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Dynamic Fiscal Multipliers for a Small and Open Economy

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Fotografía de portada: “Presentes”, conjunto escultórico en bronce, año 1983, del artista costarricense Fernando Calvo Sánchez. Colección del Banco Central de Costa Rica.

Multiplicadores fiscales dinámicos para una economía pequeña y abierta

Valerie Lankester Campos[†], Kerry Loaiza Marín[‡]

Resumen

Para determinar la efectividad de la política fiscal sobre la economía costarricense, se utiliza un modelo de vectores autorregresivos estructurales con datos trimestrales desde 1991 hasta 2018 para estimar sus multiplicadores. De los resultados se concluye que mayor flexibilidad del gasto mejora la efectividad de la política fiscal y que el efecto negativo de incrementos en impuestos es altamente persistente en el tiempo. Además, se analiza con un modelo de vectores autorregresivos de transición suave, el cambio en los multiplicadores bajo dos regímenes de crecimiento, por debajo o por encima del producto potencial. Los resultados sugieren que decisiones sobre el gasto de consumo y de capital, tienen un efecto positivo sobre el crecimiento en las recesiones, pero negativo en expansiones. Una posible explicación para este último resultado es el alto déficit fiscal, que canaliza el mecanismo de transmisión a través de expectativas negativas y el efecto estrujamiento. Finalmente, dadas las estimaciones, existe una recomendación clara e intuitiva de política: una política fiscal expansiva mediante incrementos en el gasto de consumo o en el de capital pueden ayudar a salir de una crisis economómica, pero se debe dar especial atención al proceso de financiamiento y a la validez temporal de dichos cambios.

Palabras clave: finanzas públicas, mecanismos de transmisión, multiplicador fiscal, política fiscal, VARE, VAR-TS, macroeconometría, estructura tributaria.
Clasificación JEL.: C32, E62, H20, H50.

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Summary

In order to determine the effectiveness of Costa Rica's fiscal policy, we use a structural autoregressive vector model with quarterly data from 1991 to 2018 to estimate its multipliers. From the results, it is possible to conclude that a more flexible expenditure improves fiscal policy effectiveness, and that the effect of increments in taxes is negative on output and highly time persistent. The analysis is complemented with the results of a smooth transition autoregressive vector model, for different output scenarios (over and under potential growth), which shows that increments in government consumption and capital expenditure have different impact given the economic cycle; it is positive during recessions but negative in expansions. A possible explanation for the latter is the high fiscal deficit, which channels the transmission mechanism through negative expectations and crowding-out effects. Finally, given our estimations, there is an intuitive fiscal policy recommendation: expansionary fiscal policy through increases in government consumption or capital expenditures may help overcome a crisis, but special attention should be drawn towards its funding and temporal validity.

Key words: public spending, government revenues, Ricardian equivalence, VAR, SVAR, STVAR, structural change, macroeconometrics, tax structure.
JEL codes: C32, E62, H20, H50.

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1 Introduction

After the 2008 financial crisis, the debate among economists on the possible impact of fiscal policy on economic growth strengthen, as many governments decided to implement stimulus programs, even when there was no consensus in the literature about its effectiveness. Theoretically, the discussion circles around the two main streams of the economic thought: the Neoclassic and Neokeynesian.

Under the latter, the expenditure multiplier is expected to be positive given that the government expenditure will result in an increase of the aggregated demand, boosting local production. While within Neoclassical view, a negative result is expected as the increase in the public expenditure is perceived as an action to be financed in the future with more taxes.

In general, the income multiplier is expected to be negative, as the impact of more taxes on disposable income lowers consumption. But still, there are some cases were the results point to a positive outcome which although might seem unusual, has been interpreted within high public debt contexts, as a positive signal. Therefore, an increase in taxes is perceived by economic agents as positive for public finances, diminishing uncertainty and promoting economic activity.

Given this context, empirically, the magnitude and sign of the impact of fiscal policy on production has been the center of debate when evaluating the actions policymakers could take in order to affect the economy. Therefore, the relevance of quantifying such effect is of critical importance; specifically, for the actual fiscal context of Costa Rica and the international conditions, it seems urgent. We have to consider the increase in interest rates above the zero lower bound, the possible negative effects of the implemented actions in international commerce, adjusted financial conditions, geopolitical tensions, higher bills for oil imports, and a lower forecast for the international economy dynamics (IMF, 2018).

