The Dynamic Effects of Fiscal Shocks in Latin American Countries

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Abstract

This paper analyses the dynamic effects of Fiscal Policy in countries from Latin America. We use a Structural VAR Model in order to analyze the effects of exogenous shocks of fiscal variables on the economic system. The identification procedure was proposed by Mountford and Uhlig (2009), which assumes some restrictions on the sign of the shock in some variables, whereas it is agnostic on the effect of fiscal variables in the system. We use quarterly data from three different countries in order to analyse those effects: Brazil, Chile and Mexico. Our findings suggests that, in general, an exogenous fiscal shock have a positive effect on GDP and private consumption, whereas the effects are in the opposite direction in interest rate and inflation. Our results corroborate the hypothesis of procyclical fiscal policy in Latin American Countries.

Keywords: Fiscal Policy, Bayesian Econometrics, Agnostic Identification, Latin America

Resumo

Este trabalho analisa os efeitos dinâmicos da política fiscal em países da América latina. Nós utilizamos um VAR Estrutural a fim de analisar os efeitos de choques exógenos de variáveis fiscais sobre o sitema econômico. O processo de identificação utilizado foi proposto por Mountford and Uhlig (2009), o qual assume algumas restrições sobre o sinal do choque em algumas variáveis, enquanto que é agnóstica em relação ao efeito das variáveis fiscais sobre o sistema. Utilizamos dados trimestrais de três países a fim de analisar estes efeitos: Brasil, Chile e México. Nossos resultados apontam que, em geral, um choque fiscal exógeno possui um efeito positivo sobre o PIB, consumo privado, enquanto que o efeito sobre a taxa de juros e inflação dá-se na direção oposta. Os resultados encontrados corroboram a hipótese da política fiscal pró-cíclica em países da America Latina.

Palavras-chave: Política Fiscal, Econometria Bayesiana, Identificação Agnóstica, América Latina

JEL Classification: E62, E17, E63

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1 Introduction

One important issue that applied macroeconomic researchers address is the true effect of exogenous fiscal shocks on aggregate economic variables. Theoretically, there are two main views regarding the effects of an expansionary fiscal policy on economy: The Real Business Cycle (RBC) and New Keynesian (NK) approaches. The former predicts that unexpected increases on government spending have positive impacts on GPD and negative impact on private consumption because of the negative wealth effect, whereas the latter predicts increase in both variables.

The Vector Autoregression (VAR) methodology approach has been used to find the impacts of both monetary and fiscal policy shocks. Blanchard and Perotti (2002) state that the VAR methodology is better suited to study fiscal policy than monetary policy because there are indeed exogenous fiscal shocks and implementation lags imply that there is little discretionary responses of fiscal policy to unexpected comtemporaneous changes in the other variables.

While in the monetary empirical literature a certain consensus regarding the effects of monetary policy has been stablished¹, there are a great number of studies that find different results, even on the qualitative aspect, for the fiscal shocks². Most recent literature has identified fiscal shocks by making some assumptions about the reactions of some variables to fiscal shocks. Fatás and Mihov (2001), Blanchard and Perotti (2002), Favero (2003), Perotti (2005), Gali et al. (2007) and Mountford and Uhlig (2009) use the VAR methodology to analyze the impact of fiscal shocks on GDP, consumption, inflation, and other variables. The results found provide empirical evidences of a positive response from GDP to fiscal policy. Moreover, the results also predict positive response of consumption³, which are in consonance with the New Keynesian theory.

Another widespread methodological approach for fiscal shocks uses additional information, such as timing of wars, institutional information about the tax system and historical study of policy decisions or elections. For examples of such methodology, see Romer D. and Romer (1994), Ramey and Shapiro (1998), Wendy et al. (1999), Burnside et al. (2003) and Fisher and Eichenbaum (2005). The empirical results support the traditional RBC view, which predicts positive impact on GDP and negative impact on consumption.

