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Abstract

In Chile, the empirical literature studying the dynamic effects of fiscal policy and fiscal multipliers, using linear vector autoregression models, disagrees on the effects of government spending and taxes on output. In this paper, we bring new elements to this debate. We include the nonlinear dimension of vector autoregression models to answer if the state, "tight" or "normal", of the Chilean economy, affects fiscal policy effectiveness. Last, based on the nonlinear framework we question if monetary policy has an influence on the size of fiscal multipliers. We find that: (i) once using the same quarterly data, the size of fiscal multipliers not only varies depending on the identification strategy and the linear vector autoregression model used but also on the definitions of government spending and taxes considered; (ii) the government spending multiplier from the nonlinear framework differs, being about the unit in the "tight" regime and around -0.5 in the "normal" regime; (iii) government spending and tax multipliers in the nonlinear framework are smaller when monetary policy is taken into account, which influences the effectiveness of fiscal policy.

Keywords: Fiscal Policy, Fiscal Multipliers, Vector Autoregression Models.

JEL Classification Numbers: C11, C32, E62.

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1 Introduction

In recent years a relatively new strand of literature has questioned whether the state of the economy is a determinant for the dynamic effects of fiscal policy on output and on the size and sign of fiscal multipliers (Afonso et al., 2011; Baum and Koester, 2011; Auerbach and Gorodnichenko, 2012; Batini et al., 2012; Baum et al., 2012; IMF, 2012; and Auerbach and Gorodnichenko, 2013; Riera-Crichton et al., 2014; among others). This literature, mostly focusing on developed economies (Germany: Baum and Koester, 2011; the United States: Auerbach and Gordonichenko, 2012; a group of G-7 countries: Batini et al., 2012; Baum et al., 2012; and IMF, 2012; and many of Organization for Economic Cooperation and Development (OECD) countries: Auerbach and Gordonichenko, 2013), has found that the dynamic effects of fiscal policy on output are likely nonlinear with fiscal multipliers being larger in recession than in expansion periods.[1] A contribution studying both developed and developing economies (a sample of thirty OECD countries including developing economies such as Chile, Hungary, Mexico, Poland and Turkey) by Riera-Crichton et al. (2014) also finds evidence of larger effects of fiscal policy on output during recessions than in expansions. Other recent papers studying developing economies and specifically Latin American countries, are Vargas et al. (2015) and Carrillo (2017), for Colombia and Ecuador, respectively, find similar results for these developing economies.

In this paper we focus on the case of Chile for three reasons: first, because of the lack of agreement and inconclusive results in the literature studying this country's dynamic effects of fiscal policy on output and on the size and sign of fiscal multipliers; second, because as far as we are aware of, estimates of fiscal multipliers taking into account the state of the Chilean economy do not exist; and last, due to the lack of analysis on the interactions between fiscal and monetary policies in the related literature.[2]

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[1] G-7 is a group of countries consisting of Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.

[2] The literature studying the dynamic effects of Chile's fiscal policy on output and the size and sign of fiscal multipliers, using high frequency data (at least quarterly), as far of our knowledge, includes three main contributions (Cerda et al., 2005; Restrepo and Rincón, 2006; and Céspedes et al., 2011) which get to very different results, leaving the question about the dynamic effects of fiscal policy on output and fiscal multipliers far from being conclusive. Other papers studying the effects of the Chilean fiscal policy on output and the size and sign of fiscal multipliers are Correa et al. (2014), using a narrative approach, and Grünwald and Klapp (2017), replicating Cerda et al. (2005).

The openness of the Chilean economy to the world economy, its deep financial integration to foreign markets, and its orientation to commodity exports have made it historically affected to shocks coming from international sources. On one hand, such economic integration has greatly benefited the Chilean economy by increasing its exports, capital inflows, and the arrival of multinational companies', enhancing competition in the provision of goods and services. But on the other hand it also has put important risks such as greater domestic macroeconomic instability. As a policy response, during the last decades, the Chilean economic authorities have progressively built a sound and effective macroeconomic policy framework comparable to those in place in commodity exporting developed economies, such as Australia, New Zealand and Norway. Nevertheless, in spite of such a macroeconomic policy framework, the Chilean economy is still quite exposed to shocks coming from international sources. Thus, to guarantee its macroeconomic stability, the country's fiscal policy is a key tool, with the dynamic effects of fiscal policy and the size and sign of fiscal multipliers a relevant subject.[3]

This paper seeks to contribute to the literature studying the dynamic effects of fiscal policy and the size and sign of fiscal multipliers by answering why the size of Chile's fiscal multipliers linear models are inconclusive, by considering the nonlinear dimension in the estimation of fiscal multipliers to answer if the state of the Chilean economy, "normal" or "tight", matters or not in fiscal policy effectiveness, and building on a nonlinear approach, this paper questions the influence of the short-term (monetary policy) interest rate on the size and sign of fiscal multipliers.

To explain the lack of consensus on the dynamic effects of Chile's fiscal policy on output and the size and sign of fiscal multipliers, we highlight the existing methodological differences in the related literature (Cerda et al., 2005; Restrepo and Rincón, 2006; and Céspedes et al., 2011), meaning the period of study, the data frequency, the definitions of government spending and taxes, and the vector autoregression approaches implemented, estimating linear impulse-response

[3] The Chilean macroeconomic policy framework includes: A Central Bank completely independent of the government in office decisions, responsible for monetary and exchange rate policies; a flexible exchange rate regime aiming at working as the first defensive line against foreign shocks; an inflation targeting regime to anchor prices and give certainty to the economic agents; a structural balance fiscal rule guiding the short-term government spending depending on the economy medium-term fundamentals, notably output and copper prices, allowing to isolate government spending from politically populist driven pressures; sovereign wealth funds successfully used under exceptional cases; and low public debt to gross domestic product ratio, both compared to OECD and Latin American peers economies, allowing the country access to credit in convenient conditions.

functions and calculating fiscal multipliers based on the definitions of government spending and taxes in the seminal paper by Blanchard and Perotti (2002) (after this we refer to this model as the "BP baseline model") and the alternative definitions of government spending and taxes in Cerda et al. (2005), Restrepo and Rincón (2006) and Céspedes et al. (2011) (from here on we refer to these models as the "Alternative baseline models"), using vector autoregression (VAR) and structural vector autoregression (SVAR) models. Using the same sample period, 1990Q1-2017Q4, in all our linear estimations we find that the impulse-response functions obtained and the size of fiscal multipliers not only depend on the identification strategy and the vector autoregression model used, but also on the definitions of government spending and taxes.

To respond if the state of the economy, "normal" or "tight" regime, matters in the dynamic effects of Chile's fiscal policy on output and the size and sign of fiscal multipliers, we apply a nonlinear time series analysis, concretely a Threshold VAR (TVAR) model, built on the "BP baseline model" (in the tradition of Blanchard and Perotti, 2002), closely following Batini et al. (2012), where the state of the economy, "normal" or "tight", depends on the real GDP growth, with data for the period 1990Q1-2017Q4, in a model we called "TVAR baseline model".[4] We found that fiscal multipliers, in the long-term, differ depending on the state of the economy, with government spending multipliers being positive and above the unit in the "tight" regime, and negative and about -0.5 in the "normal" regime. Tax multipliers are about zero not deferring much depending on the state of the Chilean economy.

Finally, we shed some light on the interaction between fiscal and monetary policies, we estimate a model built on the "TVAR baseline model" by adding the monetary policy stance, meaning the short-term (monetary policy) interest rate, we called "TVAR extended model". We find that when the short-term (monetary policy) interest rate is taken into account, government spending and tax multipliers are smaller compared to when it is not.

[4] Other papers as Baum and Koester (2011), Baum et al. (2012), and IMF (2012) define the state of the economy using the output gap. Further extensions of this paper could include this measure instead of the real GDP growth we use here.

The remaining part of this paper is structured as follows. Section 2 reviews the international literature studying the dynamic effects of fiscal policy on output and fiscal multipliers using nonlinear vector autoregression models and discusses the related literature studying the case of Chile. Section 3 presents the data, discusses the analytical approaches we use (VAR, SVAR and TVAR models), and explains how fiscal multipliers are computed. Then section 4 presents the impulse-response functions and fiscal multipliers from the "BP baseline model" that uses the Blanchard and Perotti (2002) government spending and taxes definitions. These results are compared with those we get using the definitions of government spending and taxes from the "Alternative baseline models". Section 5 discusses the "TVAR baseline model" results finding that fiscal multipliers, and therefore fiscal policy effectiveness, differ depending on the regime ("normal" or "tight"), with government spending multipliers about the unit in the "tight" regime and around -0.5 in the "normal" regime. Tax multipliers do not differ from zero in both regimes ("normal" and "tight"). The results from the "TVAR extended model" are provided in section 6. We find that when the short-term (monetary policy) interest rate is taken into account, government spending and tax multipliers are smaller than those not considering the monetary policy stance. Last, section 7 concludes.

2 Literature Review

In this section, we review the international literature studying the dynamic effects of fiscal policy and fiscal multipliers using nonlinear vector autoregression models, and we discuss the literature studying the case of Chile.

Most of the literature estimating the dynamic effects of fiscal policy and fiscal multipliers using vector autoregression models follows the seminal contribution by Blanchard and Perotti (2002). These authors; developing an SVAR model with data for the United States, find that government spending has a positive impact on output, the opposite happening when taxes are raised. Since Blanchard and Perotti (2002), a vast literature using linear vector autoregression models has studied the dynamic effects of fiscal policy and fiscal multipliers (Perotti, 2005; Caldara and Kamps, 2008; Ilzetzki and Végh, 2008; González-García et al, 2013; Ilzetzki et al., 2013; among others).

A significant literature review by Spilimbergo et al. (2009) argues that: (i) the size of fiscal multipliers is far from being homogenous among countries; (ii) the size of fiscal multipliers is larger if: a small part of the stimulus is spent on imports or saved by the private sector, the interest rate does not increase as a result of the fiscal expansion, and the country's fiscal position is perceived sustainable by private agents; (iii) a rule of thumb government spending multiplier (assuming a constant interest rate) is of 1.5 to one for large countries, one to 0.5 for medium size countries and of 0.5 or less for small open economies, with tax multipliers being about the half of government spending multipliers; and (iv) the risk of "simultaneity biased" is reduced when using higher frequency data, quarterly at least.