Under this scenery the main objective is to estimate the direction and magnitude of the fiscal multipliers in general, and particularly, their behaviour conditional on the state of the

economy. Multiple countries had used fiscal policy as an instrument to stabilize the economic activity but, is the dynamic effect of fiscal policy invariant to the state of the economy?

This research looks to bring evidence on this regard. It intends to characterize the effects of fiscal policy in a developing and open economy, by estimating its fiscal multipliers, which are understood as the response (in magnitude and direction) of growth to exogenous shocks on government expenditure and/or income. As these multipliers signal a measure of the effectiveness of fiscal policy, they are valuable inputs for public policy. For example, in a recession they would determine if a fiscal stimulus will have the expected outcome on economic growth and for how long.

For these estimations, other studies have included Costa Rica in a panel of countries, but this is the first time series study with quarterly data from 1991 until 2018.[1] Methodologically, we follow the seminal paper of Blanchard and Perotti (2002), which involves a structural autoregressive model and the use of impulse-response functions to measure the impact of shocks from a particular variable on the dynamics of other variables. There are two main reasons for its use. Firstly, changes in fiscal variables rarely obey to production stabilization, and secondly, decision making and implementation of fiscal policy is done with substantial lags, implying there is little space for discretionary policy changes with high frequency data.

In order to have a complete analysis of the effectiveness of fiscal policy, we additionally extend the model by including prices, interest rates, and the nominal exchange rate, following Perotti (2002). And also, we use the estimation method performed by Auerbach and Gorodnichenko (2012) in order to differentiate the responsiveness of fiscal policy conditional on the economic cycle.

The results obtained indicate that in Costa Rica, a change on government consumption, or what will be called flexible expenditure,[2] measured by the multiplier, has a positive and statistical significant impact on growth. Hence, an increase of 1% in flexible expenditure can be associated with an accumulated increment of 0.2% in production one year after the shock.

Even though, when differentiating this impact by the economic cycle, we see that for recessions it maintains a positive effect but it is negative in expansions. This may be explained by arguing that expenditure increases in expansions are perceived as an increment in the total debt level or in future taxes, which imply either a crowding out effect and less

[1] In the fiscal data, there was a methodological change between 2006 and 2009, when they changed from cash based to accrued. For research, this has implied a major limitation as the time series were not overlapped. Even though, we were able to join the series obtaining the longest fiscal data series for Costa Rica at this time.

[2] Public expenditure in Costa Rica is highly inflexible, as more than 90% relative to tax income is determined by law or constitution. What we will call flexible expenditure is what is considered as government consumption in other contexts. Therefore, flexible expenditure will be the percentage of total expenditure for which the incumbent has some degree of freedom, as it is not determined by law or constitution.

credit availability, or a drop of the agent's expected disposable income. Both which have a negative effect on production.

The tax income multiplier turned to be negative and statistically significant. Therefore, an addition of 1% in tax income is associated with an accumulated decline of 0.08% in the production one year later. When considering the economic cycle, the response of growth is positive in expansions and negative during recessions. The recessions' effect is intuitive: reductions in the disposable income and business' profits lessens the aggregated demand. But, the positive result for expansions should be taken with caution. Two hypothesis arise as explanations. In terms of methodology, it is not possible to separate the reverse causality problem between economic activity and tax income (issue that seems to not be present in the linear SVAR model). Or we may have found evidence of what has been named in the literature as an "expansionary fiscal contraction or consolidation", which relies on the argument that economies with high public debt levels could experience a boost if agents' expectations consider the tax change to be linked with an improvement of public finances, and future macroeconomic stability.

The methodology and these results will be explained in detail in section four and five, and will be preceded by a review of the theoretical and empirical literature on the topic, and by a characterization of the Costa Rican fiscal context, in order to have a comprehensive framework before the discussion of the results and robustness checks, which are presented in section six. The seventh section expands on the characterization of the dynamics of fiscal policy as it presents additional results. Specifically, it includes specifications with private consumption and investment, and the effect of current and capital public expenditure. The eighth and last section concludes summarizing the results, comparing the results with the empirical evidence from other countries, establishing the limitations of the presented estimations and mentioning areas for further research on the topic.

