# A Quantitative Analysis of the Determinants of Fiscal Multiplers and Its Policy Implications *

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**Abstract**

This research studies the effects of public spending on real economic activity over time. A VAR model with changing parameters and stochastic volatility is used, which is identified by means of agnostic sign restrictions. The analysis of the results is divided into two parts. First, the effects of public spending shocks on GDP are evaluated. Second, three types of spending multipliers are calculated and we proceed to study their determinants. Regarding the first part, the results show that the impact of public spending on economic activity has not remained constant over time. In addition, it is observed that public spending has lost power to boost economic activity after 1999. However, when studying the determinants of the spending multiplier, the debt to GDP ratio, which represents fiscal stability in the model, is estimated to be the most important factor. The policy implication of this result is that the state can increase the power of public spending by controlling public debt levels. On the other hand, to verify the existence of changing parameters in the model, three tests were calculated: the Cogley and Sargent test, the Kolmogorov and Smirnov test, and the t-test. The results of the tests show evidence that the parameters in the dynamics of the model have not remained constant over time. Likewise, to evaluate the robustness of the results, multiple sensitivity analyzes were used. In particular, the model is estimated with different specifications of the priors. Then, the model with the most lags is estimated and different specifications for the external conditions are used. In all cases, the robustness of the results estimated by the main model is verified.

***Keywords:*** Public spending, public spending multiplier, sign restrictions, TVP-VAR-SV, Bayesian econometrics.

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# 1 Introduction

In recent decades, the Peruvian economy has been impacted by multiple events such as the Russian-Asian crisis of 1997 (Velarde and Rodríguez, 2001), the El Niño phenomenon of 1998 (Cepal, 1999), or the international financial crisis of 2008 ( Yamada and Castro, 2010). In this same scenario, fiscal policy in Peru has been subject to several changes such as the implementation of a fiscal rule elaborated from observable variables in 1999, the application of a structural fiscal rule in 2013[1](Ganiko and Montoro, 2017). In this sense, both events and policy changes show that the impact of fiscal policy on economic activity may not have remained constant over time.

Indeed, Mendoza and Melgarejo (2006) detect that the impact of fiscal spending on GDP has been greater in the period 1990-2006 than in the 1980s in response to greater stability in public finances. Other works, such as Sánchez and Galindo (2013), Salinas and Chuquilín (2013) estimate that the effect of public spending is greater in a recession scenario than in a boom scenario. Of the aforementioned authors, the only ones that address the evolution of the effect of public spending are Mendoza and Melgarejo (2006). However, the work by Mendoza and Melgarejo (2006) uses an estimation by subsamples so that their analysis only implies a partial result.

In this context, Qin (2013) suggests that the econometric methodology used must allow the parameters to vary over time. Likewise, Sims (2001) and Stock (2001) emphasize that, in a context of changing parameters, the variance of the crashes is required to be changeable over time.

Therefore, this research seeks to incorporate these elements into the study of the impact of fiscal policy on economic activity. In this sense, the main objective is to study the evolution and effectiveness of public spending in the Peruvian economy over time. In particular, it seeks to answer the following questions: How has the public spending shock evolved in Peru? What factors determine the evolution over time of the spending multiplier?

The methodology used consists of estimating a VAR model with Changing Parameters and Stochastic Volatility (TVP-VAR-SV) proposed by Primiceri (2005). The TVP-VAR-SV models provide a more general estimate that outperforms the LST-VAR threshold models or the MS-VAR Markov chain models, since they do not restrict the estimate to two or three regimes (Kirchner, Cimadomo and Hauptmeier , 2010) and allows capturing soft and permanent changes (Berg, 2014). The identification of structural shocks will be formulated through sign restrictions. Fry and Pagan (2007) argue that the sign constraint methodology is superior to other identification methods. However, the implementation of the constraints can generate response impulses that do not fit the data. In that sense, following Mountford and Uhlig (2009) agnostic sign restrictions will be used to estimate the genuine response of the variables to shocks. On the other hand, the economic factors that determine the size of the cost multiplier calculated from the model will be studied, which will be chosen according to the literature.

There is little literature that addresses the study of fiscal policy using models with changing pa-

[1]In 1999, the Fiscal Prudence and Transparency Law was implemented. Then, in 2003, the rule was replaced by the Fiscal Responsibility and Transparency Law. Both rules were based on observable components. For this reason, in 2013, the Law for Strengthening Fiscal Responsibility and Transparency was implemented, which was based on structural components. However, given the complexity of estimating the structural components, in 2016 the government established the NFPS Fiscal Responsibility and Transparency Framework, which again is governed by observable components, as in the case of the first two rules. .

rameters such as the one proposed in this research: Kirchner et al. (2010), Pereira and Lopes (2010), Berg (2014) and Glocker et al. (2017) among others. Likewise, the cited literature uses recursive identification schemes, so this research is one of the first works to use an identified TVP-VAR-SV with sign restrictions for the study of fiscal policy.

This article will be organized as follows. In Section 2 the theoretical and empirical literature is discussed. Section 3 describes the methodology. Section 4 analyzes the data used for the estimation. In Section 5 the main results are discussed and analyzed. Finally, Section 6 details the conclusions.

## 2 Literature review

A first approach to the theoretical study of the effects of public spending on economic activity and the spending multiplier was provided by Keynesian theory. This theory assumes sticky prices and that consumption depends on current income. In this context, it is argued that an increase in public spending directly increases demand and therefore increases output. The increase in output raises disposable income, which in turn increases consumption. This translates into a further increase in product. This channel implies that the effect of spending on output is greater than unity, which is known as the spending multiplier (Céspedes and Galí, 2013).

However, Barro (1974) criticizes the assumption that consumption depends on current income and proposes a model where the agents are Ricardian. Assuming there are no liquidity constraints, Barro proposes that higher public spending will imply that the government raises taxes in the future, which will leave permanent income unchanged and consumption unchanged.

On the other hand, breaking the assumption of nominal rigidities, Aiyagari et al. (1992) and Baxter and King (1993) argue that an increase in public spending generates a negative wealth effect on individuals, forcing them to increase their labor supply. Consequently, the real wage decreases and output increases. The authors argue that higher capital spending financed with lump sum taxes will generate a higher multiplier, while higher current spending with the same type of tax will produce a multiplier of less than unity.

Instead, by introducing nominal rigidities, New Keynesian models[2]characterize other transmission channels. Linnemann and Schabert (2003) postulate that the increase in public spending increases the quantity demanded by the market. For this reason, firms produce more, which leads them to demand more labor. The excess demand for labor raises the real wage, therefore, consumption rises, this leads to a positive multiplier effect.

Along the same lines, Devereux et al. (1996) and Billie et al. (2005) state that an increase in government spending increases the number of firms in the interGraphste goods market equilibrium. In turn, higher spending raises the productivity of these firms and, consequently, increases real wages, which generates a positive multiplier. However, Galí, López-Salido and Vallés (2007) argue that including only nominal rigidities will produce a positive but minimal multiplier effect. For this reason, they propose that liquidity constraints should be introduced into the model. Using this specification, the authors find that the multiplier is very close to one.

[2]In New Keynesian models there can be wage and price rigidities, as well as price rigidities and wage flexibility (Goodfriend and King, 1997). Depending on the stiffness, the multiplier may change.

Likewise, Caballero and Pyndick (1996) state that the sign of the multiplier can vary depending on the macroeconomic stability of the economy. In a scenario of uncertainty and a precautionary attitude on the part of agents, the fiscal multiplier may be reduced and may even be negative. This is in response to the fact that households will seek to save their disposable income and firms will avoid investing.

As for the empirical literature, one of the first analyzes of the effects of spending was provided by Barro (1981). The author uses a reduced form model to quantify the effects of public spending on US GDP. In this way, he detects that spending has a cushioning behavior contrary to the multiplier effect.

Instead, Ramey and Shapiro (1997) employ a "narrative approach" and use the exogeneity of military spending. In his analysis, an increase in government spending leads to an increase in the product, however, the consumption of durable and non-durable goods decreases, which reinforces the results of Barro (1981).

However, Blanchard and Perotti (2002) propose a structural model. The authors estimate the tax and spending elasticities related to GDP, and introduce these relationships into the equations for the residuals of the reduced model. In this way, the authors estimate the structural model and find that a positive public spending shock expands output, but generates a significant drop in investment.

Similarly, Perotti (2005) finds similar results for multiple OECD countries. However, the author warns about the instability of the parameters in subsamples. In this regard, the author finds that the effect of public spending on GDP is positive in most countries, however, said effect is greater in the period prior to 1980. In subsequent periods the effect is considerably reduced.

The identification schemes mentioned above are built from assumptions about the exogeneity of the variables. Mountford and Uhlig (2009) criticize this assumption and suggest studying the effects of fiscal policy using an identified SVAR model with agnostic sign restrictions. The authors estimate the model using Bayesian techniques and find that an expansive fiscal policy reduces both local and foreign investment, which produces a multiplier effect of less than unity.

On the other hand, Auerbach and Gorodnichenko (2012) present a new critique of the estimated models. The authors argue that the SVAR models and DSGE models are not capable of calculating multipliers that change as a function of the economic cycle. In this sense, the authors estimate a VAR model with a smooth transition, which presents a non-linear nature. Likewise, they define two states: recession and expansion, and identify structural shocks following Blanchard and Perotti (2002). In this way, they estimate that the multiplier effect is greater in a boom regime than in a recession one.

The literature cited so far focuses on estimating the multiplier effect and discussing the sign of the effect, but not on explaining the changes present in said effect, which were emphasized by Perotti (2005). In this sense, Kirchner, Cimadomo and Hauptmeier (2010) criticize that the SVAR models do not allow capturing the changing dynamics of spending shocks. The authors argue that structural changes mean that the impact of shocks is not constant. They also criticize that STVAR models depend on the number of regimens imposed by the researcher. Along the same lines, Pereira and Lopes (2010) criticize that regressions by sub-samples lack a formal criterion and are subject to the choice of the researcher. To overcome these weaknesses, Kirchner, Cimadomo and Hauptmeier (2010) estimate an autoregressive vector model with changing parameters and TVP-VAR-SV stochastic volatility identified using the Blanchard and Perotti (2002) scheme. In this way, they calculate the evolution of fiscal shocks over time, which allows them to study the determinants of the multiplier. Estimates indicate that the fiscal multiplier is positive, but with a downward trend, and that higher credit and debt to GDP ratios contribute to lowering the multiplier.

In contrast to the model that Kirchner, Cimadomo and Hauptmeier (2010) propose, Berg (2014) emphasizes that the model used only captures unexpected shocks, when the fiscal policy is of an anticipated nature due to the fact that the authorities announce the policies. In this sense, it introduces time series of projections made by institutions to the model. The author estimates that the most important determinant of the variability of the multiplier is fiscal sustainability. But unlike the previous results, the author emphasizes that the multiplier does not show a clear trend. This is reinforced by the results of Glocker et al. (2017) who estimate a TVP-VAR with an exogeneity block.

In the Peruvian case, the literature related to the study of the effects of public spending on economic activity is limited. A first approximation is proposed by Mendoza and Melgarejo (2006) who estimate an identified SVAR through the Blanchard and Perotti (2002) scheme. The authors estimate that an expansion in public spending increases economic activity. On the other hand, Sanchez and Galindo (2013) emphasize the non-linear nature of production and estimate a logistic STVAR model. The authors find that the spending multiplier is higher in a low-growth scenario than in a high-growth one. On the other hand, Salinas and Chuquilín (2013) complement the analysis of Sanchez and Galindo (2013) disaggregating public spending into current spending and capital spending. The authors find that capital spending is more powerful than current spending. However, only the work by Mendoza and Melgarejo (2006) makes an estimate by sub-samples and documents that the fiscal stimulus of spending associated with the 1990-2006 period is greater than in the 1980-1990 period, due to the fact that the years more recent ones is registered to a greater macroeconomic stability.

