An Empirical Study of Fiscal Policy Spillovers, and Fiscal Policy Coordination

Mark Azic

The College of New Jersey

Advisor: Dr. Subarna Samanta

May 4, 2012

Abstract

I look to test whether fiscal policy in one country can have significant effects on output in another. Using a vector autoregression (VAR) framework, I test to see whether there is any significant spillover between fiscal policy in the United States, Mexico, Canada, Germany, and Australia to the output in those countries, and to what extent those nations coordinate fiscal policy with one another. After building a model and testing it, I find mixed results regarding the existence of fiscal policy spillover effects, and very little evidence of nations coordinating fiscal policy with one another.

Introduction

Developed nations currently face a dilemma regarding their fiscal policy. On the one hand, global demand remains very weak, and the fear of slipping back into recession remains very real. At the same time, many developed nations have high public debt to GDP ratios, and are looking to scale down the size of their debt by cutting spending. Developed countries have to devise a scheme that allows them to scale down their debt while at the same time avoid a double dip recession.

One proposal to this is for nations to coordinate their fiscal policy. The idea behind fiscal policy coordination is reliant on the concept of spillover effects. When one nation changes its government expenditure we expect that it will lead to some sort of change in economic activity in that country as well as some change in economic activity in other countries. This change to output in other countries is the spillover effect of fiscal policy by one country. If spillover effects are significant, they offer the possibility of nations coordinating fiscal policy so as to minimize the effects on output from decreases in government expenditure.

This paper uses a vector auto-regression model (VAR) to determine whether government spending has significant spillover effects to output in other countries. In addition, this paper will use the VAR to look for empirical evidence that answers whether or not nations have been coordinating government spending in the past.

Review of Literature

Blanchard and Perotti (1998) use a VAR approach to characterize the dynamic effects of shocks in government expenditure and taxes to economic activity in the US. They include dummy variables to account for major changes in the taxes or expenditure. Blanchard and Perotti conclude that positive government spending shocks have a positive effect on domestic output, and positive shocks to taxes have a negative effect on output. These results are in accordance with Keynesian predictions of the effects of fiscal policy on output.

Giuliodori and Beetsma (2004) use a VAR analysis to first explore the effects shocks to fiscal policy have at the national level, and then again to explore what sort of spillover effect they have. They focus their study on Germany, France, and Italy and consider fiscal policy from both the expenditure and revenue side. They determine that for Germany, a reduction in taxes is the most effective means of boosting domestic output, whereas for France and Italy increases in government expenditure are more effective. When it comes to spillover effects, they find that all three experience significant spillover effects from changes in fiscal policy.

Caldara and Kamps (2008) use VAR models to assess the effect of fiscal policy shocks on the US. Using data from 1955-2006, they find that government spending shocks lead to significant increases in real GDP, real private consumption, and in the real wage. Their results for the effects of tax shocks are uncertain; depending on the identification approach used, tax increases can be either non-distortionary or distortionary. One problem the authors cite in determining the effects of tax shocks is the automatic ways that tax revenues respond to changes in the business cycle. Because of the mixed results and uncertainty regarding the effect of tax

shocks, the authors indicate that a better form of modeling is needed to take into account changes in the business cycle and to determine the true effect of tax policy.

Beetsma, Gioliodori, and Klaassen (2006) explore the international spillover effects that fiscal policy shocks have via trade in Europe. Theoretically, they argue that expansionary fiscal policy stimulates domestic activity, which in turn should lead to more imports, and hence, more output for foreign nations. The authors do this by combing panel data on government spending, taxes, and GDP with panel data on trade. Their results lead them to conclude that fiscal policy does have significant spillover effects to trade. How large the spillover effect is dependent on how large the economy. For Germany, the largest of the EU nations, an increase in government spending of 1% of GDP, on average, leads to a corresponding increase of 2.2% in foreign exports to Germany from other EU nations. This increase in exports as a result of the fiscal expansion leads to a 0.13% increase in GDP for that country. The authors find that tax policy also has significant spillover effects, but not as great as government spending.

Hebous and Zimmermann (2010) focus on the spillover effects of shocks to the budget deficit for countries in the Eurozone. They use a multi-country Global Vector Autoregression (GVAR) model to do this, and cite that their study is the first to apply the GVAR approach to fiscal policy analysis in a cross-country setup. Their model leads them to conclude that although a budget deficit shock may or may not be positive to the GDP of the country experiencing the budget deficit shock, it does have a positive effect on output of other countries. The authors conclude by using their results to make the case for coordinated fiscal policy in the Eurozone.