The great majority of authors analyze the effects of fiscal shocks for developed nations, such as United States and most countries from OECD. The question that arises is the following: Are the effects of fiscal policy in developing countries, compatible with the results found by these studies? Michael and Perotti (1997), Talvi and Vegh (2005) and Ethan and Carlos (2008) argue that, for the case of emerging economies, the results diverge in the sense that fiscal policy is procyclical whereas in developed countries fiscal policy is countercyclical.

Mendonça et al. (2009) and Silva and Portugal (2010) for Brazil and Cerda et al. (2006) for Chile, find non-keynesian results, which are similar to the results obtained by Blanchard and Perotti (2002), Perotti (2005) and Mountford and Uhlig (2009) for developed coutries. On the other hand, Restrepo and Rincón (2006) and Peres and Ellery Jr. (2009) corroborate the argument of procyclical fiscal policy in developing nations in Latin America.

¹see Christiano and Eichenbaum (1999)

²see Perotti (2007)

³For a detailed discussion about the effects of fiscal policy on consumption see Gali et al. (2007).

Given the absense of conclusive results regarding this issue, this paper analyses the dynamic effects of Fiscal Policy in three countries (Brazil, Chile and Mexico) in order to fuel the discussion of the actual impacts of fiscal policy in Latin America. We use a Structural VAR (Vector Autoregression) Model with sign restrictions in order to identify the effects of exogenous shocks of Government Spending and Government Revenue on GDP, consumption, inflation and interest rate. Results find a positive effect of fiscal policy on GDP and consumption, whereas the effects are in the opposite direction in interest rate and inflation. Our results also corroborate the hypothesis of procyclical fiscal policy in Latin American Countries.

Our paper is organized as follows. Section 2 presents the methodological issues and discusses the identification. Section 3 discusses the results. Section 4 concludes.

2 Methodological Issues

2.1 SVAR Model

The dynamic system wich provides the relationship between the variables is represented by a Structural Vector Autoregression (SVAR) Model as follows:

$$y'_{t}A_{0} = \sum_{l=1}^{p} y'_{t-1}A_{l} + \epsilon'_{t} \quad for \quad 1 \le t \le T,$$
(1)

where y_t is a n dimensional column vector of endogenous variables, A_0 is a $n \times n$ contemporary coefficients matrix, A_l is a $n \times n$ lagged variables parameters matrix, ϵ_t is a $n \times 1$ structural disturbances column vector, p is the number of lags and T is the sample size.

The Gaussian ϵ_t distribution, conditional to past information, has mean $E(\epsilon_t|y_1, ..., y_{t-l}) = 0$ and variance-covariance matrix $E(\epsilon_t \epsilon'_{t-1}|y_1, ..., y_{t-l}) = I_{n \times n}$. Post-multiplication of each member of equation (1) by A_0^{-1} , yields the reduced form VAR model:

$$y'_{t} = \sum_{l=1}^{p} y'_{t-l} B_{l} + u'_{t} \quad for \quad 1 \le t \le T,$$
(2)

where $B_l = A_l A_0^{-1}$ for l = 1, 2, ..., p; $u'_t = \epsilon'_t A_0^{-1}$ and $\Omega = E[u_t u'_t] = (A'_0 A_0)^{-1}$ is the variance-covariance matrix of the reduced form residuals. In our case, the y_t vector is given by the natural logarithm⁴ of the following variables:

- G_t Government Expenditure;
- Y_t GDP;
- C_t Private Consumption;
- R_t Government Revenue;
- i_t Interest Rate;
- π_t Inflation.

Our y_t vector, therefore, becomes:

$$y_t = (E_t, Y_t, C_t, R_t, i_t, \pi_t).$$
 (3)

⁴Except for interest rate and inflation, which we used their values in level.

We use one lag for each variable for the three systems. Our choice was based on the Bayesian Information Criterion (BIC), as suggested by Ivanov and Kilian (2005), which indicate its use for quarterly data series. For Chile and Mexico, we based the number of lags suggested by the Akaike Information Criterion (AIC), which indicates the most parcimonious model, given the restricted number of observations.