## 3 Proposed methodology

In line with the recent findings of the empirical literature (Kirchner et al. 2010; Pereira and Lopes 2010; Berg 2014; Glocker et al. 2017) and the previous results of Mendoza and Melgarejo (2006), the estimation of a model TVP-VAR-SV to study the effect of public spending over time. Structural shocks will be identified through sign-agnostic restrictions based on the work of Mountford and Uhlig (2009). Likewise, the model will be estimated through Bayesian techniques.

Next, the procedure of the methodology is detailed:

a) First, for a better characterization of the evolution of the results over time, recessions in the economy will be estimated using the unobservable component model of Perron and Wada (2009). In this regard, Rodríguez and Guillén (2014) argue that this model is the most appropriate to estimate business cycles in Peru. Also, the results of other filters are presented. These estimates are presented in Annex 2.

b) Second, the TVP-VAR-SV model will be estimated and structural shocks will be identified through sign restrictions. Likewise, a procedure similar to Bijsterbosch and Falagiarda (2015) will be used to check whether the parameters are changing over time.

c) Third, the impact spending, present value and accumulated multipliers will be estimated. Then regression analyzes will be carried out to study the determinants of the multipliers. The dependent variables will be the three estimated multipliers and the explanatory variables will be determined based on the literature.

From the estimated impulse response functions, we will proceed to estimate 3 types of multipliers. The general notation will be as follows,$y_{h,t}$ will represent the value of the response of GDP to the spending shock in the horizon and in the period , will represent the value of the response of public spending to the spending shock in the horizon and in the period , will represent the real GDP in the period and the real public spending in the period$h = 1, 2, ..20$ and years such that $t = 1993Q3, .., 2017Q2$ . The variable $g_{h,t}$ will represent the value of the response of public spending to the spending shock at horizon $h$ and in period $t$, $Y_t$ is the real GDP in the period $t$ and $G_t$ is the real public spending in the period $t$.

a. Impact Multiplier: This type of multiplier measures how many more soles each sole of public spending introduced into the economy in the initial period generates:

$$MG_{h,t} = \frac{y_{h,t}}{g_{0,t}} \times \frac{Y_t}{G_t}$$

b. Cumulative Multiplier: This multiplier measures the long-term impact. Its interpretation is, how many more soles have been generated by each sole of public spending up to the period $h$:

$$MA_{k,t} = \frac{\sum_{j=0}^{k} y_{j,t}}{\sum_{j=0}^{k} g_{j,t}} \times \frac{Y_t}{G_t}$$

c. Present value multiplier: This multiplier measures the long-term impact in terms of today's soles. The interpretation is similar to the previous multiplier:

$$MA_{k,t} = \frac{\sum_{j=0}^{k} (1+i)^{-j} y_{j,t}}{\sum_{j=0}^{k} (1+i)^{-j} g_{j,t}} \times \frac{Y_t}{G_t}$$

where is the average interest rate of the entire sample.$i$

1. **Econometric model**

The proposed econometric model is a TVP-VAR-SV. This methodology was developed by Cogley and Sargent (2005) and Primiceri (2005), whose reduced form is:

$$Y_t = B_{0,t} + \sum_{i=1}^{L} B_{i,t} Y_{t-i} + u_t, \tag{1}$$

where $E[u_t] = 0$,$E[u_t u_t'] = \sigma_{t,i}$, and $i = j$, $E[u_t u_t'] \neq 0$ for $i \neq j$, $i, j = 1, 2, 3, 4, 5, 6$ and $Y_t$ is the vector of endogenous variables which will be discussed in Section 4.

In the model, both the parameters, the contemporaneous coefficients and the standard deviations are changing over time. Likewise, the law of movement of said coefficients is described by a random walk:

$$\beta_t = \beta_t + \xi_t \sim N(0, \Sigma_\beta)$$
$$\alpha_t = \alpha_t + \zeta_t \sim N(0, \Sigma_\alpha)$$
$$ln(\sigma_t) = \ln(\sigma_t) + \eta_t \sim N(0, \Sigma_\sigma)$$

Primiceri (2005) argues that this structure is flexible enough to capture smooth and structural changes in parameters.

The estimation process will be carried out through Bayesian techniques. Faced with the high dimensionality of the parameter space and non-linearity in the shocks, Bijsterbosch and Falagiarda (2015) argue that the Bayesian approach is the most appropriate.

The parameters to be estimated are $\beta_t$, $\alpha_t$, $\ln(\sigma_t)$, $\Sigma_\beta$, $\Sigma_\alpha$ and $\Sigma_\sigma$. The assumed prior distributions for these parameters are:

$$\beta_0 \sim N(\widehat{\beta}, \widehat{V}_\beta)$$
$$\alpha_0 \sim N(\widehat{\alpha}, \widehat{V}_\alpha)$$
$$ln(\sigma_0) \sim N(\ln(\widehat{\sigma}_0), I_n)$$
$$\Sigma_\beta \sim W(s_1 k_1 \widehat{V}_\beta, s_1)$$
$$\Sigma_\alpha \sim W(s_2 k_2 \widehat{V}_\alpha, s_2)$$
$$\Sigma_\sigma \sim W(s_3 k_3 I_n, s_3)$$

where $N(x, y)$ represents the normal distribution and $W(R, h)$ represents the Wishart distribution. The priors are calibrated by an OLS estimate of $\widehat{\beta}_0$, $\widehat{\alpha}_0$, $\ln(\widehat{\sigma}_0)$, $\widehat{V}_\beta$, $\widehat{V}_\alpha$. The parameters $s_1$, $s_2$, $s_3$ are the degrees of freedom of the innovations in , $\beta$, $\alpha$, $ln(\sigma)$ , respectively, which are equivalent to the number of coefficients of each matrix in the VAR. On the other hand, the parameters $k_1$, $k_2$, $k_3$ represent the weight of the prior in the posterior distribution. In the TVP-VAR-SV model, these parameters represent the variation over time that the investigator suspects a priori. In the present investigation, conservative priors are used: $k_1 = 0.0005$ $k_2 = 0.05$, and $k_3 = 0.05$

The number of lags chosen is .$L = 1$In the context of changing parameters, there is no proof of specification of the number of lags. However, when estimating a VAR with constant coefficients using the same variables, the criteria propose between one and two lags. For this reason, the results will be presented with 1 lag.

The model will be simulated with 10,000 Gibbs iterations and the first 5,000 will be discarded. The procedure will be such that, out of every 10 simulations, 1 will be stored. In this way, the autocorrelation in the Markov chains will be controlled.

## 4 Identification Scheme

Structural shocks will be identified by sign restrictions. In particular, the agnostic procedure proposed by Mountford and Uhlig (2009) will be used, where the sign of the response of the variables of interest is not restricted, this allows to identify the genuine response of the variables to the shocks. However, the authors only identify four shocks: cycle shock, monetary policy shock, public revenue shock, and public spending shock. Said scheme ignores supply shocks, so these shocks will be identified in the model.

Likewise, it has been documented that external shocks are one of the most important factors in the dynamics of economic cycles in Peru (Mendoza and Collantes, 2017). For this reason such shocks are introduced. In particular, the S&P GSCI (Standard & Poor's Goldman Sachs Commodity Index) index is used, which captures the movement of prices of multiple commodities traded worldwide and can capture more general effects in the external sector than the terms of trade. In this sense, the shocks identified will be aggregate demand shock, aggregate supply shock, monetary policy shock, fiscal revenue shock, fiscal expenditure shock, and external shock.

Table 1: Sign restrictions

| | GDP | Tax Income | Expenditure | Inflation | Interest rate | S&P GSCI |
|---|---|---|---|---|---|---|
| Demand Shock | + | | | | | |
| Supply Shock | + | | | - | | |
| Tax Shock | | + | | | | |
| Fiscal Expenditure Shock | | | + | | | |
| Monetary Policy Shock | + | | | + | - | |
| Global Index Shock | | | | | | + |

*Note*: The restrictions are implemented on the simulated Impulse-Response from the rotation matrix. The restriction is only imposed at the moment of impact. The symbol (+) implies that the response of the variable (columns) is positive to a given shock (rows), while the symbol (-) means that the response of the variable is negative to a given shock. Empty spaces imply that a constraint has not been imposed.

The identification is detailed below. In the first case, a positive aggregate demand shock generates, in response to excess demand, an increase in production and the price level. On the other hand, a positive supply shock increases production but decreases prices due to excess supply. In the case of monetary policy, an expansive shock lowers the short-term interest rate, which raises output and the price level.

The restrictions are implemented on the simulated Impulse-Response from the rotation matrix. Also, the restriction is only imposed at the moment of impact. The symbol (+) implies that the response of said variable (columns) is positive to a given shock (rows), while the symbol (-) means that the response of the variable is negative to a given shock. Empty spaces imply that a constraint has not been imposed.

On the other hand, regarding fiscal shocks, where the spending shock is the main interest of this research, only the response of the associated variable is restricted, but not the response of the other variables. This will make it possible to capture the genuine sign of the response of GDP and the other variables to this shock. The same procedure is applied in the case of the tax shock, where it is only restricted that the response of public revenues be positive. This procedure is compatible with Mountford and Uhlig (2009) and the results presented by Perotti (2005) regarding the response of the variables to spending shocks. Finally, the same scheme is applied to external shocks. Table 1 summarizes the proposed identification scheme.

The proposed sign restrictions are implemented on the impulse response functions for each moment in time. Likewise, the restrictions are imposed only at the moment of impact, the following periods are determined by the data. On the other hand, a time horizon of 20 quarters was determined.

# 5 Data Discussion

The variables used will be the GDP in millions of soles of 2007, the non-financial public spending of the central government, the tax revenues of the central government, the consumer price index with base 2009=100, the S&P GSCI index (abbreviated as SPGSCI) and the interbank interest rate for the period from 1992-Q2 to 2017-Q2. These variables are presented in Annex 1-Figure 1.

The public spending and tax revenue variables are deflated using the CPI with base 2009=100. Then, we proceed to seasonally adjust the GDP and the new variables of expenditure and real fiscal income using the Census-X13 method.

On the other hand, in the case of the interest rate, this variable is only available for the period 1995-Q4 to 2017-Q2. To make the estimates since 1992-Q2, a link is made between this variable and the BCRP certificate of deposit rate available since 1992-Q2. Said rate was the instrument through which the monetary authority regulated market liquidity, so that monetary policy shocks were captured in this variable, as in the case of the interbank rate today. Likewise, since the model is estimated with Bayesian techniques, the possible statistical errors of splicing are captured.