As the global financial crisis proved the inaccuracy and ineffectiveness of vector autoregression linear models to predict the dynamic effects of fiscal policy and the size and sign of fiscal multipliers, a new strand of literature developed nonlinear vector autoregression models able to capture the effectiveness of fiscal policy depending on the state of the economy. This literature includes contributions by Afonso et al. (2011), Baum and Koester (2011), Auerbach and Gorodnichenko (2012), Batini et al. (2012), Baum et al. (2012), IMF (2012), Auerbach and Gorodnichenko (2013), for developed economies, and by Riera-Crichton et al. (2014), Vargas et al. (2015), and Carillo (2017), for developing countries. In general, this new strand of literature finds large differences in the size of fiscal multipliers, with fiscal policy being more effective during recession periods, "tight" regime, than during growth periods, "normal" regime.

Among single country studies, two early contributions are Baum and Koester (2011) and Auerbach and Gordnichenko (2012). Baum and Koester (2011), using a TVAR model, compute fiscal multipliers for Germany finding that government spending multipliers are much larger in case of a negative output gap and that tax policies have a limited effect. Meanwhile, Auerbach and Gordnichenko (2012), for the United States, compute fiscal multipliers from a Markov switching vector autoregression model (MSVAR), finding that a government spending multiplier at impact is similar during "normal" and "tight" regimes (about 0.5), but presents large differences (over 2.5 in the "tight" regime and about zero in the "normal" regime) in the long-term (25 quarters).

Alternatively, papers studying a group of countries and estimating TVAR models include studies by Afonso et al. (2011), Baum et al. (2012), IMF (2012), and Batini et al. (2012), among others. Afonso et al. (2011), using a financial stress indicator proposed by Cardarelli et al. (2011) as the threshold variable, and quarterly data for Germany, Italy, the United Kingdom and the United States, study whether the dynamic effects of fiscal policy differ depending on the financial conditions, finding that the nonlinear response of output to a fiscal shock is mainly associated with different behaviors across regimes. Batini et al. (2012) using a TVAR model estimate the impact of fiscal adjustments in the United States, Europe, and Japan finding government spending multipliers much larger in downturns than in upturns, with the monetary policy not having a strong cushioning effect on the economic activity. Baum et al. (2012) using the output gap as a threshold variable, and quarterly government spending and tax data for Canada, France, Germany, Japan, the United Kingdom and the United States, find that fiscal policy shocks on output not only depend on the size and direction but also on the state of the economy, with government spending and tax multipliers being larger in "tight" regimes than in "normal" regimes. Similarly, the IMF (2012), for the G-7 countries but Italy, finds evidence suggesting that the impact of fiscal policy on output varies with the business cycle, that the average fiscal multipliers are much larger in times of negative output gaps, with government spending multipliers much bigger in absolute value than tax multipliers.

Subsequently, for a group of thirty OECD countries including both developed and developing economies, Riera-Crichton et al. (2014) ask whether the size and sign of fiscal multipliers depend on the state of the business cycle or not, finding that government spending multipliers are not only higher during "tight" regimes than in "normal" regimes, but also that government spending multipliers are higher when government spending is going up in recessions.

Country contributions focusing on Latin American include Vargas et al. (2015) and Carrillo (2017), for Colombia and Ecuador, respectively. Both studies, in line with the literature focusing on developed economies, find fiscal policy being more effective in "tight" regimes than in "normal" regimes, with government spending being more efficient to boost output than tax cuts.

In the case of Chile, the literature studying the dynamic effects of fiscal policy and fiscal multipliers has only used linear models, providing results far from conclusive. The main papers, using high frequency data (quarterly at least), Cerda et al. (2005), Restrepo and Rincón (2006), and Céspedes et al. (2011), not only reach very different results but also do not take into account the role of "normal" and "tight" regimes on the dynamic effects of fiscal policy and the size and sign of fiscal multipliers.

The first attempt to estimate the dynamic effects of Chile's fiscal policy using quarterly data was achieved by Cerda et al. (2005). These authors, using a SVAR model and data for the period 1986Q1-2001Q4, find that positive shocks to government spending have a negative effect on output during the first quarter that afterward dies out, and that positive shocks to taxes also have a negative, though very small, impact on output during the first quarter.[5] Thus, according to Cerda et al. (2005) fiscal policy in Chile has a null and even slightly negative effect on output.[6]

Later, Restrepo and Rincón (2006) also using a SVAR model, for the period 1989Q1-2005Q2, find that a one Chilean peso increase in government spending have a positive effect of 1.9 Chilean peso on real GDP growth during the first quarter and about 1.37 Chilean peso in the medium-term, meaning that one Chilean peso spent by the government generates about 37 cents, and an increase in taxes of one Chilean peso has a negative effect on GDP growth of 40 cents during the first quarter, not much different from zero afterwards.[7] Hence, Restrepo and Rincón (2006) conclude that in Chile, meanwhile, government spending might have a positive effect on output, taxes do the opposite.

More recently Céspedes et al. (2011), using a VAR model estimate government spending multipliers, not tax multipliers, for the period 1990Q1-2010Q1.[8] These authors' basic model, including government spending, real GDP, private consumption and public deficit, finds a large

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[5] Government spending corresponds to the total spending including transfers, social security, financial investment, public debt services and another fiscal spending. Taxes include all taxes net of subsidies, i.e.: income taxes, VAT, trade taxes, taxes to specific products, juridical acts taxes, and other taxes.
[6] Grünwald and Klapp (2016) replicate the paper by Cerda et al. (2005) for the period 1990Q1-2016Q3 finding that government spending increases have a null effect on output.
[7] Government spending corresponds to government spending on wages and salaries, goods and services, and investment. Taxes are net of subsidies and grants, interest payments, social security payments and capital transfers.
[8] Government spending corresponds to government consumption and government investment.

and positive government spending multiplier of 0.7 at impact and a cumulative multiplier of 2.8 after eight quarters. Their results' robustness was checked extending their model, including three other variables: long-term real copper price, investment and real exchange rate. Céspedes et al. (2011)'s results suggest that government spending multipliers are high and positive, with fiscal policy being quite effective.

In summary, the literature using linear vector autoregression models to estimate the dynamic effects of fiscal policy on output and the size and sign of fiscal multipliers in Chile are far from conclusive. Meanwhile, Cerda et al. (2005) conclude that the Chilean fiscal policy has a null and even a negative effect on the economic activity (both government spending and taxes), Restrepo and Rincón (2006) suggest that government spending might be effective but taxes not, and Céspedes et al. (2011) find that government spending is quite effective to boost the Chilean economy. We guess that these differences might be explained by the methodological choices in terms of period of study, data frequency and alternative vector autoregression models used, but also by the variables included, the number of lags the models have, and the government spending and tax definitions considered.[9] [10] A summary of these parameters is presented in Table 1.

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[9] Impulse-response functions may depend critically on the lag order of vector autoregression models (Ivanov and Kilian, 2005).

[10] Regarding the fiscal data sources, meanwhile Cerda et al. (2005) use data collected under the "cash principle" (spending and taxes are recorded at the time the cash transaction occurs.), sourced by the government's payment office (Tesorería General de la República), Restrepo and Rincón (2006) and Céspedes et al. (2011) use data sourced by the Chilean Budget Office (Dipres) built on the "accrual principle" (spending and taxes are recorded at the time of the activity that generates the obligation to pay them.). In this paper, we also use the data sourced by Dipres, built on the "accrual principle."

Table 1. Data, Analytical Approaches, and Variable Definitions in the Literature on Chile's Dynamic Effects of Fiscal Policy on Output and Fiscal Multipliers

	Cerda et al. (2005)	Restrepo and Rincón (2006)	Céspedes et al. (2011)
Period of study	1986Q1-2001Q4	1989Q1-2005Q2	1990Q1-2010Q1
Frequency	Quarterly	Quarterly	Quarterly
Approach	SVAR	SVAR	VAR
Number of lags included in the vector autoregression model	8 (Akaike information criterion)	Not mentioned	4 (Criterion not mentioned)
Variables included	Government spending, Taxes and GDP	Government spending, Taxes and GDP	Government spending, Private consumption, Public deficit and GDP 1/
Spending definition	Total spending less transfers, social security, financial investment, debt interests and other fiscal expenditure	Wages and salaries, goods and services, and investment; i.e. government spending net of transfers	Government consumption and investment
Taxes definition	Income taxes, VAT, trade taxes, taxes to specific products, taxes to juridical actions, and other taxes net of subsidies	Taxes are net of subsidies and grants, interest payments, social security payments and capital transfers	Not studied. Instead they study the dynamic effects of government transfers
Results of a positive government spending shock	Small and negative effect on output	Positive effect on output	High and positive effect on output
Results of a positive tax shock	Small and negative effect on output	Small and negative effect on output	Not studied

1/ In this paper, the GDP data excludes copper and other natural resources.

3 Methodology

In this section, we present the data, describe the variables (arrangements and changes), list the statistical tests we apply to them, and the number of lags selected and included in our models. Then we describe the analytical approaches we use (VAR, SVAR, and TVAR models) discussing their strengths and weaknesses. Last we argue how we calculate the fiscal multipliers (at impact, one year, two years and long-term) presented later in sections 4, 5 and 6.

3.1 Data

This paper covers the period 1990Q1-2017Q4. The data have a quarterly frequency, which means one hundred and twelve observations, and are sourced by the Chilean Budget Office (Dipres), the Chilean National Bureau of Statistics (INE), the Central Bank of Chile (BCCh) and the OECD.

The nominal government spending and taxes come from Dipres; the nominal GDP, consumer price index (of all items), and the short-term (monetary policy) interest rate are sourced by the BCCh and the OECD; the population comes from the INE.

Variables

The variables included in the "BP baseline model" and the "Alternative baseline models" of section 4 and the "TVAR baseline model" of section 5, are: the log of real per capita GDP in differences "dlog Y_t", the log of real per capita government spending in differences "dlog G_t", and the log of real per capita taxes in differences "dlog T_t". Section 6 "TVAR extended model" builds on the "TVAR baseline model" adding the short-term (monetary policy) interest rate in percentage and differences "di_t". To get these variables, but the short-term (monetary policy) interest rate, we deflate the nominal time series by the consumer price index (of all items), divided by the population, transformed into logarithms, seasonally adjusted using the Census X12 seasonally adjustment method, and set their differences to achieve stationarity.[11]

Unit Root Tests

The standard Augmented Dickey-Fuller, Elliot-Rothenberg-Stock and Phillips-Perron unit root tests were implemented with constant and time trend to the series in logarithms, with constant to the series in percentage, and without constant nor time trend to those in differences. The inclusion of the constant and/or time trend in the unit root tests was decided after data inspection. Meanwhile, the time series in logarithms show nonstationarity (unit root), the series in percentages observes mix results (unit root and stationarity) depending on the specific test, and the data in differences are stationary in almost all cases. These unit root tests are reported in Appendix A.