Other studies include Canzoneri, Cumby, and Diba (2002), who use VAR to present empirical evidence that shocks to US government spending have sizeable effects on GDP in

France, Great Britain, and Italy. Hoogstrate and Osang (2005) use a VAR with panel data. They explore the effects of openness to trade to savings and output. They find that openness to trade has a positive effect of GDP growth. Corsetti and Müller (2011) consider cross-border spillovers of fiscal policy from an empirical and theoretical perspective, finding evidence that there is indeed a spillover of fiscal policy to output in other countries.

There is little to no literature that provides any sort of empirical evidence of nations coordinating their fiscal policy in the way this paper explores.

Data

Because this paper uses VAR, it is best to limit the number of variables included. The reason for this, and one downside to VAR modeling, is that including too many variables can make the model difficult to estimate. This results in data that is difficult to interpret. Hence, I limit the variables to only those that are necessary: government expenditure, and gross domestic product.

The reason that two variables is already judged to be many is that this paper considers five nations: the United States, Mexico, Canada, Germany, and Australia. With five nations and two variables for each, this gives us ten variables for every time period. The idea behind including the US, Mexico, and Canada is that in addition to being large economies they are closely linked through the North American Free Trade Agreement (NAFTA). Their sizes and trade relationships with one another make it more likely that they will experience some sort of spillover effect to output. In addition, the fact that governments in each country work closely

with one another may lead to some empirical evidence of government expenditure coordination. The reasons for including Germany and Australia are that they are both fairly large economies, both integrated with the rest of the world through trade and finance, and they both offer some degree of geographical diversity to the testing.

Data is taken quarterly from the first quarter in 1991 through the fourth quarter in 2007. The reason for using only quarterly data has to do with identifying the shocks in the VAR model. The more frequent the data is, the easier it is to determine the actual effects of the shocks. With respect to fiscal policy, most nations do not make major alterations in a quarter, but by viewing the accumulated shock response information about the shock's effects can be judged. When it comes to judging the spillover effect a shock to government spending has on output, quarterly data is advantageous

Ideally, the more frequent the data is the better it is for identifying the effects of shocks (see Chin and Miller 1996). However, it is difficult more frequent data such as monthly data on the macro-variables considered in this test.

The data stops after 2007 so as to not include the financial crisis of 2008. Although times of great economic upheaval are associated with great shocks to government expenditure and output, I felt that the changes both variables experienced during the recent recession were too drastic and complicated to fully be explained by my model. The data set begins in 1991 for two reasons. One reason is that the data prior to this date is difficult to find for each of the countries used. The second – and better – reason is that over the past twenty or so years, the economies of nations have become much more closely linked through trade and finance. With this increased

economic integration, there should be some evidence of spillovers and fiscal policy coordination that may be omitted if a longer time set is used.

I consider government expenditure without including transfer payments, or interest payments on national debt. As both transfer payments and interest on debt are based on decisions that happen over a long period of time they do not represent shocks to government expenditure; changes to government expenditure caused by changes to these two factors are already predicted. For a measure of output, gross domestic product is used. I account for the effects of inflation by taking real GDP and real government expenditure. The log is taken of both sets of variables.

GDP data is the first difference of the log of real GDP. Data for the United States, Canada, and Mexico was taken from the IMF's International Financial Statistics database. Information for Germany and Australia come from their domestic statistic agencies, Statistisches Bundesamt and the Australian Bureau of Statistics, respectively. Although it would have been preferred that all the data be from one source, it was difficult to find such a source, especially when the data needed was so particular (quarterly, real).

One problem with the data for GDP and government expenditure is that it is not stationary; over time these variables trend upwards. Therefore, the data must be corrected before fitting the model and making any determinations about what causes what. As mentioned before, to make GDP stationary, I use first differencing. To make government expenditure stationary, I take two different approaches. For the first approach, I use first differencing. For the second approach, I take the ratio of the log of government expenditure to the log of GDP for each country. Because I expect the growth rate of both GDP and government expenditure to be the same over time, this ratio should give me a stationary variable that will represent government

expenditure. Dickey-Fuller tests are run on the data to confirm that these new variables are stationary.

The reason for using two different methods to make government expenditure stationary is that Granger causality will be used to determine whether variables cause one another. One downside to Granger causality is that it is sensitive to lag-length selection, and to methods used to make any variables stationary. Because I later use Granger causality to determine what is and is not significant, using two different methods to make variables stationary will lead to twice as many tests, and may lead to different results worth considering.