Although the model to be estimated consists in a reduced form VAR, such as equation (2), we seek for orthogonal impulse response functions (IRF's), which represent endogenous responses from the variables of the system to impulses from one element of the ϵ_t vector. We adopt the identifying strategy of sign restrictions to identify each element of this vector.

2.2 Identification

Identification in VAR literature usually identifies all n fundamental shocks, and therefore imposes n(n-1)/2 restrictions on the B matrix. Sims (1980) assumes a recursive ordering in the VAR, while Blanchard and Watson (1986), Quah and Blanchard (1989), Gali (1992) and others, assume some structural relationship between the variables in order to identify the entire system. We follow the identification proposed by Mountford and Uhlig (2009), identifying only three structural shocks (business cycle shock, monetary policy shock and fiscal policy shock) from the impulse matrix $[a_1, ..., a_n]^5$, a weaker condition than imposing restrictions on the entire B matrix.

The effects of fiscal policy in Latin America are identified through a bayesian approach based on agnostic identification procedure, which impose some sign restrictions on the variables. Fiscal policy shocks is regarded as existing in a two dimensional space spanned by two basic vectors, a government expenditure shock and a government revenue shock. Thus, every fiscal policy shock can be described as a linear combination of these two shocks⁶.

An empirical problem arises when we are seeking to distingush pure exogenous fiscal shocks from increases in fiscal variables given by business cycles upturns and monetary shocks. In order to solve this problem, as suggested by Mountford and Uhlig (2009), we explicitly identify the latter two shocks and require fiscal policy shocks to be orthogonal to both of them. Orthogonality of fiscal policy to business cycle implies that we can separate, for example, an increase in government revenue due to a business cycle upturn from an increase in revenue caused by a tax increase. We additionally require business cycle shocks to be causally prior to fiscal variables shocks. It means that GDP movements is explained mostly by business cycle shocks. The remaining effect can be seen as an estimate of the impact of fiscal policy⁷. The identification strategy, thus, is done as follows. We first identify an impulse which satisfies the conditions for a business cycle shock. Finally, it is identified the fiscal policy shock, which is orthogonal to both previous shocks.

We are interested in identifying the responses to a given shock. To do so, we proceed as follows. Let Ω be the VAR residuals variance-covariance matrix and Λ is a matrix such that $\Omega = \Lambda' \Lambda$. Thus, $\Lambda = \tilde{\Lambda'}Q$, where Q is an orthogonal matrix and $\tilde{\Lambda'}$ is

⁵Uhlig (2005) define the impulse vector a_k as the k-th column vector of the A matrix, so that $AA' = \Omega$

⁶See Mountford and Uhlig (2009).

⁷See Mountford and Uhlig (2009).

the lower triangular Choleski factor of Ω . Therefore, any impulse vector can be written as:

$$a = \tilde{\Lambda}^{-1} \alpha, \tag{4}$$

where *a* is the corresponding column vector from the matrix Λ , which contains contemporaneous responses to a given shock, and α are the identifying weights which are to be determined. Thus, responses from a given impulse *a* in time *k* can be obtained from Choleski decomposition shock as:

$$r_a(k) = \sum_{i=1}^n \alpha_i r_i(k).$$
(5)

Based on equation (5), we can identify the impluse vector corresponding to the fiscal shock. We need, however, to define what exactly we mean by fiscal shock. Mountford and Uhlig (2009) define monetary policy shock as a impulse vector a_{mp} so that impulse response $r_{mp}(k)$ is non-negative for inflation and non-positive for interest rate at horizon k = 0, ..., K. Accordingly, business cycle shock is defined as the impulse vector a_{bc} which provide non-negative impulse response for GDP, consumption and government revenue. In turn, we define fiscal policy in two distinct ways. First, we define fiscal shock generated by a shock on the govern expenditure as the impulse vector a_e which provides non-negative IRF $r_e(k)$ for the public expenditure for two quarters. Second, we define fiscal shock generated by a shock on government revenue as the impulse vector a_r which generates non-negative public revenue for the same period.