[11] This procedure follows what has been extensively implemented in the related literature to achieve stationarity (see, for example; Cerda et al., 2005; Restrepo and Rincón, 2006; Baum and Koester, 2011; Céspedes et al., 2011; and Grünwald and Klapp, 2016; among others).

Lag Selection

It is well-known that the lag choice has important quantitative implications for the accuracy of the vector autoregression models and impulse-response functions (Ivanov and Kilian, 2005) but at the same time the number of lags chosen by the existent lag choice criteria (Schwarz Information Criterion (SIC), Hannan-Quinn Information Criterion (HQC) and Akaike Information Criterion (AIC), among others.) can be somehow contradictory. In the literature using quarterly data, four lags are usually chosen (see for instance Balke, 2000; Blanchard and Perotti, 2002; Caldara and Kamps, 2008; Ilzetzki et al., 2013; González-García et al., 2013; and Karagyozova-Markova et al., 2013; among others), however such practice does not take into consideration the specificities of the data used by the researcher. In this paper, we follow a more “statistically based” approach to choose the number of lags included in our models, finding quite significant differences in the results depending on the number of lags chosen, and even autocorrelation in the residuals when choosing four lags.

When using vector autoregression models the lag selection process first considers choosing the maximum number of lags, which depends on the data frequency. For quarterly data, the maximum number of lags is normally four.[12] Usually, the lag selection information criteria give different answers to the question of what lag length should be chosen. For vector autoregression models with quarterly data Ivanov and Kilian (2005) recommend following the SIC if the sample size is smaller than one hundred and twenty (our sample includes one hundred and twelve quarters) and the HQC if it is bigger than one hundred and twenty. Ivanov and Kilian (2005) also find that AIC is less accurate than SIC and HQC when using quarterly data, hence this paper’s first best criterion is the SIC, followed by the HQC and then by the AIC. Last, we search for autocorrelation in the models’ residuals, modifying the lag length if evidence of autocorrelation is found.[13]

[12] The lag order obtained with sequential testing or with information criteria depends on the choice of the maximum number of lags (Lütkepohl, 2011).
[13] We use a serial correlation LM test at 99% of statistical significance.

3.2 Analytical Approaches

In the empirical literature studying the dynamic effects of fiscal policy and fiscal multipliers, three main approaches are used: (i) the estimations based on vector autoregression models; (ii) structural model-based evaluations as dynamic stochastic general equilibrium models (DSGE); and (iii) case studies based on well-documented changes in government spending and/or taxes. Among the vector autoregression models, four major strands of research stand out (Jemec et al., 2011.). First, short-term restrictions as the recursive Cholesky decomposition of the variance-covariance matrix of the model's residuals (Fatas and Mihov, 2001). Second, SVAR models based on institutional information coming out of the model (Blanchard and Perotti, 2002). Third, sign restrictions on the variables in the model (Mountford and Uhlig, 2009). And, "event studies" requiring long data series of well-established exogenous shocks (Ramey and Shapiro, 1998).

In this paper, we estimate VAR and TVAR models, with Cholesky decomposition as identification strategy, and a SVAR model using elasticities of government spending and taxes to output and contemporaneous coefficients coming out of the model. We do so because VAR and SVAR models have been used in the literature studying the dynamic effects of fiscal policy and fiscal multipliers in Chile (VAR in Céspedes et al., 2011; and SVAR in Cerda et al., 2005, and Restrepo and Rincón, 2006.), and TVAR models because these are a standard tool in modern applied macroeconomics (Afonso et al., 2011; Baum and Koester, 2011; Batini et al., 2012; Baum et al., 2012; among others.) not yet implemented, as far as we know, to the Chilean case and allowing to incorporate the state of the economy ("tight" and "normal" regimes) as a cause determining dynamic effects of fiscal policy on output and the size and sign of fiscal multipliers.

Vector Autoregression Models

VAR models are dynamic systems of equations that look at the relationship between economic variables, where each variable is explained by its own lags, plus the current and past values of the remaining variables in the system, using very limited assumptions of the underlying structure of the economy, and aiming to offer a good statistical representation of the past interactions between the variables. VAR models have the advantage of being able to characterize any vector of time series under a minimal set of conditions but have the weakness of requiring to estimate an important number of parameters leading to possible imprecision in the coefficients estimated.

VAR models in their reduced-form can be represented as follows:

$$Z_t = \alpha_0 + C(L)Z_{t-1} + U_t \qquad (1)$$

Where "Z_t" is a vector of "k" endogenous variables; "α_0" is a constant, $C(L)$ is an n^{th} – order lag polynomial, and "U_t" is a vector of reduced-form residuals with, $E[U_0] = 0$, $E[U_t U_t'] = \Sigma_U$ and $E[U_t U_s'] = 0$ for $s \neq t$.[14] In the "BP baseline model" and the "Alternative baseline models" of section 4 the vector of endogenous variables, "Z_t", includes: the log of real per capita government spending in differences "dlog G_t", the log of real per capita GDP in differences "dlog Y_t", and the log of real per capita taxes in differences "dlog T_t".[15]

To recover the structural shocks affecting the VAR endogenous variables, we use Cholesky decomposition as identification strategy. In the "BP baseline model" and the "Alternative baseline models" of section 4 the variables are ordered starting with the log of real per capita government spending in differences "dlog G_t", then the log of real per capita output in differences "dlog Y_t", and last the log of real per capita taxes in differences "dlog T_t", this in line with Fatas and Mihov (2001), Caldara and Kamps (2008), Batini et al. (2012), Caldara and Kamps (2017), and much of the recent literature (Batini et al., 2012).[16] For robustness purpose, we use alternative orderings presenting other results in the Appendix of this paper. The ordering we chose implies that: (i) government spending does not react contemporaneously to shocks either to output nor taxes; (ii) output is affected contemporaneously by government spending but not by tax shocks; and (iii) taxes respond contemporaneously to government spending and output shocks. To prove this ordering we can argue that government spending, unlike movements in taxes, are largely unrelated to the

[14] Trends and dummy variables, could also be added to the VAR model represented by Equation (1).
[15] The exception is the VAR model following Céspedes et al. (2011) government spending definition, as it does not study taxes, so it only includes government spending and output.
[16] For a detail discussion of this issue see Caldara and Kamps (2008) and Caldara and Kamps (2017).

business cycle, and that output goes before taxes because a shock to output has an immediate impact on the tax base, thus having a contemporaneous effect on tax receipts (Caldara and Kamps, 2008).

Structural Vector Autoregression Models

SVAR models are also dynamic systems of equations intending to show the relationships among economic variables, but they also include elements from the more structural and traditional macroeconomic models. These models are not difficult to carry out and do not need extensive data gathering but small changes in the coefficients coming out of the model might lead to very different results. In the case of the dynamic effects of fiscal policy on output, small changes in the elasticities of government spending and taxes to output might result in large differences in the impulse-response functions and fiscal multipliers (Ramey, 2011).

Starting from the VAR model in its reduced-form (equation 1), the reduced-form residuals "U_t" can be written as linear combinations of the underlying structural innovations "e_t" as follows:

$$AU_t = Be_t \tag{2}$$

Where matrices "A" and "B" describe the instantaneous relationship between the reduced and the structural innovations and $E(e_t e_t') = I$, i.e. the covariance matrix of the structural innovations is assumed to be an identity matrix. Thus, the structural-form VAR can be obtained by pre-multiplying the reduced-form model (equation 1) by the matrix A:

$$AZ_t = A\alpha_0 + AC(L)Z_{t-1} + Be_t \tag{3}$$

In this case the vector of endogenous variables "Z_t" includes "dlog T_t", "dlog G_t", and "dlog Y_t"; the vector of reduced-form residuals "U_t", to $U_t = [t_t, g_t, y_t]$; and the identification strategy and variables ordering follows Blanchard and Perotti (2002), Cerda et al. (2005), and Restrepo and Rincón (2006). Thus, equation (4) states that unexpected movements in taxes "t_t", can be due to three factors: the response to unexpected movements in output "y_t", the response to structural shocks to government spending "e_t^g", and to structural shocks to taxes "e_t^t". A similar interpretation applies for unexpected movements in government spending "g_t", represented by equation (5). The unexpected movements in output "y_t", can be due to unexpected movements in taxes "t_t", to unexpected movements in government spending "g_t" and to other unexpected shocks to output "e_t^y", equation (6).

$$t_t = a_1 y_t + a_2 e_t^g + e_t^t \tag{4}$$

$$g_t = b_1 y_t + b_2 e_t^t + e_t^g \tag{5}$$

$$y_t = c_1 t_t + c_2 g_t \; + e_t^y \tag{6}$$

The task of identifying the structural shocks is equivalent to find a linear relationship between the reduced-form residuals, "U_t", and the uncorrelated structural shocks, "e_t" (Franta, 2012). As the reduced-form residuals are a linear combination of the structural shocks, $U_t = A^{-1} B e_t$, they can be represented by equation (7).[17]

$$\begin{bmatrix} t_t \\ g_t \\ y_t \end{bmatrix} = \begin{bmatrix} 1 & 0 & -a_1 \\ 0 & 1 & -b_1 \\ -c_1 & -c_2 & 1 \end{bmatrix}^{-1} \begin{bmatrix} 1 & a_2 & 0 \\ b_2 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e_t^t \\ e_t^g \\ e_t^y \end{bmatrix} \tag{7}$$

With: $U_t = \begin{bmatrix} t_t \\ g_t \\ y_t \end{bmatrix}$; $A = \begin{bmatrix} 1 & 0 & -a_1 \\ 0 & 1 & -b_1 \\ -c_1 & -c_2 & 1 \end{bmatrix}$; $B = \begin{bmatrix} 1 & a_2 & 0 \\ b_2 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$; and $e_t = \begin{bmatrix} e_t^t \\ e_t^g \\ e_t^y \end{bmatrix}$

The elements of the matrix A can be interpreted as elasticities that capture the immediate effect that a change in one variable has on another variable, while the elements of the matrix B represent the immediate effect of a structural shock on a variable.

[17] In equation (7), for simplicity, we have omitted the endogenous variables lags. For an explanation that includes the treatment of a first-order SVAR see Restrepo and Rincón (2006).