Table 2: Unit root test series in levels

| | $DF^{GLS}$ | PP | Ng Perron | ERS | Zivot-Andrews |
|---|---|---|---|---|---|
| GDP | -1.16 | -1.43 | -1.54 | 18.9 | -3.93 |
| Income | -1.37 | -1.38 | -1.34 | 18.6 | -3.31 |
| Spent | -2.08 | -4.25 | -1.99 | 11.8 | -3.50 |
| CPI | -1.68 | -16.22 | -0.16 | 1381 | -5.04 |
| SPGSCI | -1.85 | -1.94 | -1.78 | 12.9 | -3.75 |
| Interest rate | -0.82 | -5.37 | -0.79 | 79.9 | -6.86 |

*Note*: All tests were calculated with a constant and a trend. In the test case $DF^{GLS}$, the critical values at 1%, 5%, and 10% are -3.52, -2.98, and -2.69, respectively. In the case of the test, these values correspond to -4.02, -3.44 and -3.14. The Ng-Perron test presented corresponds to the test, whose critical values are -3.42, -2.91 and -2.62. In the case of the Elliott, Rothenberg, and Stock test, the critical values are 4.25, 5.64, and 6.79. The Zivot-Andrews test was calculated specifying break in intercept and trend. The break point is not presented. The critical values in this test are -5.57, -5.08 and -4.82.

The stationarity of the series is evaluated using the DFGLS, PP, Ng-Perron, ERS tests and, finally, the Zivot-Adrews test with structural breaks. The results are presented in Table 4. The evidence presented by the tests suggests that most of the series are non-stationary. Based on this result, we proceed to differentiate the series. However, the interest rate is not differentiated mainly because the PP test and the Zivot-Andrews test reject the null hypothesis of non-stationarity and because this variable is stationary in nature since the central bank sets its path.

Table 3: Unit Root Test: Difference Series

| | $DF^{GLS}$ | PP | Ng-Perron | ERS | Zivot-Andrews |
|---|---|---|---|---|---|
| $\Delta$GDP | -2.53 | -3.75 | -2.06 | 2.91 | -3.51 |
| $\Delta$Tax Income | -3.17 | -3.23 | -2.87 | 1.59 | -3.58 |
| $\Delta$Expenditure | -3.15 | -7.18 | -3.18 | 0.77 | -4.46 |
| $\Delta$Inflation | -1.13 | -7.06 | -0.59 | 208 | -5.45 |
| $\Delta$Interest rate | -4.93 | -3.68 | -4.69 | 0.56 | -4.17 |

*Note*: All tests were conducted with a constant. In the case of inflation, a trend and a constant were included in all tests, and the critical values are presented in Table 2. In the $DF^{GLS}$ test, the critical values at 1%, 5%, and 10% are -2.58, -1.94, and -1.61, respectively. In the PP test, the corresponding values are -3.47, -2.88, and -2.57. The presented Ng-Perron test corresponds to the $MZ_t$ test, with critical values of -2.58, -1.98, and -1.62. In the case of the Elliott, Rothenberg, and Stock test, the critical values are 1.94, 3.10, and 4.15. The Zivot-Andrews test was calculated specifying a breakpoint at the intercept. The breakpoint is not presented. The critical values in this test are -5.34, -4.93, and -4.58.

The variables in differences are presented in Annex 1 – Figure 2. To evaluate the presence of unit roots in the differentiated series, we proceeded in a similar way as in the previous case. In particular, tests are calculated for GDP growth rates, income, expenses, SPGSCI and inflation. The results of the estimations are presented in Table 3. In all cases it is verified that the series are I(0). In this sense, since these series meet the stationarity condition, these series will be introduced together with the interbank interest rate in the model.

Table 4: Structural Break Tests by Perron and Bai (2003): Difference Series

| | ΔGDP | ΔIncome | ΔExpenditure | ΔInflation | ΔSPGSCI | Interest Rate |
|---|---|---|---|---|---|---|
| Sup $F_P$(1-0) | 8.7* | 35.7* | 1.9 | 28.9* | 9.7* | 93.2* |
| Sup $F_P$ (2-1) | 22.2* | | | 27.6* | 11.1* | 10.4* |
| Sup $F_P$ (3-2) | 36.9* | | | 17.4* | 4.8 | 7.8 |
| Sup $F_P$ (4-3) | 9.4 | | | | | |
| UD max (5%) | 3 | 1 | 0 | 1 | 5 | 2 |
| WD max (5%) | 5 | 5 | 0 | 3 | 5 | 2 |
| BIC | 3 | 4 | 0 | 1 | 2 | 2 |
| LWZ | 2 | 0 | 0 | 1 | 0 | 2 |
| $\hat{T}_1$ | 1998-Q1 | 2014-Q1 | | 1996-Q4 | 1999-Q3 | 1996-Q1 |
| $\hat{T}_2$ | 2001-Q4 | | | 2000-Q2 | 2009-Q1 | 2001-Q3 |
| $\hat{T}_3$ | 2014-Q1 | | | 2007-Q4 | | |

*Note*: The test was implemented on the annual rates of the series. The result associated with the Log SPGSCI was omitted from the table as it does not present significant structural breaks. In all cases, the tests were implemented specifying only an intercept. Additionally, a trimming of 0.15 and a maximum of 5 breaks in the series were employed for all tests. The symbol (*) indicates that the corresponding Supremum exceeds the critical value at 5%.

On the other hand, it is pertinent to evaluate if the variables that will be introduced to the model present any structural break. In this regard, Mendoza and Melgarejo (2006) use the procedure of Vogelsang (1997) and detect that the series of growth rates of GDP, expenditure and income register a structural break between the late 1989s and 1990s. Sanchez and Galindo (2013) estimate similar results using the unit root test with break. However, the Peruvian economy has been subject to multiple shocks and various reforms, so the existence of various structural breaks is plausible. In this sense, to evaluate the existence of multiple breaks, the methodology proposed by Perron and Bai (2003) is used, which admits the possibility that the series have more than one structural break.$F_P$, the and the , the and the . The estimates of these criteria are compiled in Table 4. The results suggest that there is more than one significant structural break in the GDP growth rate, in inflation, in the SPGSCI growth and in the interest rate. These results are corroborated between the different criteria. Only in the case of inflation do the criteria differ from the minimum number of structural breaks calculated by the model. Similarly, it can be observed that the dates of structural breaks differ considerably between the variables. In that sense,$UD\ \max WD\ \max BIC LWZ$

# 6 Results

## 6.1 Evidence of Changing Parameters

Following Bijsterbosch and Falagiarda (2015), with the aim of evaluating the presence of changing parameters in the model, three types of tests will be used.[3]. The first is the Trace test by Cogley

[3]In the Bayesian methodology each parameter has its own density. Likewise, in the TVP-VAR-SV model estimated with Bayesian techniques, each parameter has its own density for each moment of time. This relationship is used to contrast

and Sargent (2005) which performs a contrast between the trace of the innovation matrix and the percentiles of the later one. If the trace is less than the percentiles, it indicates evidence that the parameters have not been kept constant. The second is the Kolmogorov-Smirnov test, which allows testing whether two random samples belong to the same distribution. The third is the t-test that allows us to check if the difference between the mean of two samples is significant. In the case of the last two tests, the distributions of the parameters will be evaluated on two occasions for two different dates. First, the distribution of the parameters of 1994T1 vs 2005T1 is contrasted, then 2005T1 vs 2015T1 is contrasted.

In the case of the first test, it is estimated that the trace is 0.05, which is less than the percentiles of the later one. This indicates that shocks in the parameters generate significant time variation. In the case of the Kolmogorov-Smirnov test, the results indicate that more than half of the parameters (elements of A) have changed significantly in both cases 1994T1 vs 2005T1 and 2005T1 vs 2015T1. The same results are verified for the elements of H and B. These results are corroborated by the t-test. Based on the evidence, it can be concluded that the parameters that describe the dynamics between the variables studied show evidence of changing parameters, which supports the use of a TVP-VAR-SV model.

Table 5: Changing Coefficient and Volatility Parameter Tests

| Test de Traza | | | Test de Kolmogorov-Smirnov | | Test de Kolmogorov-Smirnov | |
|---|---|---|---|---|---|---|
| Traza | 0.05 | | 1994T1-2005T1 | 2005T1-2015T1 | 1994T1-2005T1 | 2005T1-2015T1 |
| 16% | 0.91 | A | 42/42 | 28/42 | 41/42 | 29/42 |
| 50% | 1.51 | H | 5/6 | 6/6 | 6/6 | 6/6 |
| 84% | 2.72 | B | 14/15 | 11/15 | 13/15 | 15/15 |

*Note*: The Kolmogorov-Smirnov test is applied to two samples. The test is conducted for each element of A, H, and B. The numerator indicates the number of parameters that changed in the sub-samples according to the 0.01% significance level test. The denominator indicates the total number of parameters in each matrix. Similarly, the t-test is applied to two samples. The test is conducted for each element of A, H, and B. The numerator indicates the number of parameters that changed in the sub-samples according to the 0.01% significance level test.

The Kolmogorov–Smirnov test is applied for two samples. The test is carried out for each element of A, H and B. The numerator indicates the number of parameters that changed in the sub-samples according to the 0.01% test. The denominator indicates the total number of parameters in each matrix. In the same way, the t-test is applied for two samples. The test is carried out for each element of A, H and B. The numerator indicates the number of parameters that changed in the sub-samples according to the 0.01% test.

## 6.2 Stochastic Volatility and Impulse Response Functions

In this section the results of stochastic volatility will be discussed. Then, we will proceed to analyze the average impulse responses of the spending shock. Additionally, a brief analysis of the tax shock

differences between these densities over time.

will be presented. Finally, the evolution of the public spending shock over time will be studied.

The results of stochastic volatility (Annex 3.A) indicate a different evolution for all the variables. In the case of GDP, shown in Panel(a), low volatility is recorded at the beginning of the sample. Then, in the period 1997-2002, it rises considerably until reaching around 10%. This behavior responds to two events between 1997 and 1998: the "El Niño" phenomenon that damaged infrastructure and agricultural land, and the crisis in Asian countries that generated global uncertainty and a massive movement of capital in the short term. In the first quarter of 1999, volatility reached its highest point in the entire sample (10.1%), after having consolidated the negative shocks. In subsequent years, volatility reverts to a negative trend. An interesting result is that, in the year of the global financial crisis, GDP volatility registered a slight increase (from 1% in 2006 to 4% in 2008). This result is small compared to the volatility associated with the 1998-2000 crisis. In addition, it should be noted that the volatility registered in said period is lower for the Peruvian case than the volatility estimated for developed countries as documented by Gambetti and Musso (2016). This result would respond to three factors. First of all, due to the low interest rates in the US and the EU, there was a huge flow of short and long-term capital that arrived in Peru and other Latin American countries, this boosted private investment in the region. Second, China's import demand remained constant during the financial crisis, allowing Peruvian exports to continue growing. Third, during 2008, countercyclical policies were applied that made it possible to cushion the negative external shock. After the financial crisis, GDP volatility maintains its downward trend.

On the other hand, the volatility of fiscal variables (Panel by Panel c) registers a more asymmetric evolution. Regarding tax revenues, in the period 1994-2003 relative stability was recorded where volatility was oscillating around 30%, after this period it began to rise considerably. The start of the commodities super cycle in 2003 (Radetzki, 2006) would explain this result. With the greater demand for minerals in the world, mining companies registered higher income, consequently, the level of collection of the Peruvian government increased, which increased the volatility of income. On the other hand, the volatility of spending behaves in a similar way to income, but registers a greater magnitude. At the beginning of the sample, the volatility of spending hovered around 80%. However, in 2008, volatility reached a peak of 210%. This increase would respond to the policy measures applied by the government to avoid the effects of the international financial crisis (Yamada and Castro, 2010). Then, there is a downward trend, explained in part by the period of post-crisis stability and also by the implementation of the Fiscal Responsibility and Transparency Strengthening Law, which contributed to discipline public spending in the country.

Unlike the previous variables, the volatility of inflation (panel d) shows a clear downward trend. This behavior would be explained by the measures implemented to control hyperinflation in the years 1980-1990 and the implementation of the explicit inflation targeting scheme in 2002.