These shock definitions are not sufficient to completely identify the shocks. We use a bayesian approach, in which the VAR coefficients are random variables and may generate responses which are opposite to what economic theory predicts. That is, the set of impulse vectors $\Psi(B, K, \Omega)$, which may be generated by the OLS estimated coefficients (*B*), its variance-covariance matrix (Ω) and its imposed sign restriction (by *K* periods), may have too many elements. It is worth to specify how we get the IRF's from this specific method.

We apply the sign restriction method, via minimizing a penalty function, in order to choose the impulse vectors which present the desired attribute. First, we define a criterion function f(.) in the unit sphere, which penalizes every deviation from the relevant sign restrictions⁸. Second, we solve for α and thus $a = \tilde{\Lambda} \alpha$ by minimizing:

$$\alpha = \operatorname{argmin}\Phi(\Lambda\alpha),\tag{6}$$

where the criterion function $\Phi(a)$ is given by

$$\Phi(a) = \sum_{j \in J_{s,+}} \sum_{k=0}^{K} f\left(-\frac{r_{ja}(k)}{s_j}\right) + \sum_{j \in J_{s,+}} \sum_{k=0}^{K} f\left(\frac{r_{ja}(k)}{s_j}\right).$$
(7)

The criterion function above is minimized subject to the orthogonality restrictions. It sums the penalties over the horizon k = 0, ..., K following the shock and over the indices of variables with positive $(J_{s,+})$ and negative $(J_{s,+})$ sign restrictions, respectively. The impulse responses are normalized by the standard error s_j of variable j. We, then,

⁸See Uhlig (2005).

following Uhlig (2005) and Mountford and Uhlig (2009), take a number of draws from the posterior and identify the shocks for each draw⁹.

3 Results

In this section we present the effects of fiscal policy in Brazil, Chile and Mexico. The results are showed in figures 1 to 4. The dashed lines represent confidence intervals of 68% for responses, while the solid line indicate the median response from the data. The gray area indicate the sign restriction imposed over the variables response.

It is worth to stress we do not include unit root tests in our anaysis, as we are using a bayesian approach which eliminates the issue of integration order of the series. In fact, many authors (DeJong and Whiteman (1991), Sims (1988), Koop (1992), and others) strongly suggest the bayesian alternative in contrast to the classical approach¹⁰.

3.1 Business Cycle Shock

A business cycle shock is identified as a shock that raises GDP for six months. The effects of a shock on business cycle is showed in Figure 1. It presents the responses from government spending, GDP, consumption, government revenue, and inflation, for Brazil, Chile and Mexico. We also require a positive sign from consumption and government revenue responses for six months.

Our results provide empirical support for the theory of procyclical fiscal policy in developing coutries, as stated by Michael and Perotti (1997), Ethan and Carlos (2008) and others. As we can see, Figure 1 shows a positive contemporaneous effect of a business cycle shock on public spending. GDP, consumption and revenue, by construction, present positive contemporaneous effects, whereas the contemporaneous effects, although transitory, on interest rate and inflation are negative.

3.2 Monetary Policy Shock

A monetary policy shock is identified as a shock that is orthogonal to both fiscal and business cycle shock and increases interest rate for six months after the shock. The effects of a shock on interest rate is displayed in Figure 2. It shows the responses from government spending, GDP, consumption, government revenue, and inflation, for Brazil, Chile and Mexico. In addition to requiring the sign of responses from interest rate to be positive, we restrict the response from inflation to be negative for six months.

As we can see from Figure 2, there is a higher probability of GDP contemporaneous response from a monetary shock to be positive, except for the mexican case, although we can expect a quick downward tendency after only two quarters. Monetary policy effect on consumption is uncertain, despite the positive contemporaneous effect. The effects on inflation tend to quickly disappear.

⁹See Mountford and Uhlig (2009).