To identify the system of equations, represented by equation (7), information about the elasticities of government spending and taxes to output, "a_1" and "b_1", and the effects of taxes and government spending on output, "c_1" and "c_2", need to be estimated out of the model. In this paper, we use the elasticities of government spending and taxes to output and the contemporaneous coefficients produced in Restrepo and Rincón (2006) (Table 2).[18] Such procedure leaves two coefficients to estimate, "a_2" and "b_2". As we do not have a clear idea if government spending decisions come before tax decisions, or vice versa, we follow Blanchard and Perotti (2002) assuming that tax decisions come before the government spending decisions, meaning that $a_2 = 0$ and estimating "b_2", and alternatively that government spending decisions come first so that $b_2 = 0$ leaving to estimate "a_2".

Table 2. Elasticities of Government Spending and Taxes to Output and Contemporaneous Coefficients

	a_1	b_1	c_1	c_2
Restrepo and Rincón (2006)	3.03	0.00	-0.034	0.165

Threshold Vector Autoregression Models

TVAR models are nonlinear vector autoregression models capable to separate observations into different regimes depending on a threshold, where the models are linear within each regime (International Monetary Fund, 2012). In these models, parameters are allowed to switch depending on whether the "threshold variable" crosses or not an estimated threshold. In recent years TVAR models have become increasingly popular as these are capable to overcome the problem of nonlinearity among variables that traditional linear vector autoregression models cannot deal with.[19] Nevertheless, in spite of their advantage over linear vector autoregression models, TVAR

[18] We do not calculate government spending and taxes to output elasticities and contemporaneous coefficients to avoid an extra source of differences in the impulse-response functions and fiscal multipliers we estimate using an SVAR model, though that could also be done.
[19] Alternative approaches modeling nonlinear dynamic relationships are Markov switching vector autoregression models (MSVAR).

models have the drawback of potential arbitrariness in the threshold selection (Riera-Crichton et al., 2014).

TVAR models can be expressed as follows:

$$W_t = I_{\{c_{t-d<\gamma}\}}[B^1 Z_t + F^1(L)Z_{t-1}] + I_{\{c_{t-d\geq\gamma}\}}[B^2 Z_t + F^2(L)Z_{t-1}] + \varepsilon_t \qquad (8)$$

Where "Z_t" is a vector of endogenous variables. In this paper meanwhile, the "TVAR baseline model" of section 5 includes "dlog G_t", "dlog Y_t", and "dlog T_t", the "TVAR extended model" of section 6, building on the "TVAR baseline model", includes "di_t" as well. In this paper "dlog Y_t", the GDP growth, is both an endogenous and the threshold variable.

Consequently, B^1 and B^2 represent the structural contemporaneous relationships in the two regimes we study, "normal" and "tight", $F^1(L)$ and $F^2(L)$ are lag polynomial matrices, and ε_t are structural disturbances. "c_{t-d}" represents the threshold determining which regime the system is in. $I_{\{\ \}}$ is an indicator function that equals one when $c_{t-d>\gamma}$ and zero otherwise. Following Balke (2000), Afonso et al. (2011) and Batini et al. (2012), among others, we set "$d = 1$" because we need at least one lag of the threshold variable to recursively feed the TVAR and as our interest is in the response to fiscal shocks when a regime switch has just occurred (Batini et al., 2012).

The setting described by equation (8) implies that we deal with two alternative regimes governing the dynamics of the TVAR, "normal" and "tight".

Identification is achieved through Cholesky decomposition. The variables ordering in the "TVAR baseline model" of section 5 considers "dlog G_t" first, "dlog Y_t" second, and "dlog T_t" last. The "TVAR extended model" of section 6 follows the ordering of the variables in the "TVAR baseline model" with the exception that "dlog T_t" goes third and "di_t" is placed last as Batini et al. (2012) do. Finally, to allow comparability with section 4 results, the number of lags included is also 2. For robustness we estimate the "TVAR baseline model" and the "TVAR extended model" following alternative variable ordering (results in Appendices G and H).

3.3 Fiscal Multipliers

To check the dynamic effects of fiscal policy on the output, we estimate VAR, SVAR, and TVAR models, obtaining impulse-response functions and computing fiscal multipliers of government spending and taxes.

Aware of the existence of alternative ways to compute fiscal multipliers, in this paper we follow the definition in Spilimbergo et al. (2009), meaning the ratio of a change in output to an exogenous change in government spending or taxes, with respect to their respective baselines (as Batini et al. (2012), González-García et al. (2013), and Ilzetzki et al. (2013), among others).

Hence we compute two alternative multipliers, the impact multiplier (IM) and the cumulative multiplier (CM). Meanwhile, the IM takes into account the effects of fiscal policy on output in the very short-term, and the CM summarizes the total effect that a fiscal policy shock has on output over a certain period. The IMs of government spending (equation 9) and taxes (equation 10) are defined as follows:

$$\text{IM spending} = dY_t / dG_t \tag{9}$$

$$\text{IM taxes} = dY_t / dT_t \tag{10}$$

Where "dY_t" is the change in output followed by a change in government spending, "dG_t", or taxes, "dT_t", in the very short-term (at impact).

Subsequently, the CMs represent the sum effects of government spending and taxes on output at certain time horizon after impact. These are defined as follow:

$$\text{CM spending} = \sum_{j=1}^{N} dY_{t+j} / \sum_{j=1}^{N} dG_{t+j} \tag{11}$$

$$\text{CM taxes} = \sum_{j=1}^{N} dY_{t+j} / \sum_{j=1}^{N} dT_{t+j} \tag{12}$$

Where "dY_{t+j}" is the change in output with respect to the baseline "j" periods after the fiscal shock, and "dG_{t+j}" and "dT_{t+j}" are the changes in government spending and taxes "j" periods after the fiscal shock (Spilimbergo et al., 2009; Batini et al., 2012).

Then, in addition to the IMs of government spending and taxes we also compute the CMs of government spending and taxes after one year, two years and in the long-term, it means when "$N = 4$", "$N = 8$", and "$N = 20$", respectively.[20] In the coming sections we alternatively report government spending and tax multipliers, at impact, after a year, two years and in the long-term.

To compute the IMs and the CMs from the impulse-response functions, we use the following standard transformations (Céspedes et al., 2011; González-García et al., 2013):

$$\text{IM spending} = dY_t/dG_t = d\log Y_t/d\log G_t * \overline{Y}/\overline{G} \tag{13}$$

$$\text{IM taxes} = dY_t/dT_t = d\log Y_t/d\log T_t * \overline{Y}/\overline{T} \tag{14}$$

$$\text{CM spending} = \sum_{j=1}^{N} dY_{t+j} / \sum_{j=1}^{N} dG_{t+j} = \sum_{j=1}^{N} (d\log Y_{t+j} / \sum_{j=1}^{N} d\log G_{t+j}) * \overline{Y}/\overline{G} \tag{15}$$

$$\text{CM taxes} = \sum_{j=1}^{N} dY_{t+j} / \sum_{j=1}^{N} dT_{t+j} = \sum_{j=1}^{N} (d\log Y_{t+j} / \sum_{j=1}^{N} d\log T_{t+j}) * \overline{Y}/\overline{T} \tag{16}$$

4 "BP Baseline Model" and Comparison with the "Alternative Baseline Models"

To respond why the dynamic effects of Chile's fiscal policy on output and the size and sign of fiscal multipliers are not conclusive in the literature using linear vector autoregression models, we analyze the potential sources of differences described in Table 1, meaning, the period of study, the data frequency, the analytical approach, the number of lags, the variables included, and the

[20] The long-term multiplier is defined as the multiplier when "$N \to \infty$" but in practice, after a sufficiently large number of periods the CM reaches a constant level. In this paper, we refer to the long-term multiplier when the CM reaches twenty quarters, i.e.: $N = 20$.

definitions of government spending and taxes. In this section we control for all these differences with the exception of the alternative linear vector autoregression models and the definitions of government spending and taxes, implying that the differences we find following Cerda et al. (2005), Restrepo and Rincón (2006) and Céspedes et al. (2011) are due to these two reasons.

Therefore, we estimate linear vector autoregression models, obtaining impulse-response functions and calculating fiscal multipliers of government spending and taxes using Blanchard and Perotti (2002) definitions of government spending and taxes ("BP baseline model"), to then compare them with those we get following the alternative definitions of government spending and taxes in Cerda et al. (2005), Restrepo and Rincón (2006) and Céspedes et al. (2011), "Alternative baseline models", using VAR (Table 3) and SVAR (Table 4) models.[21] The variables included are "dlog G_t", "dlog Y_t", "dlog T_t" and a constant. The variable ordering in the VAR models considers "dlog G_t" first, "dlog Y_t" second, and "dlog T_t" last. In this sense, we follow the ordering proposed in the literature (Fatas and Mihov, 2001; Caldara and Kamps, 2008; Batini et al., 2012; Caldara and Kamps, 2012; among others). However, as a robustness exercise, we also estimate VAR models with alternative orderings (results are presented in Appendix F).

To decide the number of lags Appendix B reports the AIC, SIC, and HQC criteria, including a maximum of four lags, for the "BP baseline model" and the "Alternative baseline models". When we tested for autocorrelation (Appendix C) we found that the VAR models using the number of lags proposed by the SIC were autocorrelated. This was not the case when using the number of lags recommended by the HQC. Hence, in this section, we include as a benchmark the number of lags suggested by the HQC. In all models but the one using Céspedes et al. (2011) definition of government spending, the number of lags that HQC chooses is two, and SIC chooses one (Appendix B). Last, VAR models using one and two lags satisfy the stability condition, with no root of the characteristic polynomial outside the unit circle (Appendix D). For robustness, the results of the models using the number of lags suggested by the SIC are presented in Appendix E.

[21] "We define expenditure as total purchases of goods and services, i.e. government consumption plus government investment." (Blanchard and Perotti, 2002). In this paper, we call it "government spending". "We define the revenue variable as total tax revenues minus transfers (including interest payments)." (Blanchard and Perotti, 2002). This definition of government revenue is equal to the sum of personal taxes and nontax receipts, corporate profit tax receipts, indirect business taxes and nontax accruals, and contributions for social insurance, less net transfer payments to persons and net interest paid by government". In this paper, we call it "taxes".

Table 3. Government Spending and Tax Multipliers (VAR Model)

VAR model with a constant and the number of lags suggested by the HQC 1/

Government Spending Definition	IM	CM (1 year)	CM (2 years)	CM (long-term)
Blanchard and Perotti (2002)	0.23	0.54	0.54	0.54
Cerda et al. (2005)	0.34	0.85	0.85	0.85
Céspedes et al. (2011) 2/	0.37	1.20	1.20	1.20
Restrepo and Rincón (2006)	0.69	2.21	2.23	2.23

Taxes Definition	IM	CM (1 year)	CM (2 years)	CM (long-term)
Blanchard and Perotti (2002)	0.00	0.03	0.02	0.02
Cerda et al. (2005)	0.00	-0.01	-0.04	-0.04
Restrepo and Rincón (2006)	0.00	0.04	0.04	0.04

Note: Impact multiplier (IM), Cumulative muliplier (CM).