On the other hand, the S&P GSCI index (Panel e) registers much more volatility than the rest of the variables. Likewise, it can be seen that the highest volatility peaks are reached in global crisis scenarios. For example, during the Russian-Asian crisis, the volatility of the index increased from 100% to 300%, while during the international financial crisis the volatility rose considerably to 1100%.

Regarding the short-term interest rate, the results indicate the existence of two phases. The first is related to the stage where the central bank controlled market liquidity, in that period the volatility of the interest rate remained above 5%. The second stage corresponds to the period where the central bank implemented the explicit inflation targeting scheme and began to set the interest rate. During this policy regime, the volatility of the rate was reduced to values below 1%.

Regarding the impulse response functions, since a TVP-VAR-SV was used, then results are estimated for each moment of time. In particular, since the sample is made up of 96 observations included in the period 1993T3-2017T2, then there are 96 impulses with their corresponding evolution from h=1 to h=20. In this sense, to improve the interpretation of how the impact of fiscal policy evolves over time, the impulse response functions are normalized with respect to the magnitude of the spending shock. In this way, it is simulated that the spending shock is 1% in all periods (which can be seen in Panel c of Annex 3.C).

The results of the agnostic identification indicate that a positive public spending shock (Figure 5 - Annex 3.B) generates a positive response in economic activity (Panel a). On average, a 1% increase in public spending raises GDP by 0.18% at the time of impact. Based on the 68% confidence bands, product response is significant up to two quarters after the shock. On the other hand, the response of revenue to the spending shock is not significant, which suggests that, although spending expands economic activity, this will not translate into higher tax collection. This responds to the high degree of informality in the country that generates multiple obstacles to tax collection, such informality amounts to 69% of the EAP according to BCRP (2017c). On the other hand,

On the other hand, the results of a positive tax revenue shock are also presented (Figure 6 - Annex 3B). The results indicate that an increase in income increases production. This result contradicts the standard macroeconomic theory where it is stated that an increase in income or taxes reduces consumption, therefore, decreases the product. Furthermore, the confidence bands indicate that this result is significant, at least at the moment of impact. Likewise, since the identification scheme was agnostic, this behavior is typical of the variables used.[4]. The response to this behavior in the Peruvian case would be explained by the low level of tax collection, which amounts to 17.1% of GDP compared to the 34.3% registered, on average, by the most developed countries (OECD, 2015). In this sense, faced with a higher level of taxes, the government can collect more resources, so it can increase public spending so that this effect is stronger than the negative shock. However, the implications of this effect are not rigorously analyzed in this paper, which is why this analysis is proposed for future research.

The evolution of the impact of the public spending shock over time is presented in Annex 3C. The normalization process will make it possible to compare the effect of a 1% increase in public spending in 1993Q1 with the effect of the same shock in subsequent periods. The results indicate that the impact of public spending on GDP has not remained constant over time (Panel a). At the beginning of the sample, there is a brief decrease in the effect of public spending on output, which would correspond to the high volatility generated by the structural reforms of 1990-1993. In the following periods, the effectiveness of public spending increased and maintained its upward trend until the end of 1998, when it rose to 0.44%.

[4]In this regard, Perroti (2005) finds similar results for Australia, the United Kingdom and Germany, where a positive tax shock generates a positive response in GDP.

The positive trend of the effect of public spending was reversed in 1999. After this year, the impact of public spending began to decrease until reaching values close to 0.1% in recent years. This structural change in the effect of spending would respond to the consolidation of the neoliberal reforms implemented at the beginning of the 1990s that contributed to reducing the role of the government in the economy. In particular, in the commercial sphere, tariffs were reduced and quantitative restrictions were eliminated (Saavedra, 1997), while in the financial sector, controls on active rates were eliminated and the free flow of foreign capital was allowed (Ledesma, 2001). ). These reforms were consolidated towards the end of the 1990s and the beginning of 2000, precisely when the trend turned negative.

In this sense, although the impact of spending increased gradually from 1995 to 1998, fiscal spending as an instrument of fiscal policy has lost power since 1999, which contrasts with the results of Mendoza and Melgarejo (2006), who estimate that the fiscal policy has gained power in the period 1990-2006. However, the results of Mendoza and Melgarejo (2006) could respond to an average effect.

In previous lines, the average impulse response functions were presented, where it was estimated that the effect of fiscal policy on output is approximately 0.18%. However, when observing the evolution of the impulse response at the moment of impact, it can be detected that in recent years the effect is close to 0.1%. This implies that the average impact of 0.18% on GDP is generated by the high peaks between 1996-1998. In this sense, if the average is taken for the effect in the same period as estimated by Mendoza and Melgarejo (2006), the result is 0.22%, which is equal to the value estimated by said authors. However, the method they used does not capture the fall from 1999. This analysis explains the results of Mendoza and Melgarejo (2006) and why they found a greater power of fiscal policy, when the results presented in this investigation show that, from 1999, the power begins to decrease. On the other hand, this result is in line with other works that estimate a reduction in the effectiveness of fiscal policy, for example, Kirchner et al. (2010).

### 6.3 Expense Multipliers and Their Determinants

In this section a brief analysis of the results of the multipliers will be presented. Then, we will proceed to discuss the determinants of the spending multipliers proposed by the literature. Finally, the effects of these determinants will be estimated through regression analysis.

Estimates of the evolution of the spending multipliers are presented in Annex 4. In Panel(a) it can be seen that the trajectory of the impact multiplier over time is similar to the impulse response reported in Annex 3.C, such as expected. The highest values of the impact multiplier are found in the period 1997-2000, where the multiplier effect of spending oscillated around 2 monetary units, in other words, for every sol of public spending that the government introduced into the economy, 2 were generated. soles during said period. However, this effect loses power in the following years. Starting in 2005, the multiplier effect decreases to values less than unity and in the following years it remains oscillating around 0.68 soles.

Panel(b) and Panel(c) present the results of the cumulative expense multiplier and present value, respectively. In both cases, the result is presented for 1 year after the shock, for the middle and for the end of the impulse response horizon. Regarding the cumulative multiplier, there is a high volatility in the periods after the shock, which would indicate that in the medium and long term there is more uncertainty about the effects of fiscal policy. Regarding the present value multiplier, estimates indicate less volatility. However, in both cases, it can be seen that the medium and long-term effect is greater than the short-term effect. This would suggest that although public spending has lost power to stimulate economic activity, this result would correspond mainly to the short term, while in the medium and long term spending has not lost as much power to boost GDP. In addition, it can be seen that in the period 2005-2017, the value of said multipliers is oscillating around 1.5 soles.

What are the factors that determine the behavior of the spending multiplier? To provide a quantitative answer to this question, regression analysis will be used where the estimated spending multiplier will be the endogenous variable and the exogenous variables will be determined by the economic literature. In this way, it will be possible to contrast proposed hypotheses about the factors that explain the multiplier.

The first hypothesis proposed follows Auerbach and Gorodnichenko (2012) who postulate that, in an expansion scenario, the spending multiplier is lower than in a recessionary period. In this sense, the estimated cycle of the Perron and Wada (2009) model will be introduced as a determinant of the multiplier to evaluate said approach. On the other hand, Berg (2014) argues that the spending effect tends to be greater in periods of financial stress because liquidity restrictions increase. To evaluate this effect, the spread between the active and passive rate is used. In particular, a higher spread can represent situations of financial stress, since banks raise the lending rate in response to greater uncertainty and reduce the deposit rate due to lower income from unpaid loans.

Likewise, according to Galí, López-Salido, and Vallés (2007), the size of the multiplier can vary depending on the degree of credit restrictions in the economy. An expanding credit market will imply fewer restrictions for households, this will translate into a greater magnitude of Ricardian agents in the economy, so the effect of fiscal policy will decrease. In line with this approach, credit growth will be introduced[5]as a determinant of the multiplier. On the other hand, the literature suggests that the stability of public finances has effects on the credibility and confidence of agents, and therefore on the effects that fiscal policy may have on GDP (Ilzetzki et al., 2013). In this regard, it is argued that greater stability leads to a greater multiplier effect. To assess this effect, the ratio of public debt to GDP will be introduced as a determinant of the multiplier.

Likewise, the Keynesian model suggests that the size of the multiplier can be affected by the degree of trade openness and the savings rate (Kirchner et al., 2010). In the first case, when the economy is open to trade, the additional household income can be distributed among national or imported goods. If the economy is more open, more of the income will go to imported goods and the multiplier effect will be smaller. In the same way, if the level of household savings is high, when receiving additional income, households will allocate this to their savings and their additional consumption will be low. In this sense, greater savings will generate a lower multiplier effect. To analyze the implications of these hypotheses, the ratio of exports plus imports to GDP and the savings rate will

[5]Credit growth is used instead of the credit-to-GDP ratio, since although the credit-to-GDP ratio measures the level of financial development, it does not necessarily capture the credit constraints faced by agents from period to period. In that sense, credit growth can measure how credit crunch evolves. In particular, if credit growth is higher, credit restrictions will be less, so the multiplier effect will be less.

be included.

The regression analysis will distinguish short-term and long-term effects. To study the short-term implications, the impact multiplier (Annex 4 - Panel a) will be used as the endogenous variable, while to study the long-term the accumulated multiplier (Annex 4 - Panel b - yellow line) and value multiplier will be used. present (Annex 4 - Panel c - yellow line) both at the end of the impulse horizon. Due to the nature of the public spending multiplier, it can influence the value of the determinants through different channels. In this sense, to control for the possibility of reverse causality in the regression, the determinants lagged one period are used. Also, a constant and a trend are introduced in the model. On the other hand, the Newey-West method is used to control for heteroscedasticity and autocorrelation in the residuals. Finally, with the aim ofTo compare the effects of the factors and determine which variables have a stronger effect on the multipliers, the standardized coefficients are presented.

Table 6: Determinants of fiscal multipliers

| | Impact Multiplier | Accumulated Multiplier | Present Value Multiplier |
|---|---|---|---|
| Business Cycle | -0.08 | -0.51** | -0.51*** |
| | (-1.78) | (-1.63) | (-1.70) |
| Interest Rate Spread | 0.20 | 0.11 | 0.15 |
| | (-0.86) | (-0.94) | (-0.89) |
| Credit Growth | -0.30** | -0.44** | -0.41* |
| | (-0.31) | (-0.44) | (-0.48) |
| Debt/GDP Ratio | -1.61** | -1.56** | -1.90** |
| | (-2.55) | (-1.50) | (-1.21) |
| Export and Import/GDP | -0.94** | -0.24 | -0.43* |
| | (-1.93) | (-1.65) | (-1.62) |
| Savings Rate | -0.07** | 0.06 | 0.02** |
| | (-0.35) | (-0.79) | (-0.65) |
| Constant | 8.80** | 5.54*** | 6.17*** |
| | (-2.03) | (-1.05) | (-0.97) |
| Trend | -0.02** | -0.02*** | -0.02*** |
| | (-0.01) | (-0.01) | (-0.01) |
| Adjusted R-squared | 0.73 | 0.59 | 0.63 |

*Note*: The estimation was conducted controlling for heteroscedasticity and autocorrelation in the residuals using the Newey-West methodology. The lag lengths for autocorrelation of errors were selected based on the AIC criterion. All variables enter with a lag of one period. The coefficients presented in the table are standardized coefficients. Standard errors are shown in parentheses. The symbols ***, **, and * represent the significance levels at 1%, 5%, and 10%, respectively.