¹⁰See Mendonça et al. (2009).

3.3 Government Spending Shock

A government spending shock is identified as a shock that is orthogonal to both monetary and business cycle shock and increases public spending for six months after the shock. The effects of a government spending shock is showed in Figure 3. It presents the responses of GDP, consumption, government revenue, interest rate, and inflation for Brazil, Chile, and Mexico. In all cases we only restricted the sign of the response of government spending to be positive during a horizon of six months, i.e., we are following a completely agnostic procedure to identify the effects of the fiscal shocks on our variables of interest.

Figure 3 shows a positive contemporaneous effect of government spending shock on GDP for the brazilian case. The effect of government spending on consumption is quite interesting. The contemporaneous effect seems to be negative, while it tends to reverse its trend, being positive after one period. On theoretical basis, this result can be explained by the so-called Ricardian Equivalence, where families assume that current increases in public expenditure will be financed by future tax raise, thus current consumption falls in order to pay for increase in taxes in the future¹¹. We can also see a negative contemporaneous effect of a spending shock in government revenue, suggesting that increases in expenditure is basicaly financed by a budgetary deficit, and in interest rate. Inflation also present a decline, which is a couter-intuitive result. Nevertheless, this negative relationship between price level and government spendings has also been found in another studies, such as Wendy et al. (1999), Fatas et al. (2000), Canova and Pappa (2003) and Mountford and Uhlig (2009).

We find similar results for Chile. As Figure 3 shows, there is a higher probability of a positive response from GDP, reaching its maximum response one year after the shock. Consumption also presents a higher probability of contemporaneous negative response to a government spending shock, turning to positive one quarter after the shock. We also find a negative contemporaneous effect on public revenue, interest rate and inflation. Those effects tend to disappear in 14 periods after the shock.

For the mexican case, a spending shock on GDP and consumption appears to be positive, given that most part of the probability function mass is in the up part of the graph, in Figure 3. As in the brazilian and chilean cases, contemporaneous response from revenue seems to be negative, revering its sign one quarter after the shock. However, we cannot surely predict the contemporaneous effect of public revenue shock on interest rate, although it is negative after three months. Spending shock has little effect on inflation.

We find, therefore, different results from those obtained by Cerda et al. (2006), and Mendonça et al. (2009), for Chile and Brazil respectively. We contradict their findings of a negative transitory effect of a spending shock on GDP and interest rate, and a positive effect on consumption. Our results are more in consonance with Restrepo and Rincón (2006), which find a positive effect on GDP for Chile and Colombia, and Peres and Ellery Jr. (2009) and Silva and Portugal (2010), finding the same result for Brazil.

¹¹Gali et al. (2007), in a DSGE Model, finds different results for the consumption response to fiscal shocks, which depend on the presence of non-ricardian individuals in economy.

3.4 Government Revenue Shock

A government revenue shock is identified as a shock that is orthogonal to both monetary and business cycle shock and increases public revenue for six months after the shock. The effects of a government revenue shock is presented in Figure 4. It represents responses from spending, GDP, consumption, interest rate, and inflation, to a raise in public revenue. As in the previous case, we only require the sign of response from revenue to be positive during six months. Thus, we do not impose any further restriction regarding the response of our system variables.

As figure 4 shows, the impact of a public revenue shock on GDP and consumption is negative for all cases. This result is very intuitive and is in accordance with previous studies, see for example Mountford and Uhlig (2009) and Restrepo and Rincón (2006). We also find a positive, however transitory, effect on interest rates and inflation, where in approximately 10 to 12 quarters the shock has no longer any effect¹². The government expenditure response to the revenue shock is contemporaneously negative, except possibly for Brazil.

4 Conclusions

In this paper we analyzed the dynamic effects of fiscal policy in Latin American countries. We adopted a bayesian agnostic strategy, proposed by Mountford and Uhlig (2009), which distinguishes exogenous fiscal variables shocks from responses to business cycles movements and monetary policy. This method allows us to impose minimal restrictions in our variables of interest: GDP, consumption, interest rate and inflation.