1/ As suggested by the Hannan-Quinn information criterion (HQC) the VAR model include 2 lags for all the "Baseline models" but Céspedes et al. (2011) which includes 1 lag.

2/ The VAR model that follows Céspedes et al. (2011) definitions does not include taxes.

Table 3 displays the government spending and tax multipliers calculated using a VAR model and the alternative definitions of government spending and taxes available in Blanchard and Perotti (2002), Cerda et al. (2005), Restrepo and Rincón (2006) and Céspedes et al. (2011). The government spending multiplier at impact goes from 0.23 (Blanchard and Perotti, 2002 definition) to 0.69 (Restrepo and Rincón, 2006 definition), and in the long-term it is also positive, ranging between 0.54 (Blanchard and Perotti, 2002 definition) to 2.23 (Restrepo and Rincón, 2006 definition). Yet different, all government spending multipliers are positive at impact, and around the unit in the long-term (except to Restrepo and Rincón, 2006 definition). In contrast, the tax multiplier by definition (Cholesky decomposition identification strategy assumes that taxes affect contemporaneously neither government spending nor output during the first period) is null at impact, while in the long-term it is about zero in all cases (Blanchard and Perotti, 2002 definition, 0.02; Cerda et al., 2005 definition, -0.04; and Restrepo and Rincón, 2006 definition, 0.04).

In short, using the same quarterly data and a VAR model including the government spending, taxes and output as endogenous variables (hence, we do not consider Céspedes et al., 2011 definition), we found that independent of the fiscal variable definitions: (i) the government spending multiplier is slightly positive at impact and around the unit in the long-term (the exceptions is Restrepo and Rincón, 2006 definition) and (ii) the tax multiplier is null at impact (because of Cholesky decomposition) and around zero in the long-term.[22]

Hereafter we do not calculate fiscal multipliers following Céspedes et al. (2011) definition of government spending as we want to keep this paper within the fiscal multipliers tradition where vector autoregression models include government spending, output and taxes (Fatas and Mihov, 2001; Blanchard and Perotti, 2002; among many others).

[22] Appendix E presents the government spending and tax multipliers using alternative VAR models, meaning: A VAR model that does not include a constant but considers the number of lags suggested by the HQC, with results more positive than those in Table 3; and a VAR model with a constant and the number of lags suggested by the SIC, which also finds positive government spending multipliers at impact and in the long-term but instead slightly positive (not null) tax multipliers in the long-term. This suggests that the VAR model multipliers are sensitive to the inclusion of a constant or not, and that tax multipliers sign and size might be sensible to the number of lags selected.
Appendix F presents the government spending and tax multipliers using alternative variables ordering. First, we report a model with the variables following the ordering, taxes first, government spending then, and output last; and second we have a model where government spending is placed first, followed by taxes, and output last. Compared to the fiscal multipliers in Table 3 those in Appendix F are alike when we observe the size and sign of government spending multipliers, about 0.5 at impact and the unit in the long-term. Nevertheless, a difference appears when comparing the tax multipliers, while in Table 3 these are about null those in Appendix F are slightly positive at impact and about 0.5 in the long-term.

Table 4. Government Spending and Tax Multipliers (SVAR Model)

SVAR model with a constant and the number of lags suggested by the HQC 1/

Government Spending Definition	Coefficients	IM	CM (1 year)	CM (2 years)	CM (long-term)
Blanchard and Perotti (2002)	2/	0.75	2.35	2.23	2.26
	3/	0.85	2.76	2.75	2.77
Cerda et al. (2005)	2/	0.75	2.34	2.17	2.18
	3/	0.83	2.71	2.58	2.60
Restrepo and Rincón (2006)	2/	1.90	5.98	5.73	5.75
	3/	2.02	6.46	6.22	6.27

Taxes Definition	Coefficients	IM	CM (1 year)	CM (2 years)	CM (long-term)
Blanchard and Perotti (2002)	2/	-0.26	-0.90	-1.03	-1.02
	3/	-0.16	-0.52	-0.62	-0.61
Cerda et al. (2005)	2/	-0.31	-0.95	-1.02	-1.02
	3/	-0.21	-0.65	-0.72	-0.72
Restrepo and Rincón (2006)	2/	-0.33	-0.95	-0.98	-0.99
	3/	-0.21	-0.54	-0.56	-0.56

Note: Impact multiplier (IM), Cumulative multiplier (CM).

1/ The SVAR model includes a constant and the number of lags suggested by the Hannan-Quinn information criterion (HQC), i.e. 2 lags.

2/ Restrepo and Rincón (2006) coefficients: $a_1 = 3.03$; $b_1 = 0$; $c_1 = -0.034$; $c_2 = 0.165$; $a_2 = 0$ (Taxes decisions come before government spending decisions).

3/ Restrepo and Rincón (2006) coefficients: $a_1 = 3.03$; $b_1 = 0$; $c_1 = -0.034$; $c_2 = 0.165$; $b_2 = 0$ (Government spending decisions come before taxes decisions).

In Table 4 we present the fiscal multipliers of government spending and taxes using a SVAR model with constant and the number of lags suggested by HQC, i.e. 2 lags. The elasticities of government spending and taxes to output and the contemporaneous coefficients we use to estimate the SVAR model are sourced by Restrepo and Rincón (2006). The results we found for government spending and tax multipliers differ depending on the definition used, and are in general bigger, in absolute terms than those obtained using a VAR model (Table 3). Meanwhile government spending multipliers at impact are all about the unit, ranging between 0.75 (Blanchard and Perotti, 2002; and Cerda et al., 2005 definitions) to 2.02 (Restrepo and Rincón, 2006 definition), in the long-term they are higher than one, on one extreme 2.18 (Cerda et al., 2011 definition) and on the other 6.27 (Restrepo and Rincón, 2006 definition). Tax multipliers are all negative, close to -0.2 at impact and ranging between -0.56 and -1.02 in the long-term. These results suggest that when using a SVAR model the fiscal multipliers sign and size seem very sensitive to the definitions of government spending and taxes, to the elasticities of government and taxes to output, and to the contemporaneous coefficients estimated out of the model. Hence, it seems that Ramey's (2011) critique of SVAR model applies to the case of Chile.

In summary, Tables 3 and 4 show that: (i) Fiscal multipliers differ when using alternative definitions of government spending and taxes; (ii) Fiscal multipliers size greatly differs depending on the vector autoregression model used (VAR and SVAR); (iii) VAR results are more in line with the findings in the international evidence compared to SVAR results, with government spending multipliers around 0.3 at impact and 0.5 in the long-term, and tax multipliers slightly negative or very close to zero in the long-term (Spilimbergo et al., 2009).

5 TVAR Baseline Model

In this section, we present and discuss the results of estimating the "TVAR baseline model". To do so we closely follow Batini et al. (2012), using the method originally developed by Balke (2000), estimating a TVAR model that changes its structure according to the GDP growth (our threshold variable), obtaining regime dependent impulse-response functions and hence fiscal multipliers in "normal" and "tight" regimes. The "TVAR baseline model" includes the three endogenous variables defined in section 3 and used in section 4, meaning "dlog G_t", "dlog Y_t" and "dlog T_t". Identification is achieved through Cholesky decomposition, with "dlog G_t" ordered first, followed by "dlog Y_t", and last "dlog T_t". For robustness purpose, estimations with alternative variable orderings are presented in Appendix G. The "TVAR baseline model" includes a constant and two lags allowing comparison with the VAR model results of section 4. We set the parameter describing the delay of the threshold variable, "d", equal to one as our interest is in the response to fiscal shocks when a regime switch has just occurred. In this sense, we follow the studies by Balke (2000), Calza and Souza (2006), Afonso et al. (2011), and Batini et al. (2012). The critical value estimated as threshold sets a GDP growth rate equal to 1.13%, which we use to split our sample in the "normal" (above 1.13% GDP growth) and the "tight" (below 1.13% GDP growth) regimes.

Table 5. Government Spending and Tax Multipliers (TVAR Baseline Model)

TVAR model with constant and the number of lags suggested by the HQC 1/

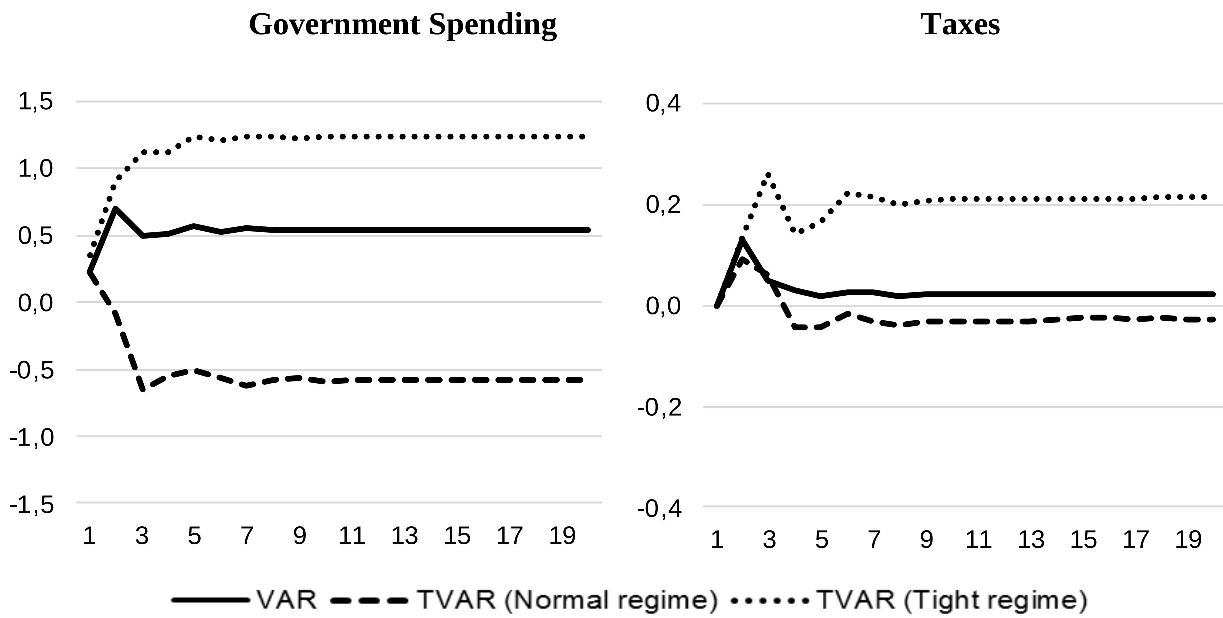
	Regime	IM	CM (1 year)	CM (2 years)	CM (long-term)
Government Spending	Tight	0.35	1.12	1.24	1.23
	Normal	0.22	-0.55	-0.58	-0.57
Taxes	Tight	0.00	0.14	0.20	0.21
	Normal	0.00	-0.04	-0.04	-0.03

Note: Impact multiplier (IM), Cumulative multiplier (CM).

