanchard and Perotti methodology. The responses for U.S. and Canadian GDP are larger, and stay positive for longer, using sign restrictions, but the responses for the other three variables are nearly identical. As a result, when shocks are identified from total government spending it does not seem to matter much which of the methods is used. In contrast, the shock to government spending from Ramey's defense news variable is barely above zero on impact, becoming negative before eventually returning to zero. It is probably for this reason that the responses of the other variables differ in direction and magnitude from those using the other identification methods. One possible explanation for the difference in responses here and those

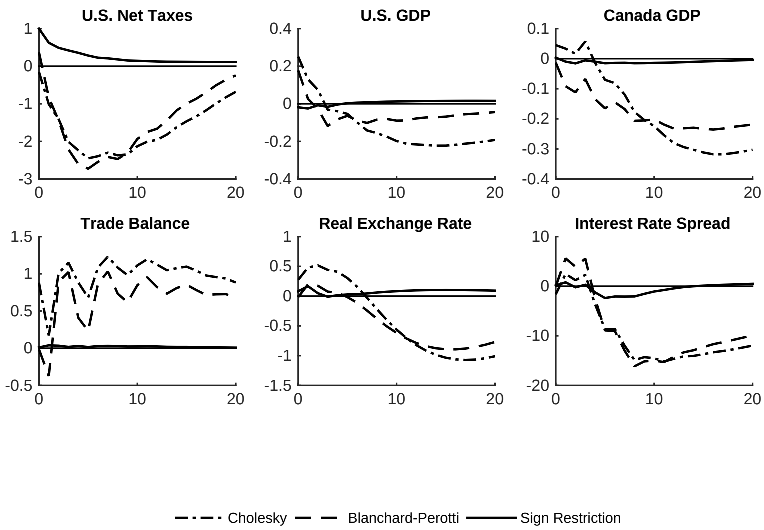

Figure 5: Effect of 1% increase in Net Taxes.

found by Ramey (2011b) is the different sample: Ramey (2011b) uses samples that range from 1939, 1947, and 1955 through 2008 while I use a sample from 1975 through 2014.

For net tax shocks, the differences across identification methods become much starker. In particular, the magnitude of the responses to a net tax shock are much greater when using the recursive and Blanchard and Perotti methods than when using either sign restrictions or the narrative approach of Romer and Romer (2010). While sign restrictions and the Romer tax variable provide responses with similar magnitudes, the direction of the responses is mostly different. The differences appear to be caused by the longer persistence of tax shocks estimated by sign restrictions than those using the Romer method. It is clear that the effect of tax shocks is sensitive to the method for identifying them; further work is needed in this area.

4 Discussion and Conclusions

The response to U.S. fiscal shocks is not uniform across countries or type of shock, though some patterns emerge. Qualitatively, positive U.S. spending shocks are expansionary for Canada, Japan, and the U.K. in the short run, though in Canada the response of GDP eventually becomes negative. This result is consistent with the predictions of most theoretical models of fiscal policy transmission. Moreover, the GDP “reversal” in Canada is consistent with the models of Betts and

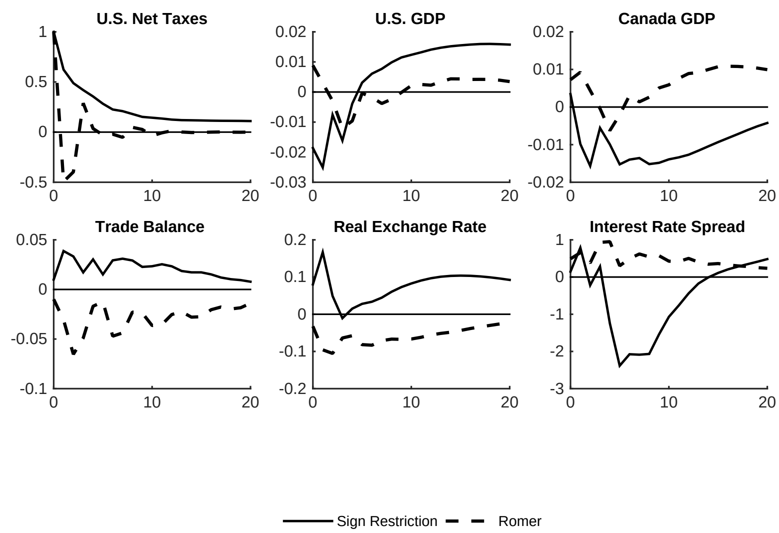

Figure 6: Effect of 1% increase in Net Taxes.