The estimates are presented in Table 4.Regarding the determinants of the impact multiplier, it is estimated that the effect of the position of the economic cycle is indeed negative, but it is not significant. This implies that, although the effect of public spending is less in periods of expansion, the difference with the multiplier effect in times of recession is insignificant, at least at the moment of impact. This evidence contrasts with the results presented by Sánchez and Galindo (2013), who estimate that the multiplier effect is greater in periods of recession.[6].

In order to assess the robustness of this result, the different economic cycle estimation methodologies reported in Annex 2 – Panel(c) were used as substitute exogenous variables for the cycle calculated by the UC model. The results of the estimations indicate the same results. However, although in the short term the cycle phase does not play a role in the size of the multiplier, the results indicate that in the long term the cycle phase does have a significant effect, which can be observed in the multiplier results. cumulative and present value multiplier. These results are similar to those reported by Kirchner et al. (2010).

On the other hand, it is estimated that the effect of financial stability, measured through the interest rate spread, is positive in the size of the multiplier, which would suggest that, in periods of financial stress, the expense multiplier is actually higher, as the literature suggests it. However, this effect is not significant in both the short and long term.

Regarding the degree of credit restrictions, it is estimated that an increase in the credit growth rate, which implies less credit restrictions for agents, leads to a reduction of -0.33 standard deviations of the expense multiplier. In particular, if credit registers a greater expansion, more agents will follow a Ricardian behavior and the multiplier effect will be less. This dynamic is compatible with the Peruvian case according to estimates. Likewise, evidence is presented that this effect is significant in the long term.

On the other hand, the results indicate that an increase in the magnitude of public debt with respect to GDP has a negative and significant impact on the public spending multiplier both in the short and long term. In addition, it is estimated that, of the determinants analyzed, the debt to GDP ratio is the main determinant of the expense multiplier, since the impact of this variable is equivalent to-1.61 standard deviations in the multiplier, which is greater than all other cases. An important policy implication derived from this result is that the government can increase the power of fiscal spending to boost economic activity by reducing and controlling the level of debt relative to GDP. This measure would not only make it possible to increase the power of fiscal policy in the short term, but also in the long term, according to the estimates made in this paper.

Regarding the level of trade openness, measured through the ratio of exports plus imports to GDP, it is estimated that an increase in this variable decreases the spending multiplier, which would be in line with standard Keynesian theory. In addition, it is recorded that said effect is significant at 1%. Likewise, the results indicate that a higher savings rate generates a significant negative impact on the spending multiplier, as suggested by Keynesian theory. However, the results for both the degree of openness and the savings rate are not significant in the long run.

[6]These authors estimate that in periods of growth the multiplier oscillates between 0.48–0.62, while in times of low growth it is between 1.25–1.35. In this regard, although the authors study the non-linearities in the multiplier with an LSTVAR model, they do not evaluate the possibility of changes in the parameters as Mendoza and Melgarejo (2006) detected early. Likewise, the sensitivity analysis presented by the authors shows that the difference between the boom and expansion multipliers is very sensitive to the specification of the smoothing parameter. These elements suggest that the results of Sánchez and Galindo (2013) may not be plausible.

### 6.4 Sensitivity Analysis

In order to study the robustness of the results presented in the previous sections, modifications to the main model will be implemented. First, we will proceed to estimate the model with different specifications of the priors. Second, we will proceed to estimate the model with L=2 and then replace the SPGSCI index with the terms of trade. The results of stochastic volatility, the average impulse response function, the evolution of the normalized impulse response at the moment of impact and the spending multiplier will be presented, all for the case of GDP.

Regarding the first case, the Primiceri (2005) specification will be used: , and . The second specification will be based on Castillo, Montoya and Quinache (2016) who estimate a TVP-VAR-SV for Peru: , and . The estimates are presented in Annex 5 – Figure 10. In general, the results indicate that there are no substantial differences when the priors are modified.$k_1 = 0.01 k_2 = 0.01 k_3 = 0.1 k_1 = 0.01 k_2 = 1 k_3 = 0.1$Regarding the second case, the model is estimated using 2 lags and then the model is estimated substituting the SPGSCI with the terms of trade. The estimation of the models is presented in theAnnex 5 – Figure 11. In the case of volatility, certain differences are recorded at the beginning of the sample, but the volatility pattern that follows is maintained in all cases. Regarding the average response impulses and the evolution of the response impulse, it is verified that the different specifications show equivalent results. In short, the sensitivity analysis suggests that the estimates of the main model are robust against the different specifications.

## 7 Conclusions

This research studies the effects of public spending on real economic activity over time. A TVP-VAR-SV model is used, which is identified by means of agnostic sign restrictions. To verify the existence of changing parameters in the model, three tests were calculated: the Cogley and Sargent test, the Kolmogorov and Smirnov test, and the t-test. The results of the tests suggest that the parameters have not remained constant, which supports the use of the TVP-VAR-SV model. The results show that public spending has lost power to boost economic activity after 1999. However, when studying the determinants of the spending multiplier, it is estimated that the debt to GDP ratio, which represents fiscal stability in the model, it's the most important factor.

# 8 Bibliography


1. Aiyagari, SR, Christiano, LJ, & Eichenbaum, M. (1992). "The output, employment, and interest rate effects of government consumption". Journal of Monetary Economics, 30(1), 73-86.

2. Auerbach, AJ, & Gorodnichenko, Y. (2012). "Measuring the output responses to fiscal policy". American Economic Journal: Economic Policy, 4(2), 1-27.

3. Mud, R. J. (1974). Are government bonds net wealth? Journal of political economy, 82(6), 1095-1117.

4. Mud, R. J. (1981). "Output effects of government purchases". Journal of Political Economy, 89(6), 1086-1121.

5. Baxter, M., & King, RG (1993). "Fiscal policy in general equilibrium". The American Economic Review, 315-334.

6. Berg, TO (2015). "Time varying fiscal multipliers in Germany". Review of Economics, 66(1), 13-46.

7. Bijsterbosch, M., & Falagiarda, M. (2015). "The macroeconomic impact of financial fragmentation in the euro area: Which role for credit supply?". Journal of International Money and Finance, 54, 93-115.

8. Bilbiie, F., Ghironi, F., & Melitz, MJ (2005). "Business cycles and firm dynamics". In 2005 meeting papers (Vol. 842). Society for Economic Dynamics.

9. Blanchard, O., & Perotti, R. (2002). "An empirical characterization of the dynamic effects of changes in government spending and taxes on output". The Quarterly Journal of economics, 117(4), 1329-1368.

10. Caballero, RJ, & Pindyck, RS (1996). "Uncertainty, Investment, and Industry Evolution". International Economic Review, 37(3), 641-662.

11. Castillo, P., Montoya, J., & Quineche, R. (2016). "From the "Great Inflation" to the "Great Moderation" in Peru: A Time Varying Structural Vector Autoregressions Analysis". Working paper No. 2016-003. Central Reserve Bank of Peru.

12. ECLAC, N. (1999). "Macroeconomic effects of the El Niño phenomenon of 1997-1998: its impact on the Andean economies".

13. Céspedes, LF, & Galí, J. (2013). "Fiscal Policy and Macroeconomic Performance". Central Bank of Chile.

14. Cogley, T., & Sargent, TJ (2005). "Drifts and volatilities: monetary policies and outcomes in the post WWII US". Review of Economic Dynamics, 8(2), 262-302.

15. Devereux, MB, Head, AC, & Lapham, BJ (1996). "Monopolistic competition, increasing returns, and the effects of government spending". Journal of Money, Credit and Banking, 28(2), 233-254.

16. Fatás, A., & Mihov, I. (2001). “The effects of fiscal policy on consumption and employment: theory and evidence”.

17. Fry, R., & Pagan, A. (2007). “Some issues in using sign restrictions for identifying structural VARs”. National Center for Econometric Research Working Paper, 14, 2007

18. Galí, J., López-Salido, JD, & Vallés, J. (2007). “Understanding the effects of government spending on consumption”. Journal of the European Economic Association, 5(1), 227-270.

19. Gambetti, L., & Musso, A. (2017). “Loan supply shocks and the business cycle”. Journal of Applied Econometrics, 32(4), 764-782.

20. Ganiko, G., & Montoro, J. (2017). “Fiscal rules for commodity exporters: An application for Peru”. Research Document No. 001-2017. Fiscal Council.

21. Glocker, C., Sestieri, G., & Towbin, P. (2017). “Time-varying fiscal spending multipliers in the UK”. Bank of France.

22. Guillén, Á., & Rodríguez, G. (2014). “Trend-cycle decomposition for Peruvian GDP: application of an alternative method”. Latin American Economic Review, 23(1), 5.

23. Yamada, G., & Castro, J. (2010). ”The Peruvian economy in the last decade: better performance and greater resilience to crises”. University of the Pacific - CIUP.

24. Ilzetzki, E., Mendoza, MEG, & Gramont, MCAV (2011). How big (small?) are fiscal multipliers? (No. 11-52). International Monetary Fund.

25. Kirchner, M., & Cimadomo, J. Hauptmeier (2010) “Transmission of government spending shocks in the euro area: time variation and driving forces”. ECB Working Paper Series 1219, European Central Bank.

26. Liébana, PL (2001). The peruvian experience with financial liberalization, 1990–1999. manuscript. Chicago: Northwestern University.

27. Linnemann, L., & Schabert, A. (2003). “Fiscal policy in the new neoclassical synthesis”. Journal of Money, Credit, and Banking, 35(6), 911-929.

28. Mendoza, W., & Goicochea, EC (2017). “The PPK economy. Promises and results: the distance that separates them”. Department of Economics PUCP -DDD440.

29. Mendoza, W., & Melgarejo, K. (2008). ”The effectiveness of fiscal policy in Peru: 1980-2006”. Department of Economics PUCP - DDD262.

30. Mountford, A., & Uhlig, H. (2009). “What are the effects of fiscal policy shocks?”. Journal of applied econometrics”, 24(6), 960-992.

31. OECD, et al. (2015). “Revenue Statistics in Latin America and the Caribbean 2015”. OECD Publishing, Paris.

32. Pereira, MC, & Lopes, AS (2010). “Time-varying fiscal policy in the US”. Working Papers w201021, Bank of Portugal. Economics and Research Department.

33. Perotti, R. (2005). “Estimating the effects of fiscal policy in OECD countries”.

34. Perron, P., & Wada, T. (2009). “Let's take a break: Trends and cycles in US real GDP”. Journal of monetary Economics, 56(6), 749-765.

35. Bai, J., & Perron, P. (2003). Computation and analysis of multiple structural change models. Journal of applied econometrics, 18(1), 1-22.

36. Primiceri, G.E. (2005). “Time varying structural vector autoregressions and monetary policy”. The Review of Economic Studies, 72(3), 821-852.

37. Qin, D. (2013). “A history of econometrics: the reformation from the 1970s”. Oxford University Press.

38. Radetzki, M. (2006). “The anatomy of three commodity booms”. Resources Policy, 31(1), 56-64.

39. Ramey, VA, & Shapiro, MD (1998, June). “Costly capital reallocation and the effects of government spending”. In Carnegie-Rochester Conference Series on Public Policy (Vol. 48, pp. 145-194). North-Holland.

40. Saavedra, J. (2003). “Trade liberalization and manufacturing industry in Peru”. Development Analysis Group and Economic and Social Research Consortium.

41. Salinas, C. & Chuquilin, M. (2013). “The asymmetries of fiscal policy in an emerging economy: the case of Peru, 1992-2013”. Editorial Fund, University of the Pacific.