1/ As suggested by the Hannan-Quinn information criterion (HQC) the "TVAR BP baseline model" include 2 lags.

Table 5 presents the "TVAR baseline model" results. As expected both fiscal multipliers (government spending and taxes) differ depending on whether the Chilean economy is in the "normal" or in the "tight" regime. Meanwhile, the government spending multiplier at impact is positive and about 0.3 in both regimes, the cumulative multiplier differs substantially, being above one (1.23) when the economy is in the "tight" regime and negative (-0.57) when the economy is in the "normal" regime. These results suggest that government spending seems effective to boost the Chilean economy when the GDP growth rate is below 1.13% and ineffective when the opposite occurs. Likewise in the VAR model of section 4 tax multipliers in the "normal" and the "tight" regimes are zero at impact, as we assume that tax multipliers do not affect contemporaneously neither government spending nor output, though in the long-term cumulative tax multipliers differ, being slightly positive in the "tight" regime (0.23) and about null in the "normal" regime (-0.03). Then if the goal is to boost the Chilean economy, taxes seem not being as effective as government spending.

Figure 1. Government Spending and Tax Multipliers (VAR and TVAR Baseline Models)



Subsequently, Figure 1 presents the government spending and tax multipliers dynamics for the VAR and TVAR baseline models. Regarding the government spending multiplier, as previously highlighted, it is above 1 in the "tight" regime, about 0.5 in the VAR model and about -0.5 in the "normal" regime. Whereas, the tax multipliers are not that different to zero in the three cases (VAR, TVAR in the "tight" regime, and TVAR in the "normal" regime).

In summary, Table 5 and Figure 1 show that: (i) Fiscal multipliers and therefore fiscal policy effectiveness differ depending if the economy is in the "normal" or in the "tight" regime, this in line with the international literature where fiscal policy seems to have different effects depending on the state of the economy; (ii) TVAR model results confirm that the dynamic effects of Chile's fiscal policy are nonlinear, with fiscal multipliers, particularly government spending multipliers, being positive and above the unit in the "tight" regime and negative and about -0.5 in the "normal" regime; and (iii) TVAR taxes multipliers in the long-term are about zero.

6 TVAR Extended Model

The literature studying the dynamic effects of fiscal policy and fiscal multipliers in occasions includes other variables than government spending, taxes and output, to investigate possible interactions between fiscal and other macroeconomic variables. In this sense, evidence on the interaction between fiscal and monetary policies, as a determinant of the effects of fiscal policy on output (Ahrend et al, 2006; Spilimbergo et al., 2009; Canova and Pappa, 2011; Batini et al., 2012; and Ilzetzki et al., 2013), relates the monetary policy stance with the size and sign of fiscal multipliers.

Building on the "TVAR baseline model" of section 5, this section estimates a model that also includes the short-term (monetary policy) interest rate to take into account possible interactions between the Chilean fiscal and monetary policies, and to study the effects of the monetary policy interest rate on the size and sign of fiscal multipliers.[23] We called this model "TVAR extended model". It includes four variables: government spending, taxes, output and the short-term (monetary policy) interest rate. The model changes its structure depending on the GDP growth rate (our threshold variable) into two regimes, "normal" and "tight". The ordering of the variables included in the model is the following: first "dlog G_t", then "dlog Y_t", "dlog T_t", and "di_t" last. This ordering follows Batini et al. (2012) and identification is achieved through Cholesky decomposition. Nevertheless for robustness purpose, alternative orderings are examined in Appendix H. Finally, the "TVAR extended model" includes a constant and 2 lags to allow comparability with the fiscal multipliers presented in Table 5 and Figure 1.

[23] We include the short-term (monetary policy) interest rate because the notion that monetary accommodation plays an important role in the expansionary effect of fiscal policy, that turns out to be related to those studies showing that fiscal multipliers are larger when central banks' policy interest rate is at the zero lower bound.

Table 6. Government Spending and Tax Multipliers (TVAR Extended Model)
TVAR model with a constant and the number of lags suggested by the HQC 1/

	Regime	IM	CM (1 year)	CM (2 years)	CM (long-term)
Government Spending	Tight	0.33	1.07	0.99	0.99
	Normal	0.13	-0.88	-0.77	-0.78
Taxes	Tight	0.00	-0.12	-0.18	-0.16
	Normal	0.00	-0.14	-0.22	-0.20

Note: Impact multiplier (IM), Cumulative multiplier (CM).
1/ As suggested by the Hannan-Quinn information criterion (HQC) the "TVAR extended model" include 2 lags.

Table 6 presents the "TVAR extended model" government spending and tax multipliers. The results show that government spending multipliers at impact are similar, about 0.1 in the "normal" regime and 0.3 in the "tight" regime. However, in the long-term meanwhile the government spending multiplier in the "tight" regime is about one, it is about -0.8 in the "normal" regime. Regarding the tax multiplier, it is zero at impact (Cholesky decomposition assumption to achieve identification) and about -0.2 in the long-term in both regimes. Comparing the fiscal multipliers from the "TVAR extended model" (Table 6) and the "TVAR baseline model" (Table 5) we see that those including the short-term (monetary policy) interest rate ("TVAR extended model") are smaller than those not including it. This finding suggests that monetary policy seems to make fiscal policy less effective to boost the Chilean output.

Figure 2. Government Spending and Tax Multipliers (TVAR Baseline Model and TVAR Extended Model)

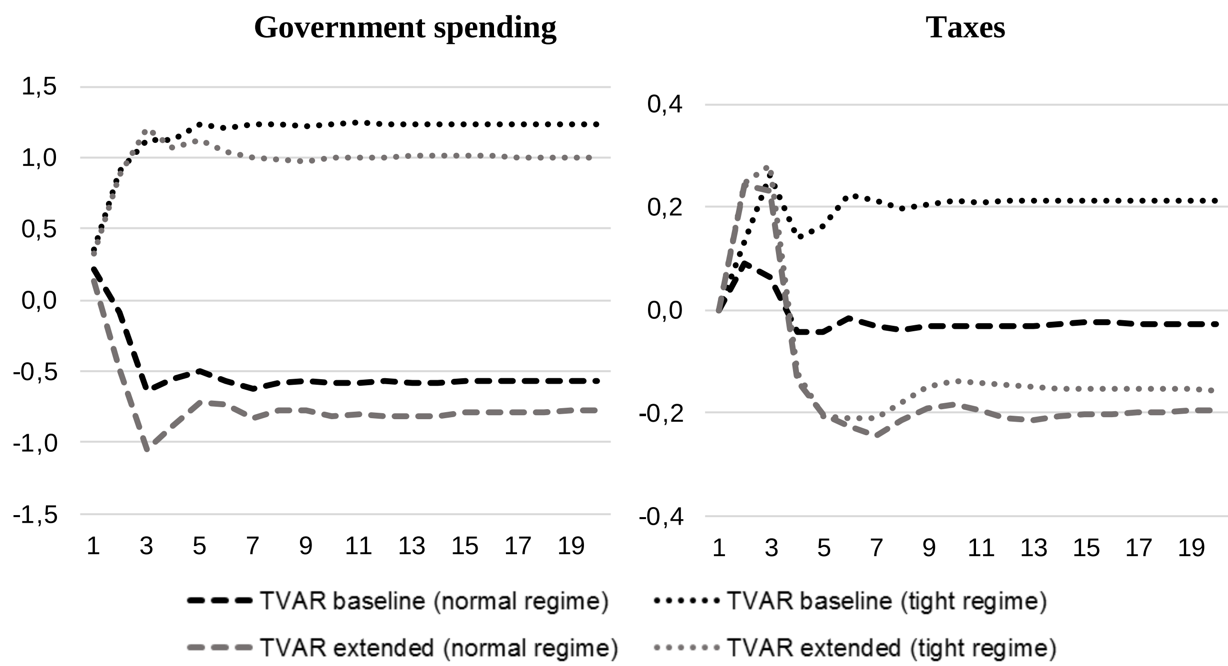


Figure 2 displays the "TVAR baseline model" and "TVAR extended model" dynamics of the government spending and tax multipliers. We see that independent of the regime in which the Chilean economy is in, the government spending multipliers are smaller when the short-term (monetary policy) interest rate is taken into account ("TVAR extended model") compared to when it is not included ("TVAR baseline model"). On its hand, tax multipliers are zero at impact and smaller when estimated using the "TVAR extended model" *vis-à-vis* to using the "TVAR baseline model". Overall smaller government spending and tax multipliers evidence some pressure of fiscal policy on inflation, and therefore on the short-term (monetary policy) interest rate, making monetary policy accommodative to the circumstances. Hence, we found that when the short-term (monetary policy) interest rate is taken into account, government spending and tax multipliers are smaller than those when it is not the case.

7 Conclusions

In this paper, we estimate linear and non-linear vector autoregression models (VAR, SVAR and TVAR) and calculate fiscal multipliers (government spending and taxes) for Chile using quarterly data, alternative definitions of government spending and taxes, and different number of endogenous variables (government spending, taxes, GDP, and short-term (monetary policy) interest rate).

The results we obtained from the linear vector autoregression models, “BP baseline model” and the “Alternative baseline models”, which include government spending, taxes and output as endogenous variables and different definitions of government spending and taxes, not only vary because of the identification strategy and model used, but also because of the definition of government spending and taxes followed. Hence we find that: (i) government spending multipliers are positive at impact and different in size in the long-term depending on the model used; (ii) tax multipliers at impact are null when Cholesky decomposition is the identification strategy (VAR models) and negative when a SVAR model is estimated; and (iii) tax multipliers are null or negative in the long-term, depending on the model used.