2 Literature Review

Empirical studies, within this topic, have shown divergent conclusions based in a wide spectrum of assumptions, and are inconclusive on the effect fiscal policy may have on growth in the short, medium, and long run. In general, the effects in the short run have been described through aggregate demand, while the medium and long term effects through the supply side. Therefore, it seems that effectiveness of fiscal policy will depend on the temporal horizon considered, the assumptions about the agents' behavior, and the credibility of the decisions taken by the government.

The conclusions of the theoretical models on this matter are also divergent. The Keynesians

and Neokeynesians would forecast a consumption, and hence, a demand response in the same direction with a fiscal policy expansion. While Neoclassicals would predict a zero or even negative effect. For the former, the aggregate demand is composed by consumption, investment, public expenditure, and net exports. Therefore, its variations generate an impact on employment and real GDP, before that on the price level. An increase in each of its components (one at the time), ceteris paribus, would generate an increase in production of the same amount. Under the assumption of price rigidities, economic policy measures on the demand side will provoke variations in the level of production and employment. However once full employment is achieved, increments in the aggregate demand will only generate inflation (UPV/EHU, 2015). The traditional Neokeynesian theory assumes a medium term horizon, with myopic agents that do not consider the government's intertemporal budget constraint when making decisions. Under this context it is expected a positive equal multiplier in the short run.

On the other side, Neoclassical theory assumes rational agents, an infinite temporal horizon, an intertemporal budget constraint which considers the government's constraint, and decision making with long run perspectives.[3] Under their scope, an increase in the government expenditure today will be translated into an increase of tomorrow's taxes, therefore the disposable income would not change inter-temporally. As the agent could forecast this scenario, there are no changes in consumption. In other words, fiscal policy would be neutral (Ricardian equivalence); independently on how the expenditure is financed, it does not have an impact on consumption and hence neither on production. Within this line of thought, the markets of productive factors are highly flexible, which allow a quick convergence to equilibrium implying it is the aggregate supply the major component in the economic activity. At the same time, if it exists an inflation goal, there will exist pressure on prices which turns into interest rates increments with crowding out effects on private investments.

There exists other type of models that considers non-linear behavior, Sutherland (1997) is one of them. In the author's study, the agent behaves under the guidelines of the Keynesian theory when the public debt stock is low, but in a different way if the debt levels are excessive and considered as threat of insolvency for the future generations. In other words, the non-linearity is provoked by the insolvency probabilities of the public sector: if it is low, the individuals will not consider increases in short run taxes, but if the probability is high, then the agents save because increases in taxes would be imminent.

When looking at the empirical literature, there are also divergent results, which seem as context dependant. In general, positive short run expenditure multipliers due to expansionary

[3]These are based on Modigliani's life cycle theory, and Friedman's permanent income theory.

fiscal policies have been the outcome of macro structural models and VAR analysis, but they differ in magnitude and duration.

For the United States case, Blanchard and Perotti (2002) were the first to estimate in a convincing way fiscal policy effect, as methodologically they were able to isolate the reverse causality problems involved in the production's and fiscal variables' interactions. They found that expansive fiscal policy shocks increase output. From a direct expenditure shock, the private consumption responds positively and the private investment negatively. The identification method proposed was also adopted by Perotti (2002) for a sample of five OECD countries. The five equation system created included the gross domestic product, GDP, the GDP deflator, government expenditures, net government income, and the interest rate; but different results were obtained when comparing to those of Blanchard and Perotti (2002). The author concludes that fiscal policy effects on GDP and its components became weaker as time passed because he found that both income and expenditure multipliers, had negative effects.

As part of the varied results, Romer and Romer (2010) estimated for the United States that a 1% change in fiscal policy increases GDP around 1%, but it could raise to 2 or 3% when the effect is on its peak some years later. Also, Corsetti and Müller (2006) studied the fiscal shocks for the United States, Canada, United Kingdom, and Australia, and presented evidence of the twin deficit phenomena: it is more restricted in relatively closed economies, and the fiscal shocks are less persistent.