42. Sanchez, W., & Galindo, H. (2013). “Asymmetric Multipliers of Public Expenditure and Taxes in Peru”. Working document, Ministry of Economy and Finance.

43. Sims, CA (2001). “Evolving Post-World War II US Inflation Dynamics”: Comment. NBER macroeconomics annual, 16, 373-379.

44. Stock, JH (2001). “Evolving Post-World War II US Inflation Dynamics”: Comment. NBER macroeconomics annual, 16, 379-387.

45. Velarde, J., & Rodríguez, M. (2001). “Effects of the international financial crisis on the Peruvian economy 1997-1998”. University of the Pacific and CIES.

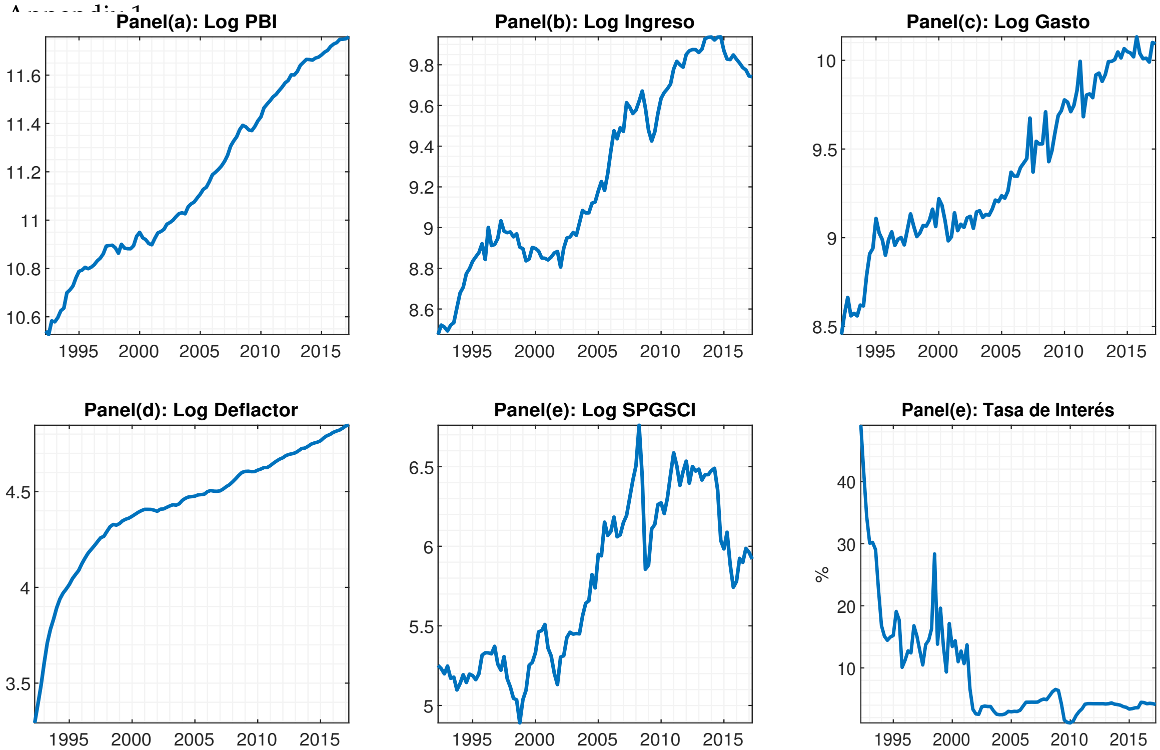


Figure 1: Series in Levels. GDP, Expenditure, Income, were seasonally adjusted using CENSUS X13. In the case of the interest rate, no logarithm has been taken. Source: BCRP.

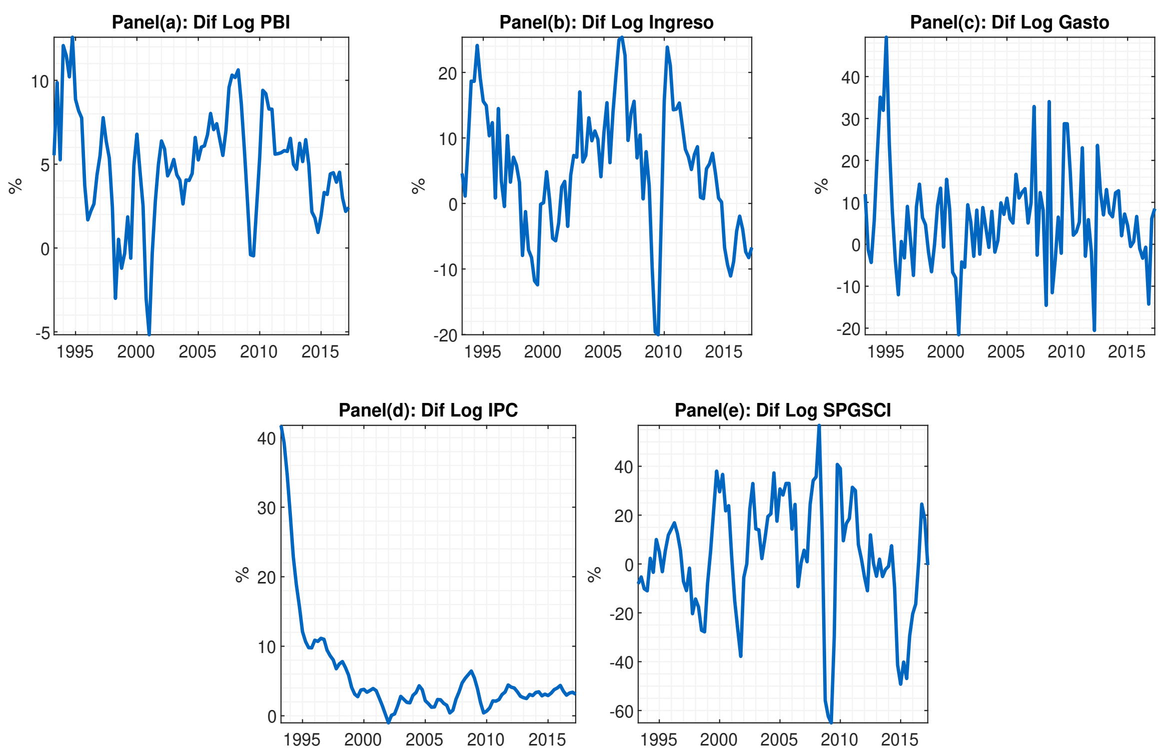


Figure 2: Series in differences. The annual difference has been taken, that is, with respect to the same quarter of the previous year. The interest rate has not been differentiated. Source: BCRP.

Appendix 2

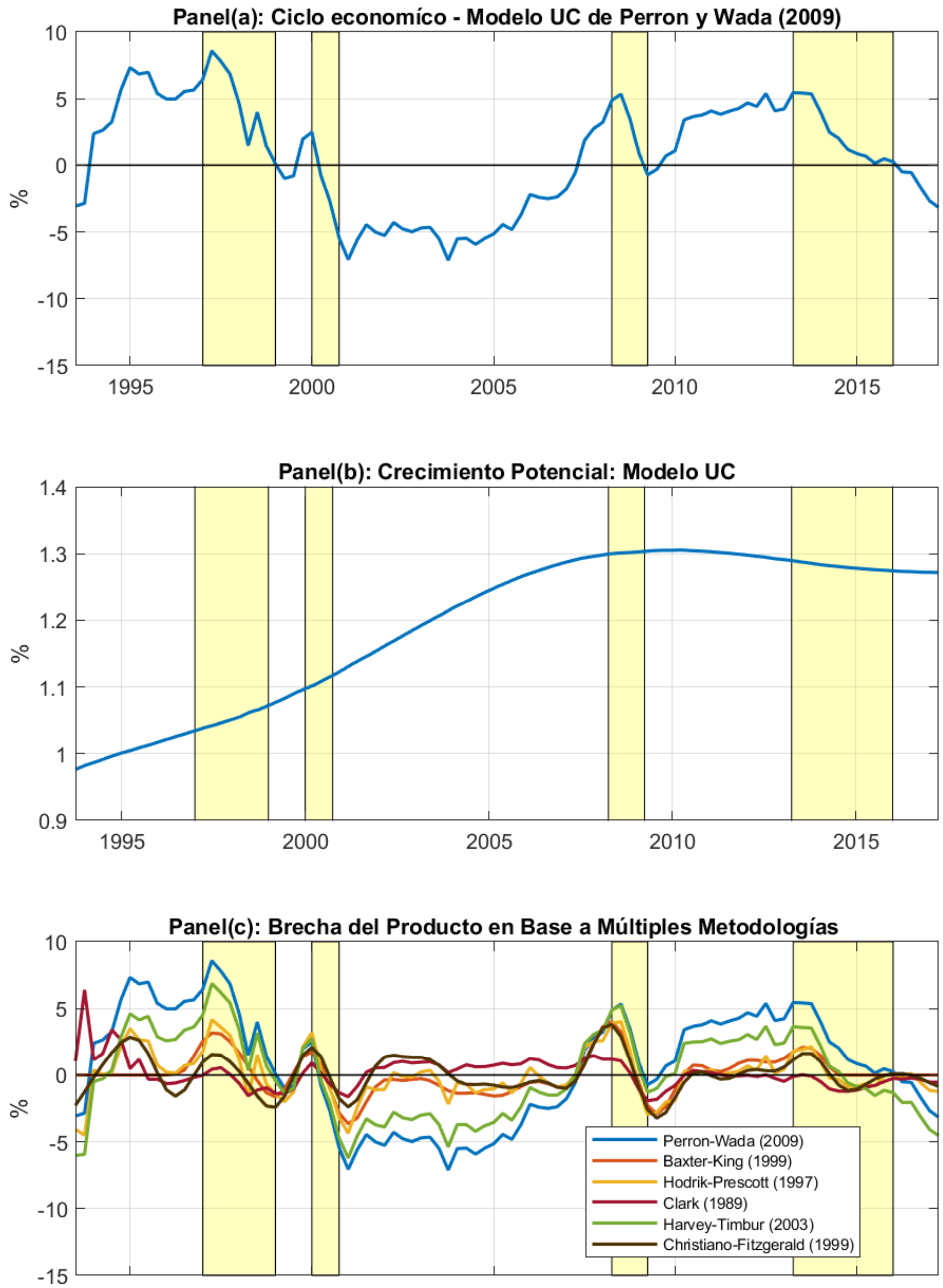


Figure 3: Economic Cycle. The first graph: estimated cycle of the UC model assuming endogenous break and mixture of normals in the trend and the cycle. The second graph: growth of the estimated trend of the UC model. The third graph compares the estimation of the UC model with other filters usually used in macroeconomics. In all cases, the shaded area represents the recession periods identified by the Unobservable Components (UC) Model.