The first non-linear vector autoregression model, “TVAR baseline model”, we estimate defines two alternative regimes, “tight” or “normal”, the Chilean economy finds a government spending multiplier in the long-term, negative in the “normal” regime, about -0.5, and a positive and above the unit in the “tight” regime. Tax multipliers in the long-term are about zero in both regimes. On its hand, the “TVAR extended model” finds fiscal multipliers smaller when considering monetary policy, compared to those from the “TVAR baseline model”. This indicates that when fiscal policy has put pressure on prices, monetary policy has played an accommodative role.

Possible avenues for future research might include the estimation of fiscal multipliers using alternative nonlinear models such as MSVAR and the use of different threshold variables, for instance the output gap.

A. Unit Root Tests 1/

Variables in levels 2/

		Augmented Dickey-Fuller 3/	Phillips-Perron 4/	Elliot-Rothenberg-Stock 5/
GDP	Evidence of unit root	Yes	Yes	Yes
	t-statistic	-2.207964	-1.985766	-2.237923
	critical value 1%	-4.045236	-4.044415	-3.570400
	critical value 5%	-3.451959	-3.451568	-3.022000
	critical value 10%	-3.151440	-3.151211	-2.732000
Blanchard and Perotti (2002)				
Government Spending	Evidence of unit root	Yes	Yes	Yes
	t-statistic	-2.262152	-3.178805	-2.247576
	critical value 1%	-4.045236	-4.044415	-3.570400
	critical value 5%	-3.451959	-3.451568	-3.022000
	critical value 10%	-3.151440	-3.151211	-2.732000
Taxes	Evidence of unit root	No	No	No
	t-statistic	-3.636398	-3.598085	-3.196233
	critical value 1%	-4.044415	-4.044415	-3.569200
	critical value 5%	-3.451568	-3.451568	-3.021000
	critical value 10%	-3.151211	-3.151211	-2.731000
Cerda et al. (2005)				
Government Spending	Evidence of unit root	Yes	Yes	Yes
	t-statistic	-2.262152	-3.178805	-2.247576
	critical value 1%	-4.045236	-4.044415	-3.570400
	critical value 5%	-3.451959	-3.451568	-3.022000
	critical value 10%	-3.151440	-3.151211	-2.732000
Taxes	Evidence of unit root	No	No	No
	t-statistic	-3.896134	-3.861958	-3.382209
	critical value 1%	-4.044415	-4.044415	-3.569200
	critical value 5%	-3.451568	-3.451568	-3.021000
	critical value 10%	-3.151211	-3.151211	-2.731000
Céspedes et al. (2011)				
Government Spending	Evidence of unit root	Yes	Yes	Yes
	t-statistic	-2.006822	-3.357810	-1.885565
	critical value 1%	-4.046072	-4.044415	-3.571600
	critical value 5%	-3.452358	-3.451568	-3.023000
	critical value 10%	-3.151673	-3.151211	-2.733000
Restrepo and Rincón (2006)				
Government Spending	Evidence of unit root	Yes	Yes	Yes
	t-statistic	-2.284713	-2.640380	-2.151950
	critical value 1%	-4.045236	-4.044415	-3.570400
	critical value 5%	-3.451959	-3.451568	-3.022000
	critical value 10%	-3.151440	-3.151211	-2.732000
Taxes	Evidence of unit root	No	No	No
	t-statistic	-3.896134	-3.861958	-3.382209
	critical value 1%	-4.044415	-4.044415	-3.569200
	critical value 5%	-3.451568	-3.451568	-3.021000
	critical value 10%	-3.151211	-3.151211	-2.731000

1/ "No" indicates absence of evidence of unit root at 95 percent of statistical confidence, and "Yes" indicates evidence of unit root also at 95 percent of statistical confidence.

2/ After data inspection we decided to apply the unit root tests with intercept and trend.

3/ The null hypothesis indicates that the selected variable has a unit root. The t-statistic has been compared to the 5% critical value.

4/ The null hypothesis indicates that the selected variable has a unit root. The t-statistic has been compared to the 5% critical value.

5/ The null hypothesis indicates that the selected variable has a unit root. The t-statistic has been compared to the 5% critical value.

A. **Unit Root Tests (Cont.) 1/**

Variables in differences 2/

		Augmented Dickey-Fuller 3/	Phillips-Perron 4/	Elliot-Rothenberg-Stock 5/
GDP	Evidence of unit root	No	No	No
	t-statistic	-5.558223	-5.630116	-4.690385
	critical value 1%	-2.586550	-2.586550	-2.586550
	critical value 5%	-1.943824	-1.943824	-1.943824
	critical value 10%	-1.614767	-1.614767	-1.614767
Blanchard and Perotti (2002)				
Government Spending	Evidence of unit root	Yes	No	Yes
	t-statistic	-1.512365	-13.05172	-1.373766
	critical value 1%	-2.587831	-2.586550	-2.587831
	critical value 5%	-1.944006	-1.943824	-1.944006
	critical value 10%	-1.614656	-1.614767	-1.614656
Taxes	Evidence of unit root	No	No	No
	t-statistic	-12.49727	-12.48955	-3.038611
	critical value 1%	-2.586550	-2.586550	-2.586960
	critical value 5%	-1.943824	-1.943824	-1.943882
	critical value 10%	-1.614767	-1.614767	-1.614731
Cerda *et al.* (2005)				
Government Spending	Evidence of unit root	Yes	No	Yes
	t-statistic	-1.512365	-13.05172	-1.373766
	critical value 1%	-2.587831	-2.586550	-2.587831
	critical value 5%	-1.944006	-1.943824	-1.944006
	critical value 10%	-1.614656	-1.614767	-1.614656
Taxes	Evidence of unit root	No	No	No
	t-statistic	-11.37126	-11.38801	-11.34355
	critical value 1%	-2.586550	-2.586550	-2.586550
	critical value 5%	-1.943824	-1.943824	-1.943824
	critical value 10%	-1.614767	-1.614767	-1.614767
Céspedes *et al.* (2011)				
Government Spending	Evidence of unit root	No	No	Yes
	t-statistic	-10.72421	-17.76331	-1.000980
	critical value 1%	-2.586753	-3.491928	-2.587831
	critical value 5%	-1.943853	-2.888411	-1.944006
	critical value 10%	-1.614749	-2.581176	-1.614656
Restrepo and Rincón (2006)				
Government Spending	Evidence of unit root	No	No	Yes
	t-statistic	-13.99693	-13.86455	-0.955048
	critical value 1%	-2.586550	-2.586550	-2.587831
	critical value 5%	-1.943824	-1.943824	-1.944006
	critical value 10%	-1.614767	-1.614767	-1.614656
Taxes	Evidence of unit root	No	No	No
	t-statistic	-11.37126	-11.38801	-11.34355
	critical value 1%	-2.586550	-2.586550	-2.586550
	critical value 5%	-1.943824	-1.943824	-1.943824
	critical value 10%	-1.614767	-1.614767	-1.614767

1/ "No" indicates absence of evidence of unit root at 95 percent of statistical confidence, and "Yes" indicates evidence of unit root also at 95 percent of statistical confidence.

2/ After data inspection we decided to apply the unit root tests without intercept nor trend.

3/ The null hypothesis indicates that the selected variable has a unit root. The t-statistic has been compared to the 5% critical value.

4/ The null hypothesis indicates that the selected variable has a unit root. The t-statistic has been compared to the 5% critical value.

5/ The null hypothesis indicates that the selected variable has a unit root. The t-statistic has been compared to the 5% critical value.

A. Unit Root Tests (Cont.) 1/

The monetary policy interest rate

Short-term Interest Rate		Augmented Dickey-Fuller 2/	Phillips-Perron 3/	Elliot-Rothenberg-Stock 4/
Percentage	Evidence of unit root	No	Yes	Yes
	t-statistic	-3.717362	-2.849870	-1.374539
	critical value 1%	-3.491928	-3.491345	-2.586753
	critical value 5%	-2.888411	-2.888157	-1.943853
	critical value 10%	-2.581176	-2.581041	-1.614749
d(percentage)	Evidence of unit root	No	No	No
	t-statistic	-6.837439	-5.597866	-6.865863
	critical value 1%	-2.586753	-2.586550	-2.586753
	critical value 5%	-1.943853	-1.943824	-1.943853
	critical value 10%	-1.614749	-1.614767	-1.614749

1/ "No" indicates absence of evidence of unit root at 95 percent of statistical confidence, and "Yes" indicates evidence of unit root also at 95 percent of statistical confidence.

2/ The null hypothesis indicates that the selected variable has a unit root. The t-statistic has been compared to the 5% critical value.

3/ The null hypothesis indicates that the selected variable has a unit root. The t-statistic has been compared to the 5% critical value.

4/ The null hypothesis indicates that the selected variable has a unit root. The t-statistic has been compared to the 5% critical value.

B. Lag Order Selection Criteria (VAR Model with constant)

Endogenous variables: "dlog Gt" "dlog Yt" "dlog Tt"
Maximum number of lags: 4

Blanchard and Perotti (2002) 1/	AIC	SIC	HQC
0	11.23262	11.30845	11.26335
1	10.71275	11.01606*	10.83565
2	10.60675*	11.13754	10.82184*
3	10.64288	11.40116	10.95015
4	10.65844	11.64420	11.05789

Cerda et al. (2005) 1/	AIC	SIC	HQC
0	11.15217	11.22799	11.18289
1	10.60349	10.90680*	10.72640
2	10.41614	10.94693	10.63123*
3	10.41258*	11.17085	10.71985
4	10.42163	11.40739	10.82108

Céspedes et al. (2011) 1/	AIC	SIC	HQC
0	8.013638	8.064190	8.034123
1	7.662848	7.814503*	7.724302*
2	7.660545*	7.913303	7.762967
3	7.695353	8.049214	7.838745
4	7.716982	8.171947	7.901343

Restrepo and Rincón (2006) 1/	AIC	SIC	HQC
0	11.81154	11.88736	11.84226
1	11.41573	11.71904*	11.53863
2	11.27701*	11.80781	11.49210*
3	11.31758	12.07586	11.62485
4	11.32462	12.31038	11.72407

1/ Number of lags.
* Indicates lag order selected by the criterion.
AIC: Akaike information criterion.
SIC: Schwarz information criterion.
HQC: Hannan-Quinn information criterion.