Although Granger causality is sensitive to the lag length chosen, I only consider one lag length. In order to determine the order of the lag length, I used Akaike Information Criterion for finite samples (AICC). The reason for this is that for relatively small sample sizes, of around 60 and below, AICC minimizes the chance of under estimation while maximizing the chance of recovering the true lag length (Khim-Sen Liew 2004). After testing VAR regressions with several other lag lengths and comparing AICC values, I decided on using a 4th order VAR. This is consistent with the order used in other papers that also used quarterly data and VAR modeling.

Modeling

The reason for using a vector auto-regression model is that I expect there to be some feedback effects between the different variables. These feedback effects would not be captured in a standard regression model approach.

I presume that output across nations is not independent, that output in one nation is not independent of government spending in that nation or in other nations, and that government spending in one nation is not independent of government spending in other nations (***). Therefore, if these variables are not independent with respect to one another, there will be some sort of feedback effect between the different variables. These feedback effects would not be captured in a standard regression model approach. By using a VAR, we are able to capture the dynamic effects in our panel data set to actually judge what is and is not significant.

A VAR model of order p estimates the model $$Z_t = \sum_{i=1}^{k}\sum_{j=1}^{p}A_{ij}X_{it-j} + u_{it}$$ where $Z_t = $ $(X_{1,t}, X_{2,t} ..... ,X_{k,t})'$ is a vector made up of k different macro-variables, and u_t is the error vector. In the case of my test, Z_t will be a vector made up of the variables for output for each of the nations, as well as the variables for government expenditure in each of the nations. As mentioned before, the order, p of the model was determined to be $p = 4$, or a lag of 4 quarters.

Note, there is no intercept term in this VAR model. Because I only want to test for significance, rather than develop a model for forecasting, the intercept is irrelevant, and therefore does not appear in the model. For the same reasoning, the parameter matrix is not given careful analysis and consideration for any of the tests run.

The first question I want to answer is if government spending in foreign nations provides a significant spillover to output in a given nation. To do so, I consider two different approaches. In the first approach, I take into account changes in government expenditure for all five countries as well as changes in output for four of the five countries. The country for which output is not included is the dependent variable, and I want to see if the other variables Granger cause the

dependent. For example, to determine if the US is subject to spillover effects, I see if the US is Granger caused by output changes and government spending changes Mexico, Canada, Germany, and Australia, as well as government spending changes in the US. The reason for taking into account changes to output in the other four countries is that there will be factors other than government spending that affect output in the dependent country. By accounting for changes in output in all of these other nations as well as changes in government spending, I am able to use a broad measure, GDP, to factor for these other effects.

The second approach I take to determining the significance of spillovers from government spending to output is the same as the one mentioned before, only this time without considering output in other nations. Therefore, the question is whether output in the dependent country is Granger caused by changes to government spending in all five nations. This test omits the idea of other factors happening at the same time potentially causing the change in output, which is unrealistic. However, by including output in other nations, the previous test allows for factors other than changes to government expenditure to be Granger causing changes in the dependent variable. Therefore, both approaches are considered.

Previously it was mentioned that Granger causality is sensitive to methods used to make variables stationary. This led to two different methods being employed in making government spending stationary. Hence, for both of the above approaches, consider government spending represented first with first differencing, and then secondly as a ratio of government spending to GDP. With two different approaches to testing for the spillover to output and two different methods of making the government spending variable stationary, there is a total of four tests for the spillover effect of government spending.

To answer the second question of interest, whether or not there is empirical evidence that nations do coordinate their fiscal policy, we again turn to Granger causality testing. However, in this case, I ignore the effects of changes in output. The reason for this is that there is no real theoretical reason to believe output in another country has to be controlled for when determining if government spending in one nation affects government spending in another. Hence, for the Granger tests I let government spending in one country be the dependent variable, and government spending in the other four countries be the variables that cause it. Since there are two different methods of making the government spending variable stationary, this approach leads to two different tests.

Results and Analysis

The first test run for Granger causality is with the dependent variable as the output in a country, and the independent variables the output for the other four countries and the government expenditure variables for all five nations. When the government expenditure variable is made stationary by first differencing, the significant results are shown in Table 1. When the government expenditure variable is made stationary by taking the ratio of government expenditure to GDP, the significant results are shown in Table 2.