Annex 3.A

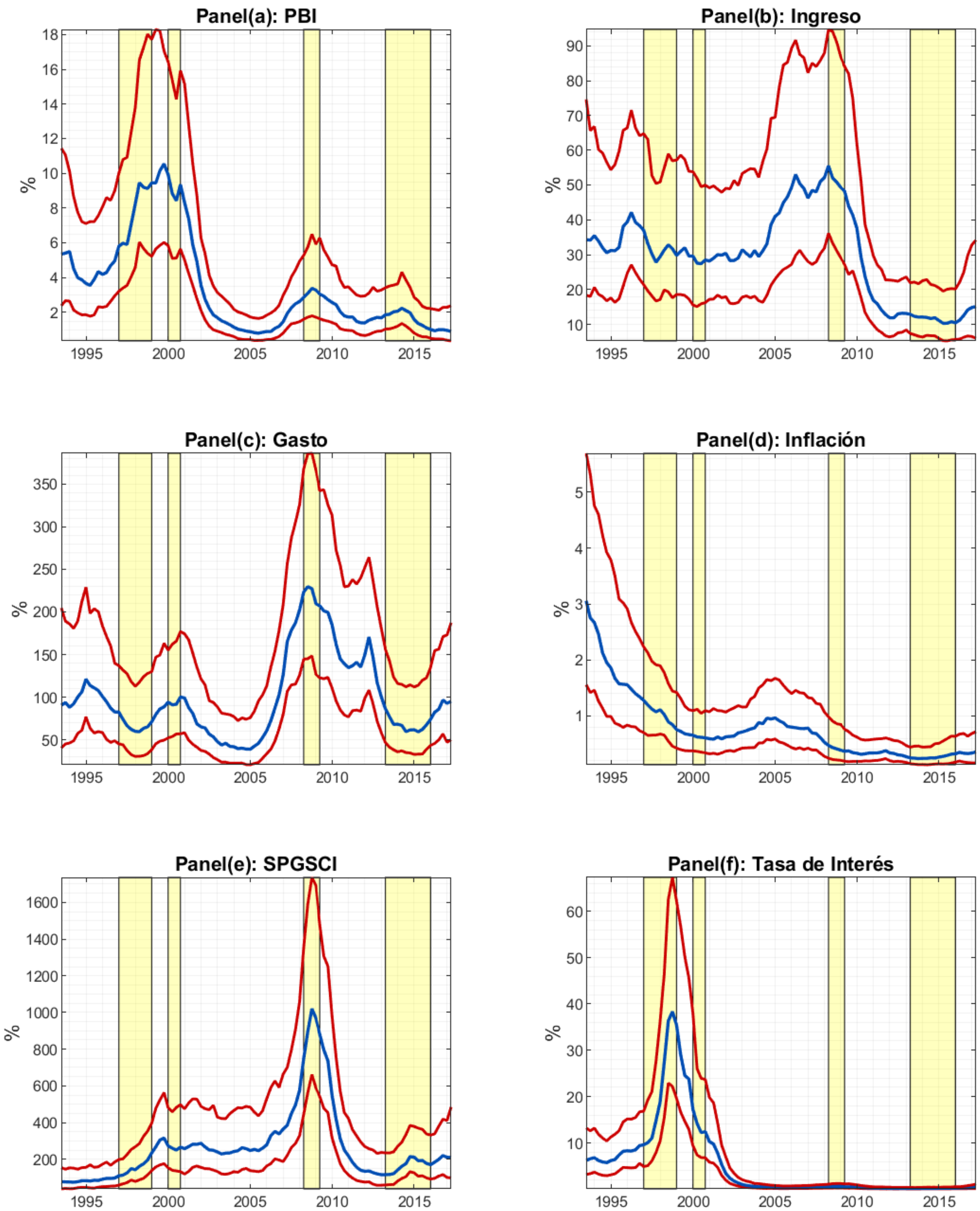


Figure 4: Stochastic Volatility. The red lines represent the 68% confidence bands. The upper red line and the lower red line represent the 84% and 16% percentiles of the posterior distribution. Likewise, the blue line represents the 50% percentile. The shaded area represents the recession periods identified by the UC model.

Annex 3.B

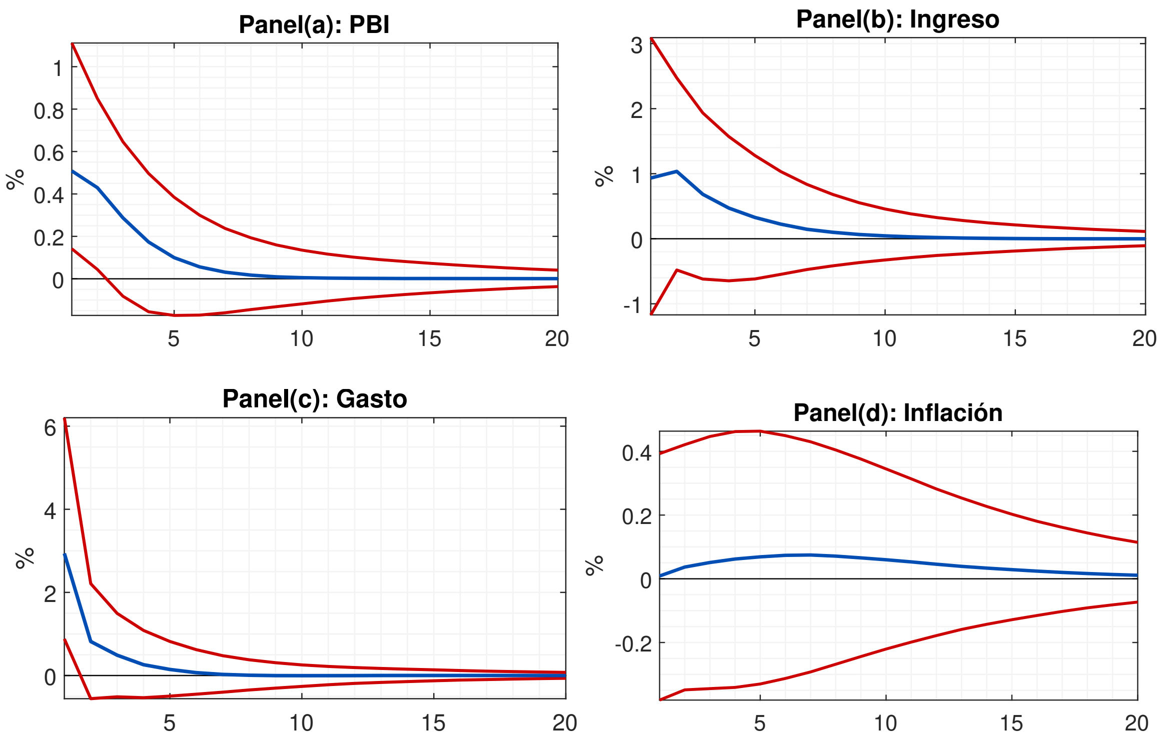


Figure 5: Expenditure Shock. The upper red line and the lower red line represent the 84% and 16% percentiles, respectively. Likewise, the blue line represents the 50% percentile. The analysis horizon is 20 quarters.

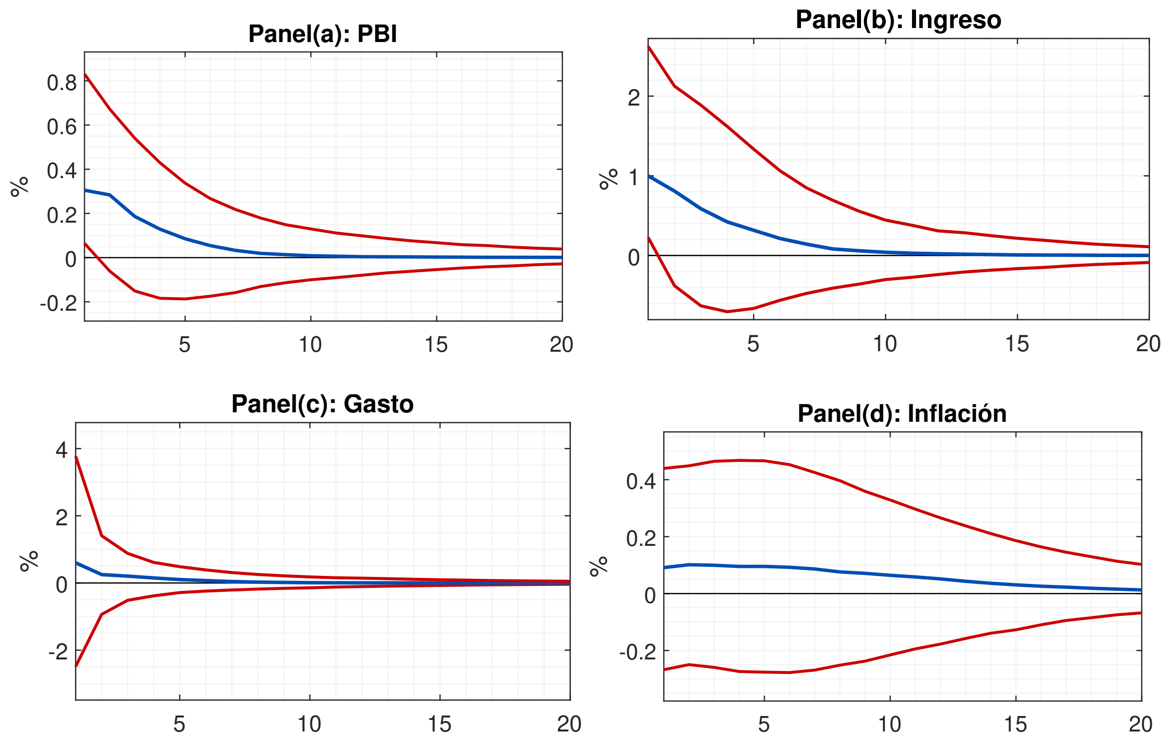


Figure 6: Tax Shock. The upper red line and the lower red line represent the 84% and 16% percentiles, respectively. Likewise, the blue line represents the 50% percentile. The analysis horizon is 20 quarters.