Our results find positive response from GDP and consumption, whereas interest rate and inflation responses are negatively related to an exogenous spending shock. We also identify business cycle and monetary policy shocks, which are orthogonal to fiscal shocks. We find that the suggestion of prociclical fiscal policy in developing countries applies to the sampled countries.

A public revenue shock negatively affects GDP and consumption in Latin America. Interest rate and inflation responses are positive and transitory for both Chile an Mexico. The government revenue shock in Brazil seems to take longer to be vanished.

This paper findings suggest that fiscal policy in Latin America, in contrast to developed countries, yields positive longstanding effects on economic activity, in special for the brazilian case. In fact, our results seem to suit well to the Neokeynesian theory, where public spendings stimulate private consumption, promoting GDP short-term growth.

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¹²For the brazilian case, the adjustment process seems to be more protracted for both interest rate and inflation, as showed in Figure 2.

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A The Data

We use quarterly data for all the three countries. The seasonal components were removed from all series by the X-11 method. For the Brazilian case, the sample ranges from the first quarter of 1995 to the forth quarter of 2010. The data sum 64 observations. The macroeconomic variables included in the model are presented in Table 1.

Variable	Serie	Description
G	Real Govern- ment Spending	Final consumption of public adminstration divided by the CPI. Source: National Ac- count System
Y	Real GDP	Gross domestic product divided by the CPI. Source: National Account System
C	Real Consump- tion	Final consumption of households divided by the CPI. Source: National Account Sys- tem
R	Real Revenue	Federal Revenue divided by the CPI. Source: Secretaria da Receita Federal
i	Interest Rate	Interest Rate - Over/Selic. Source: Brazil- ian Central Bank
π	Inflation	General CPI percentual variation. Source: IBGE

Table 1: Data - Brazil's Model

Source: Prepared by the authors

For Mexico and Chile, we used a narrowed dataset. For Chile, sample goes from the first quarter of 2003 to the last quarter of 2010. The data sum 32 observations. The set of variables used for Chile are displayed in Table 2.

For the mexican case, the sample ranges from 2003:1 to 2011:1, totalizing 33 observations. The description of variables used for Mexico are presented in Table 3.

Variable	Serie	Description
G	Real Govern-	Government consumption divided by the
	ment Spending	CPI. Source: Chilean Central Bank
Y	Real GDP	Gross domestic product divided by the
		CPI. Source: Chilean Central Bank
C	Real Consump-	Household consumption divided by the
	tion	CPI. Source: Chilean Central Bank
R	Real Revenue	Revenue divided by the CPI. Source: Inter-
		American Development Bank
i	Interest Rate	Interest Rate. Source: Inter-American De-
		velopment Bank
π	Inflation	General CPI percentual variation. Source:
		Chilean Central Bank

Table 2: Data - Chile's Model

Source: Prepared by the authors

Variable	Serie	Description
G	Real Govern- ment Spending	Public sector spendings divided by the CPI. Source: Dirección General Adjunta de Es- tadística de la Hacienda Pública. Unidad de Planeación Económica de la Hacienda Pública
Y	Real GDP	Gross domestic product divided by the CPI. Source: Mexican National Account System
C	Real Consump- tion	Private consumption divided by the CPI. Source: Mexican National Account System
R	Real Revenue	Public Sectot Revenue divided by the CPI. Source: Dirección General Adjunta de Es- tadística de la Hacienda Pública. Unidad de Planeación Económica de la Hacienda Pública
i	Interest Rate	Nominal Interest Rate - Over/Selic. Source: INEGI and Bank of Mexico
π	Inflation	General CPI percentual variation. Source: Bank of Mexico

Source: Prepared by the authors

B Figures



Figure 1: Business cycle shocks on latin american countries



Figure 2: Monetary shocks on latin american countries



Figure 3: Spending shocks on latin american countries



Figure 4: Revenue shocks on latin american countries