Table 1: Spillovers to GDP, first differencing on government expenditure, controlling for GDP

Dependent	Independent	$Pr>\chi^2$
Canada*	Output: US, Mex, Ger, Aus GovExp: US, Mex, Can, Ger, Aus	.0838
Germany*	Output: US, Mex, Can, Aus GovExp: US, Mex, Can, Ger, Aus	.1003

*-- indicates that it is significant at 10% level

** -- indicates that it is significant at 5% level

Table 2: Spillovers to GDP, ratio of government expenditure to GDP, controlling for GDP

Dependent	Independent	$Pr>\chi^2$
Canada**	Output: US, Mex, Ger, Aus GovExp: US, Mex, Can, Ger, Aus	.0052

Canada is the only nation to show up as significant regardless of which method for making the government expenditure variable stationary is employed. The fact that Germany only shows up as significant in the first tests results, and barely significant in that one even, casts doubt as to whether it should be considered significant. That Canada shows up as significant in both tests, allows us to say that changes in government expenditure and output in the US, Mexico, Germany, and Australia do Granger cause changes in output in Canada. Hence, Canada does experience spillover effects.

The above two cases consider Granger causality when output changes in the independent nations is controlled for. In the modeling section it was mentioned that the scenario where changes in output are not controlled for would also be investigated. This is seen in the following two tables, 3 and 4, which employ first differencing and the government expenditure to GDP ratios, respectively, to make the government expenditure variable stationary.

Table 3: Spillovers to GDP, first differencing on government expenditure

Dependent	Independent	$Pr>\chi^2$
Mex**	GovExp: US, Mex, Can, Ger, Aus	<.0001
Can**	GovExp: US, Mex, Can, Ger, Aus	<.0001
Ger**	GovExp: US, Mex, Can, Ger, Aus	.0023
Aus**	GovExp: US, Mex, Can, Ger, Aus	.01351

Table 4: Spillovers to GDP, ratio of government expenditure to GDP

Dependent	Independent	$Pr>\chi^2$
US*	GovExp: US, Mex, Can, Ger, Aus	.0765
Mex**	GovExp: US, Mex, Can, Ger, Aus	<.0001
Can**	GovExp: US, Mex, Can, Ger, Aus	.0056
Ger**	GovExp: US, Mex, Can, Ger, Aus	<.0001
Aus**	GovExp: US, Mex, Can, Ger, Aus	<.0001

What is right away noticeable in Tables 3 and 4 is that more nations are considered significant than before. In Table 3 we get that every country except for the US experiences significant spillover effects, and in Table 4 we have that all five nations experience significant spillovers.

In a way, this is expected. Periods of recession and economic boom across these select countries are correlated. Therefore, when we control for changes to output in other countries, the spillover effect of foreign government expenditure to output is likely to be lower than when only considering government expenditure.

Neither the approach taken to produce Tables 1 and 2 or the one taken to produce 3 and 4 is entirely correct. However the fact that Canada shows up as significant in each case and that Germany is significant in three of the four cases likely means that these nations do experience more significant spillover effects than the others.

The next thing this paper tests is whether or not governments coordinate their expenditure. For this granger causality test, we take the dependent variable to be one nation's government expenditure and the independent variables to be government expenditure in the other four nations.

Table 5 shows significant results when first differencing is used to make government expenditure stationary, and Table 6 shows what is significant when the government expenditure to GDP ratio is used.

Table 5: Spillovers to government spending, first differencing on government expenditure

Dependent	Independent	Pr>χ^2
Mex**	US, Can, Ger, Aus	<.0001
Ger*	US, Mex, Can, Aus	<.0878
Aus**	US, Mex, Can, Aus	0.0104

Table 6: Spillovers to government spending, ratio of government expenditure to GDP

| Dependent	Independent	Pr>χ^2
US*	Mex, Can, Ger, Aus	.0988
Mex**	US, Can, Ger, Aus	<.0001
Can**	US, Mex, Ger, Aus	<.0001
Ger**	US, Mex, Can, Aus	<.0001

What these charts show is that government expenditure in Mexico and Germany is significantly caused by government expenditure changes in the other countries.