Devereux (2001) and Corsetti and Müller (2013) discussed earlier (as is the reversal in the effect on U.S. GDP). Another common pattern is the negative response of the short-term interest rate differential across countries, implying most likely a rise in the short-term U.S. real interest rate, a finding that is not consistent with these models but is consistent with the basic Mundell-Fleming model. The short-run response of the trade balance and the real exchange rate varies across countries, though eventually the U.S. trade balance with all three countries improves and the real exchange rate appreciates. The size of the responses are almost all economically significant and are statistically significant over much of the response horizon.

In general the response to net tax shocks is much smaller — often an order of magnitude — than the response to government spending shocks. My results were neither statistically nor economically significant.

None of the theoretical models discussed above is consistent with all of the results presented for any of the countries individually, and, given the different results across countries it seems that no single model may be able to explain the transmission of U.S. fiscal policy with respect to each of its trading partners. Identifying which aspects of each bilateral relationship are significant for transmission is an important question raised by my results and suggests an avenue for future research.

While this paper made use of an identification method for fiscal shocks that has conceptual benefits over other common identification methods, when government spending shocks are identified from total government spending in a VAR each of the identification methods discussed produces similar results. For net tax shocks the identification method matters, particularly for the magnitude of the responses.

To return to the question posed in the Introduction, should policy makers worry that fiscal stimulus measures may benefit their trading partners? My results suggest that the answer is yes. In many countries political support for fiscal stimulus has declined in recent years, particularly for programs that involve increased government spending and despite tepid recoveries or continued recession. While tax cuts may be more politically palatable — and have small spillover effects according to my results — their domestic effects are smaller too. So the worry is even more relevant now than it was in 2008. This suggests that international coordination may be even more important in the future for generating support for fiscal responses to economic downturns.

Appendix A: Generating Candidate Responses

To generate candidate sets of impulse responses it is useful to note that there is an arbitrarily large number of matrices for which $BB' = \widehat{\Sigma}_u$. As Fry and Pagan (2007) emphasize, each of these matrices represents a separate structural model, all of which are observationally equivalent in the sense that they produce residuals with the same covariance structure. To generate each set of impulse responses, I start with the Cholesky factorization (P) and multiply by an orthonormal matrix Q which has the property that $Q'Q = QQ' = I$. Accordingly, $PQQ'P' = \widehat{\Sigma}_u$. The sign restrictions I impose are restrictions on the responses of the first three variables in the VAR (government spending, g_t, net taxes, t_t, and U.S. GDP, y_t, respectively). The matrix Q that I construct therefore makes use of a Givens rotation in three dimensions. Specifically, for each set of candidate responses I draw $(\theta_1, \theta_2, \theta_3)$ from a uniform distribution on $[0, \pi]$ and calculate

$$Q_3 = \begin{bmatrix} \cos(\theta_1) & -\sin(\theta_1) & 0 \\ \sin(\theta_1) & \cos(\theta_1) & 0 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} \cos(\theta_2) & 0 & -\sin(\theta_2) \\ 0 & 1 & 0 \\ \sin(\theta_2) & 0 & \cos(\theta_2) \end{bmatrix} \times \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(\theta_3) & -\sin(\theta_3) \\ 0 & \sin(\theta_3) & \cos(\theta_3) \end{bmatrix},$$

where Q_3 is the upper left 3×3 section of Q. The rest of Q consists of ones on the diagonal and zeros everywhere else.

Appendix B: Data

Data for the U.S. variables is from the U.S. Bureau of Economic Analysis (BEA) National Income and Product Accounts (NIPA). Bilateral trade data are from the BEA's International Transactions Accounts. Foreign data is from the International Monetary Fund's International Financial Statistics Database. U.S. NIPA and IMF data are seasonally adjusted by the source. The international trade data were seasonally adjusted by me using the U.S. Census Bureau's X12-ARIMA.[7]

U.S. real net taxes are from NIPA Table 3.1 and calculated as the sum of Current Tax Receipts (line 2), Contributions for Government Social Insurance (line 7) and Current Transfer Receipts (line 13) minus the sum of Current Transfer Payments (line 19), Interest Payments (line 24) and Subsidies (line 27). Interest rate differentials are calculated as the U.S. rate minus the foreign rate. Ex-post real interest rates are calculated by subtracting the quarterly CPI inflation rate. The real bilateral exchange rate is calculated as:

$$\text{Nominal Exchange Rate (units of foreign / \$ U.S.)} \times \frac{\text{US CPI}}{\text{Foreign CPI}}.$$

The trade balance is calculated as the log ratio of exports to imports. The Ramey defense news variable was downloaded from Valerie Ramey's website and the Romer tax variable was downloaded from David Romer's website.

[7] This was done using the IRIS Toolbox for Matlab. http://www.iris-toolbox.com

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