C. VAR Residual Serial Correlation LM Test (VAR Model with constant)

Null Hypothesis: No serial correlation at lag order h

Blanchard and Perotti (2002)	Lag order h	LM-Stat	Prob	
VAR(1) SIC	1	26.91286	0.0014	Rejects Null Hypothesis at 1%
VAR(2) AIC and HQC *	1	18.55348	0.0293	Cannot reject Null Hypothesis at 1%
	2	21.88611	0.0092	Rejects Null Hypothesis at 1%

Cerda et al. (2005)	Lag order h	LM-Stat	Prob	
VAR(1) SIC	1	31.76258	0.0002	Rejects Null Hypothesis at 1%
VAR(2) HQC *	1	22.74949	0.0068	Rejects Null Hypothesis at 1%
	2	20.56179	0.0147	Cannot reject Null Hypothesis at 1%
VAR(3) AIC	1	22.91540	0.0064	Rejects Null Hypothesis at 1%
	2	24.80344	0.0032	Rejects Null Hypothesis at 1%
	3	7.367435	0.5989	Cannot reject Null Hypothesis at 1%

Céspedes et al. (2011)	Lag order h	LM-Stat	Prob	
VAR(1) SIC and HQC *	1	8.690410	0.0693	Cannot reject Null Hypothesis at 1%
VAR(2) AIC *	1	2.563196	0.6334	Cannot reject Null Hypothesis at 1%
	2	3.416022	0.4908	Cannot reject Null Hypothesis at 1%

Restrepo and Rincón (2006)	Lag order h	LM-Stat	Prob	
VAR(1) SIC	1	25.14794	0.0028	Rejects Null Hypothesis at 1%
VAR(2) AIC and HQC *	1	17.69694	0.0389	Cannot reject Null Hypothesis at 1%
	2	12.86906	0.1686	Cannot reject Null Hypothesis at 1%

* Indicates the model chosen.

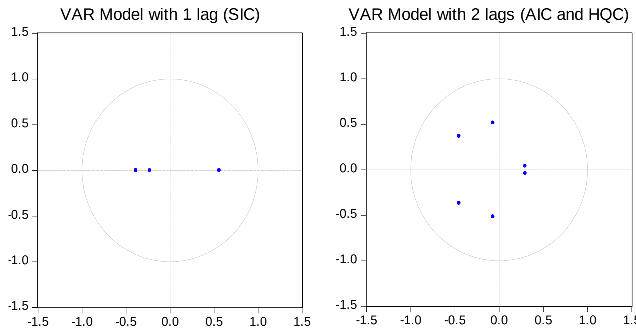
AIC: Akaike information criterion.

SIC: Schwarz information criterion.

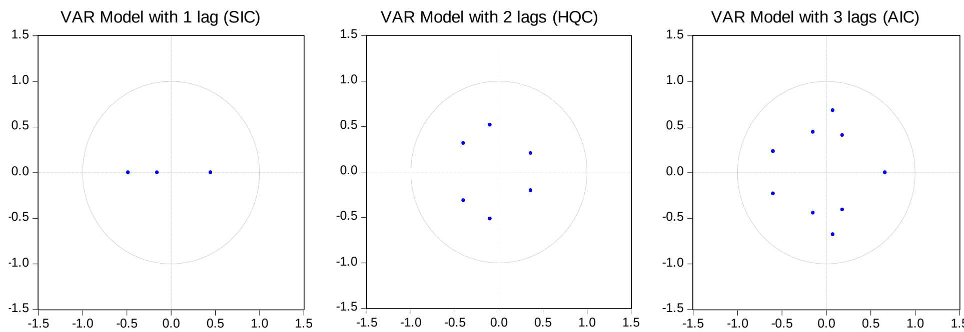
HQC: Hannan-Quinn information

D. Inverse Roots of AR Characteristic Polynomial

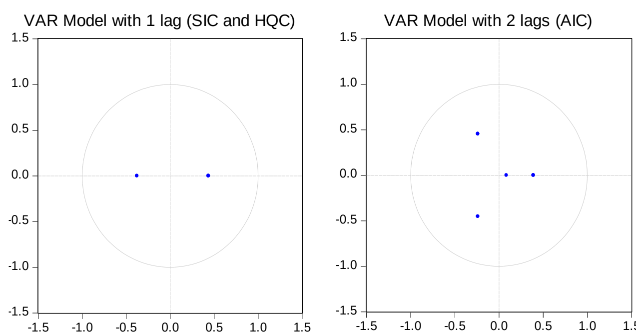
Blanchard and Perotti (2002)



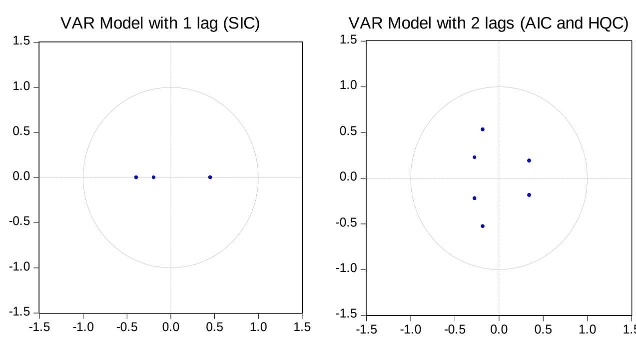
Cerda et al. (2005)



Céspedes et al. (2011)



Restrepo and Rincón (2006)



1/ No root lies outside the unit circle. The models satisfy the stability condition.

AIC: Akaike information criterion.

SIC: Schwarz information criterion.

HQC: Hannan-Quinn information criterion.

E. Government Spending and Tax Multipliers "Alternative baseline models"

VAR model without constant and the number of lags suggested by the HQC 1/

Government Spending Definition	IM	CM (1 year)	CM (2 years)	CM (long-term)
Blanchard and Perotti (2002)	0.50	2.16	2.44	2.53
Cerda et al. (2005)	0.58	2.44	2.66	2.76
Céspedes et al. (2011) 2/	0.62	2.31	2.52	2.54
Restrepo and Rincón (2006)	1.05	4.58	5.09	5.25

Taxes Definition	IM	CM (1 year)	CM (2 years)	CM (long-term)
Blanchard and Perotti (2002)	0.00	0.31	0.43	0.45
Cerda et al. (2005)	0.00	0.37	0.52	0.55
Restrepo and Rincón (2006)	0.00	0.28	0.37	0.39

VAR model with constant and the number of lags suggested by the SIC 3/

Government Spending Definition	IM	CM (1 year)	CM (2 years)	CM (long-term)
Blanchard and Perotti (2002)	0.28	0.87	0.88	0.88
Cerda et al. (2005)	0.32	0.91	0.90	0.90
Céspedes et al. (2011) 2/	0.37	1.18	1.20	1.20
Restrepo and Rincón (2006)	0.55	1.56	1.59	1.59

Taxes Definition	IM	CM (1 year)	CM (2 years)	CM (long-term)
Blanchard and Perotti (2002)	0.00	0.12	0.12	0.12
Cerda et al. (2005)	0.00	0.26	0.27	0.27
Restrepo and Rincón (2006)	0.00	0.26	0.28	0.28

Note: Impact multiplier (IM), Cumulative muliplier (CM).

1/ As suggested by the Hannan-Quinn information criterion (HQC) the VAR model includes 2 lags for all the "Baseline models" but Céspedes et al. (2011) which includes 1 lag.

2/ The VAR model that follows Céspedes et al. (2011) definition does not include taxes.

3/ As suggested by the Schwarz information criterion (SIC) the VAR models include 1 lag for all the "Baseline models".

F. Government Spending and Tax Multipliers "Alternative variables ordering"

VAR model with constant and the number of lags suggested by the HQC 1/
Ordering: Taxes first, followed by Government Spending, and Output last

Government Spending Definition	IM	CM (1 year)	CM (2 years)	CM (long-term)
Blanchard and Perotti (2002)	0.37	0.98	0.97	0.98
Cerda et al. (2005)	0.37	0.97	0.94	0.94
Céspedes et al. (2011) 2/	0.37	1.20	1.20	1.20
Restrepo and Rincón (2006)	0.73	2.35	2.32	2.33

Taxes Definition	IM	CM (1 year)	CM (2 years)	CM (long-term)
Blanchard and Perotti (2002)	0.21	0.55	0.57	0.58
Cerda et al. (2005)	0.10	0.25	0.23	0.24
Restrepo and Rincón (2006)	0.10	0.27	0.28	0.28

VAR model with constant and the number of lags suggested by the HQC 1/
Ordering: Government Spending first, followed by Taxes, and Output last

Government Spending Definition	IM	CM (1 year)	CM (2 years)	CM (long-term)
Blanchard and Perotti (2002)	0.23	0.51	0.54	0.54
Cerda et al. (2005)	0.34	0.85	0.85	0.85
Céspedes et al. (2011) 2/	0.37	1.20	1.20	1.20
Restrepo and Rincón (2006)	0.69	2.24	2.21	2.23

Taxes Definition	IM	CM (1 year)	CM (2 years)	CM (long-term)
Blanchard and Perotti (2002)	0.25	0.62	0.66	0.67
Cerda et al. (2005)	0.14	0.32	0.30	0.31
Restrepo and Rincón (2006)	0.13	0.33	0.34	0.34

Note: Impact multiplier (IM), Cumulative muliplier (CM).

1/ As suggested by the Hannan-Quinn information criterion (HQC) the VAR model includes 2 lags for all the "Baseline models" but Céspedes et al. (2011) which includes 1 lag.

2/ The VAR model that follows Céspedes et al. (2011) definition does not include taxes.

G. Government Spending and Tax Multipliers "Alternative variables ordering"

TVAR baseline model with constant and the number of lags suggested by the HQC 1/
Ordering: Taxes, Government Spending, and Output

	Regime	IM	CM (1 year)	CM (2 years)	CM (long-term)
Government Spending	Tight	0.48	1.60	1.73	1.71
	Normal	0.31	-0.29	-0.28	-0.29
Taxes	Tight	0.15	0.46	0.50	0.51
	Normal	0.23	0.68	0.75	0.76

Note: Impact multiplier (IM), Cumulative multiplier (CM).

1/ As suggested by the Hannan-Quinn information criterion (HQC) the "TVAR baseline model" include 2 lags.

H. Government Spending and Tax Multipliers "Alternative variables ordering"

TVAR extended model with constant and the number of lags suggested by the HQC 1/
Ordering: Taxes, Government Spending, Output, and Monetary Policy Interest Rate

	Regime	IM	CM (1 year)	CM (2 years)	CM (long-term)
Government Spending	Tight	0.43	1.39	1.21	1.25
	Normal	0.31	-0.37	-0.22	-0.16
Taxes	Tight	0.16	0.33	0.29	0.33
	Normal	0.31	0.78	0.74	0.78

Note: Impact multiplier (IM), Cumulative multiplier (CM).

1/ As suggested by the Hannan-Quinn information criterion (HQC) the "TVAR extended model" include 2 lags.

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