In most all of the tests for Granger causality (many of which were not included), the country that is most significant is Mexico. Mexico experiences significant spillover effects like no other nation, and going strictly by testing results appears to show strong evidence for spillover effects from government expenditure. However, the significance of spillovers to Mexico is something that deserves skepticism. Looking at the summary statistics for the data variables, it is clear that Mexico government expenditure is by far the most volatile. One reason for this is that

while the time period chosen did not include major recessions for the other nations, it did include

the Mexican financial crisis of 1994. Dubbed the "Tequila Crisis", the currency crisis Mexico

experienced between 1994 and 1996 saw wild swings in government expenditure and output, as

did the years following the crisis. The idea of taking this period of time out was considered, but

doing so was judged inappropriate, as it would then leave us with data on Mexico from the early

1990s and the late 1990s into the 2000s. Having such fractured data seems to make little sense.

Therefore, if this time period were to be removed, it might make sense to just entirely remove

Mexico. Instead, Mexico was included, but with the knowledge that its results should be treated

with skepticism.

As an example of how Mexico's data fluctuated over this period of time, consider the

following graph, which compares first differenced log of real GDP from 1994 through 1996 for

Mexico and the United States

Chart 1: First differenced government spending for Mexico and US, 1994-1996
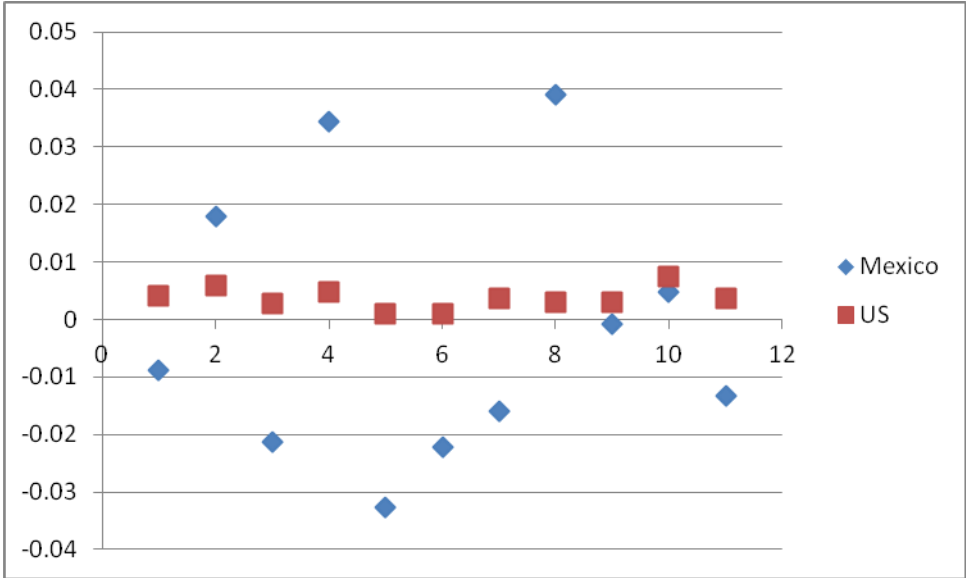
Another possibility is that how open a nation is to trade determines whether or not government spending abroad affects their output. The following table lists the nations studied and two measures of their economic reliance on trade, the sum of exports and imports over total GDP, and the ratio of exports to GDP. Our results had that Germany and Canada were significantly affected by other nations' government expenditure, both when other nations' GDP was and was not taken into account. They both have high openness to trade and dependency on exports – much higher than the US, whose output is less significantly affected by foreign government expenditure. Theoretically this result makes sense. Government expenditure will increase income in an economy, allowing that economy to purchase more foreign goods. Hence, increases in government spending in one nation will have positive shocks to its trading partners who will experience a shock to exports to that country. However, this theory is not thoroughly tested here, and should be the subject of its own study.

Table 7: Trade dependency of countries

Country	(Exports+Imports)/GDP	Exports/GDP
Germany	0.68	0.36
Mexico	0.48	0.25
Canada	0.45	0.22
Australia	0.26	0.17
United States	0.248	0.10

Further study

While this paper investigates the spillover effect that government expenditure has on output it is in not as thorough as others. Other studies take into account both government expenditure and revenue (taxes), as well as variables such as inflation, interest rates, and exchange rates amongst other things. By omitting these variables, the significance of changes in government spending to other nations' output or government expenditure may be significant due to something other than government expenditure that the model omits. Also, although this paper concerns itself with whether government expenditure has significant effects or not, in order to get an actual idea of how big a spillover government expenditure has, other variables would need to be controlled for. Including omitted variables would also need to be a part of any sort of model used for forecasting. However, this could lead to a VAR being too big. The tradeoff between including macro-variables and including more nations is something to be considered, and if a model were to grow in complexity, it may have to use data from fewer nations.