Annex 3.C

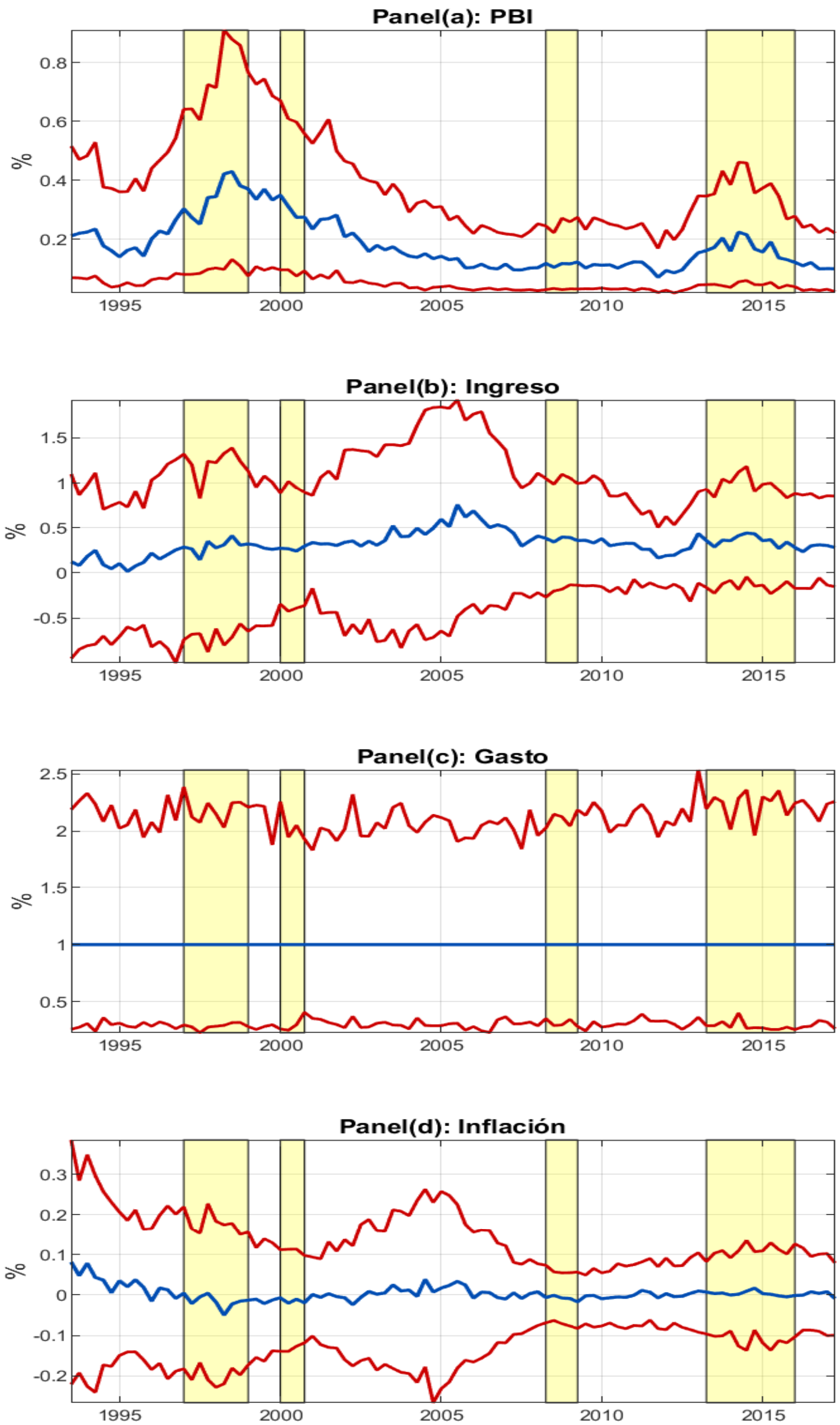


Figure 7: Shock of Expenses at the moment of normalized impact. The red lines represent the 84% and 16% percentiles, respectively. Likewise, the blue line represents the 50% percentile. The spending shock was normalized to 1%. The shaded area represents the recession periods identified by the UC model.

Annex 4

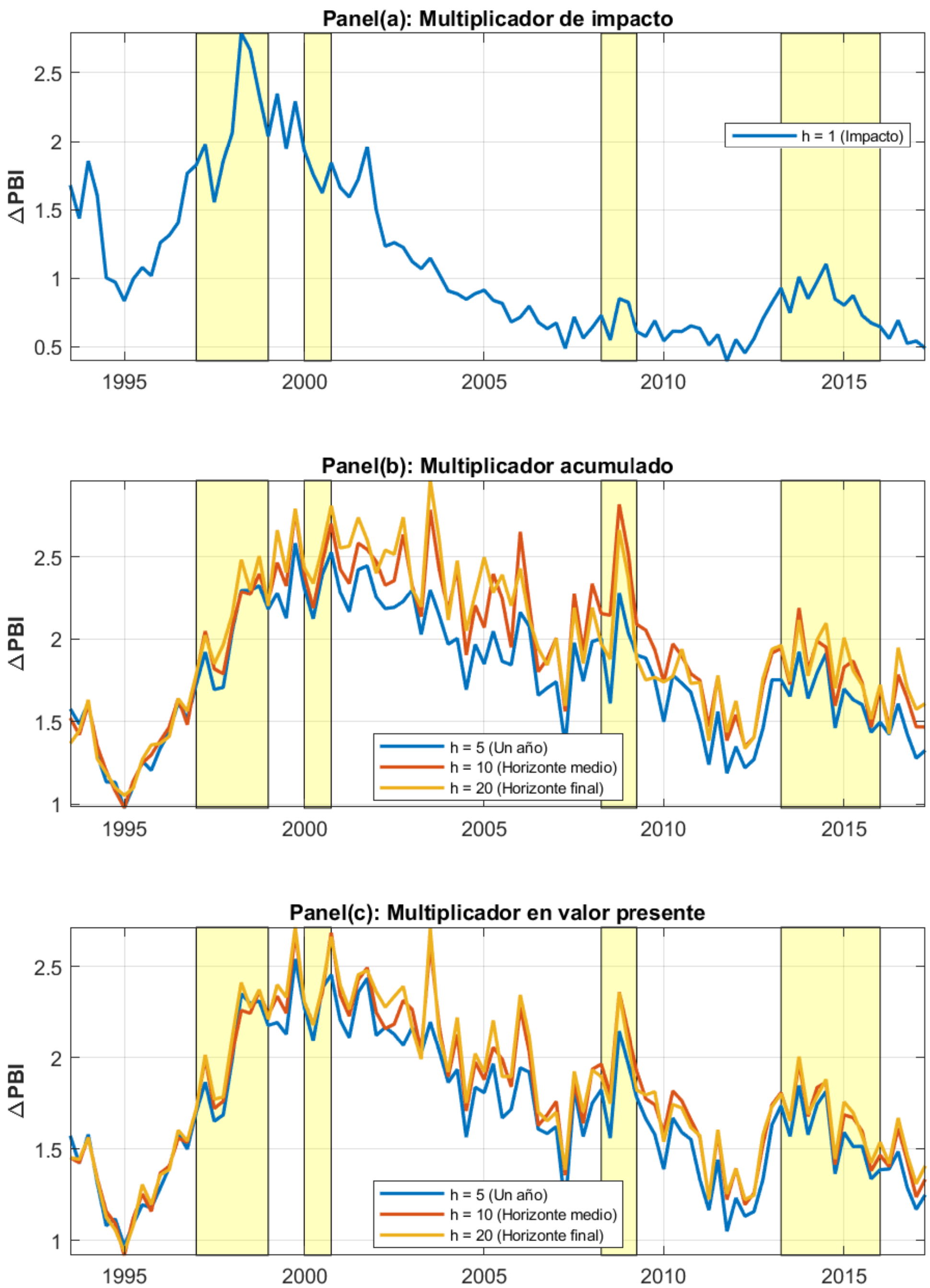


Figure 8: Spending Multipliers. Panel(a) shows the impact multiplier at h=1 calculated using formula (1) from Section 3. The blue line represents the Graphsn of the simulations. Panel(b) and Panel(c) show the cumulative multiplier and the present value multiplier, respectively. In both cases, the Graphsn of the simulations is presented in three different periods, at h=5, that is, 1 year after the impact, at h=10, which is equivalent to the middle of the horizon, and at h=20, the end of the horizon of the impact. impulse response. The cumulative multiplier and the present value multiplier are calculated with formulas (2) and (3) of Section 3, respectively. The shaded area represents the recession periods identified by the UC model.

Annex 5

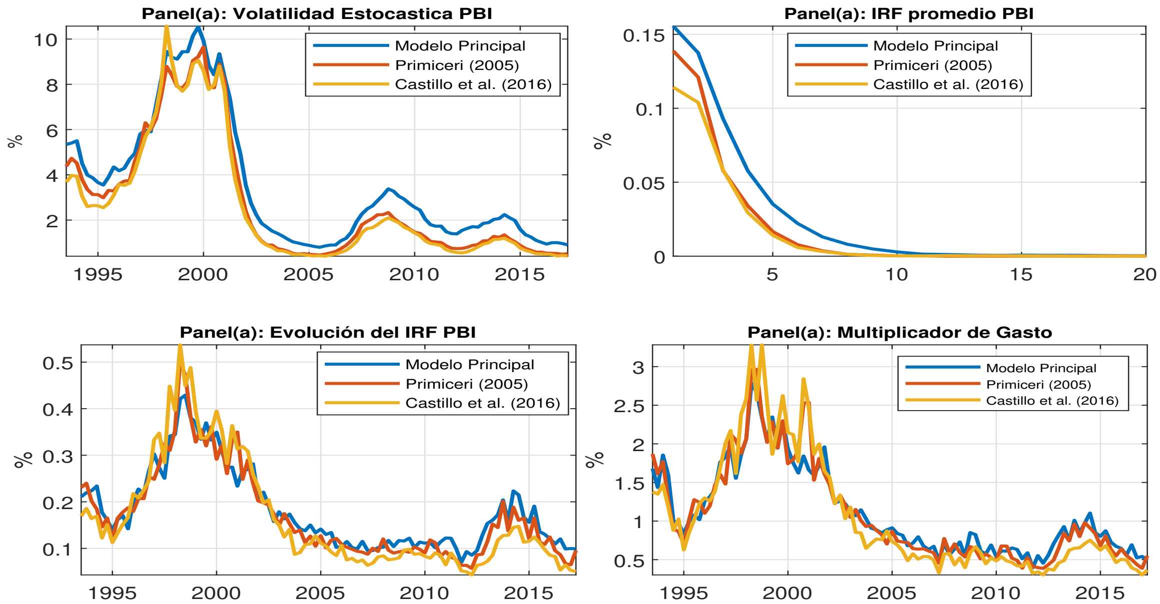


Figure 10: Sensitivity analysis 1. Stochastic volatility, the average impulse response function, the evolution of the normalized impulse response at the moment of impact and the expense multiplier are presented. Everything for the case of GDP. The results of the main model and the results of the estimation using the priors of Primiceri (2005) and Castillo et al. (2016).

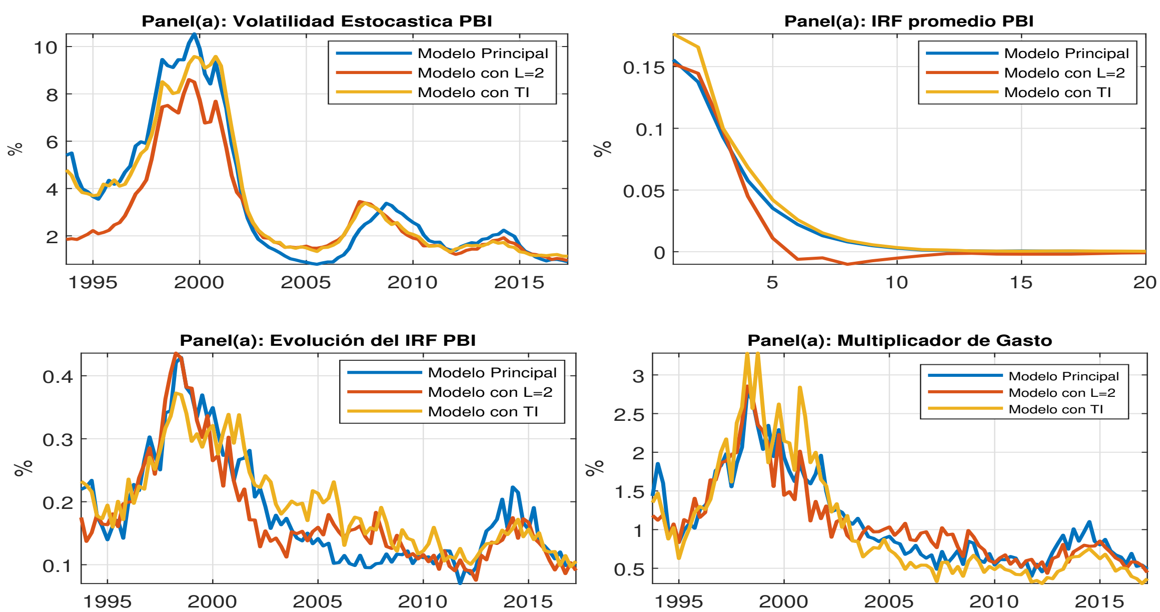


Figure 11: Sensitivity analysis 2. Stochastic volatility, the average impulse response function, the evolution of the normalized impulse response at the moment of impact and the expense multiplier are presented. Everything for the case of GDP. The results of the main model and the results of the estimation using two lags and the results of the model replacing the SPGSCI with the terms of trade are shown.