There is also a plus to repeating the study, only with more countries. Had I included more countries, I would more comfortably be able to say something about the effect of spillovers from government expenditure on the average. However, by limiting the study to five countries, all of which are relatively large, it is difficult to say anything about what spillover effects are like for the average nation. Including countries of different sizes would be one way of remedying this.

Either way, if more variables are included or more countries, future studies should try to incorporate data over a longer time period. Although the increased economic integration of the past twenty years was a reason for my limiting the data to 1991 onwards, I still would have been able to accomplish the same testing by using dummy variables to control for different time

periods. Using a data set that went back further in time would also offer the possibility of testing for structural breaks. If the global economy has changed over the past few decades, then there is also the possibility that spillover effects have fiscal policy coordination have also changed.

As mentioned before, it appeared that those nations more open to trade (Germany, Canada) experienced a more significant spillover effect to changes in foreign government spending than less open nations did (the US). Although this makes sense theoretically, this study is not thorough enough to claim any evidence of such a relationship. A future study could investigate this by using a process similar to the one used in this paper, only instead of output, substitute exports. If a positive shock to foreign government expenditure causes a positive shock to exports then there is evidence that the more a nation's economy is dependent on exports, the more significant changes to foreign government spending will be to it.

Another idea I was interested in seeing was whether or not there were nations that were "leaders" in fiscal policy. The idea behind this is that when larger economies make a change to fiscal policy it could prompt smaller economies to follow with similar fiscal policies. This would show up in a positive fiscal shock to the leader's fiscal policy leading to an accumulated positive shock to its followers. The reason the response is more likely to show up as accumulated than immediate is that if followers adopt fiscal policy based off of leader nations, it would naturally take a few quarters for them to adopt such policies. There was no real strong evidence of this in the graphs of the accumulated shocks. Because the accumulated response graphs are the sum of the shocks effects over time, rather than immediate, the longer the lag considered, the greater the variance the shock's effect will have. In the graphs of the accumulated response this shows up as a widening of the light grey lines that represent 2 times the standard deviation. Because of this increase to variance over time, the accumulated response is not statistically different from zero.

Although the leader theory mentioned above was not observed, that does not mean that it does not happen amongst other sets of countries. A future study could look at the countries in the EU, particularly those in the Eurozone. These nations coordinate on many economic issues, are very open to trade with one another, and for the most part, smaller than the economies considered in this paper. Hence, there may be evidence of fiscal policy coordination amongst them.

Another possible alteration is substituting GDP and government expenditure for GDP per capita and government expenditure per capita. This would have the added effect of controlling for population growth. Although population growth was not significant enough to affect the variables used being stationary, over time, population growth would lead to a natural increase in both variables, and should be accounted for.

Works Cited

Beetsma, Roel, Massimo Giuliodori, and Franc Klaassen. "Trade Spill-overs of Fiscal Policy in the European Union: A Panel Analysis." *Centre for Economic Policy Research* DP5222 (2005). Print.

Blanchard, Olivier, and Roberto Perotti. "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output*." *Quarterly Journal of Economics* 117.4 (2002). Print.

Caldara, Dario, and Christophe Kamps. "What Are the Effects of Fiscal Policy Shocks? A VAR-BASED Comparative Analysis." *European Central Bank Working Paper Series* 877 (2008). Web.

Canzoneri, Matthew M., Robert E. Cumby, and Behzad T. Diba. "New Views on the Transatlantic Transmission of Fiscal Policy and Macroeconomic Policy Coordination." *European Commission Workshop - "The Interactions Between Fiscal and Monetary Policies in EMU"* (2002). Print.

Corsetti, Giancarlo, and Gernot Muller. "Rethinking Multilateral Policy Coordination in the XXI Century: What Do We Know about Cross-border Effects of Fiscal Policy?" *NBER - for Conference "Globalization in an Age of Crisis"* (2011). Print.

Giuliodori, Massimo, and Roel Beetsma. "What Are the Spill-overs from Fiscal Shocks in Europe? An Empirical Analysis." *European Central Bank* 325 (2004). Print.

Hebous, Shafik, and Tom Zimmermann. "Budget Deficit Spillover Effects in the Euro Area."

(2010). Print.

Hoogstrate, A. J., and Thomas Osang. "Saving, Openness, and Growth." *Tilburg University,*

Center for Economic Research 47 (1998). Print.

Liew, Venus Khim-Sen. "Which Lag Length Selection Criteria Should We Employ?" *Economics*

Bulletin 3.33 (2004): 1-9. Print.