For open economies, Monacelli and Perotti (2006) used SVAR techniques, for a sample of OECD countries, to estimate the government expenditure shocks effects on the real exchange rate, the trade balance and their co-movements with GDP and private consumption. First, they found that in all the countries an increase in government expenditure lead to a depreciation of the real exchange rate, and a trade balance deficit. Second, in all the countries, private consumption increased in response to the same fiscal shock, and hence it co-moves positively with the real exchange rate. They argue that these results are in clear contrast with virtually all the complete financial market models and separable utility functions, including a Neokeynesian open economy model with rigid prices and capital accumulation. But that there exists an extension of the model, which includes non-separable preferences in consumption and leisure, that would support their results as it is capable of replicating (at least qualitatively) the consumption and real exchange rate responses they found in the data. Additionally, if the substitution elasticity between foreign and domestic products is sufficiently small, the model is also successful in showing the correct co-movement between the real exchange rate and trade balance.

As mentioned, Corsetti and Müller (2006) focused on the international transmission

mechanism of fiscal policy shocks through terms of trade, and showed that the probability and magnitude of the twin deficit increases in accordance to the economy's openness degree, and decreases with the persistence of fiscal shocks. They also found that, for a given fiscal shock persistence, the crowding out effect on investment is stronger in a relatively closer economy, meaning that its trade balance deterioration is not very sharp. Hence, given a greater openness degree, the crowding out effect on investment is stronger when the fiscal shock is persistent. The mechanism behind these results emphasizes an important macroeconomic trade for economic policy: fiscal expansions reduce the domestic capital or the trade balance.

There are also differences in fiscal policy effectiveness when conditioning on the economic cycle. Since the Auerbach and Gorodnichenko (2012) paper, more attention has been given to the fact that fiscal policy's impact will depend on the state of the economy. These authors, with changing regime models, found significant differences in the size of expenditure multipliers for expansions and recessions, with fiscal policy being considerably more effective in recessions than in expansions in the United States. Even when controlling for the fiscal shocks' expected components, the size of the multipliers tends to increase in recessions.

In contrast Owyang et al. (2013) with data from the United States and Canada examined if the government expenditure multipliers are bigger during slowdown periods. Particularly they looked to exploit information of the two World Wars and the Great Depression. They did not find larger multipliers in recession periods for the United States, but they did for Canada. Similarly for the United States, Caggiano et al. (2015) used a non-linear VAR model with expectation revisions on fiscal expenses to control for the private agents' fiscal prevision. The anticipated fiscal shocks measurements turned to be valuable information about the future public expenditure dynamics. With generalized impulse responses, the authors suggest that fiscal multipliers in recessions are larger than one, but are not statistically different from those in expansions. Subsequently, they argue that non-linearities emerge when considering extreme events, i.e. strong recessions against strong expansions.

For other countries, Baum et al. (2012) with a sample of G7 countries (excluding Italy) showed that fiscal multipliers are diverse between countries, and also dependant on the business cycle. They suggest that, on average, expenditure and income multipliers tend to be greater (in absolute value) in recessions than in expansions.

For the Turkish case, Cebi (2016) used local projection methods to estimate the fiscal multiplier variation in high and low growth, given the potential level. They found that fiscal policy is stronger in periods of low economic growth in comparison with times of high growth. While for France, Cléaud et al. (2017) found that the multiplier does not evolve significantly for any temporal horizon and that there is no evidence of a larger multiplier during recessions with a SVAR time-varying model, emphasizing the government expenditure in goods and

services.

When comparing, there is much more literature for developed countries, than for developing countries, and even more than for Latin American economies. Moreover, there are scarce estimations on fiscal policy effectiveness conditional on the state of the economy. But among all, there is a wide variability of results in magnitude, duration and even direction.

Restrepo and Rincón (2006), estimated SVAR and SVEC models for Chile and Colombia with data from 1990 until 2005. The authors looked to identify fiscal policy shocks and measure the peso by peso impact of an increase in taxes or in central government expenditure on GDP. They performed the Johansen cointegration test where Colombia presented evidence of one cointegrating vector, while the Chilean evidence was not conclusive towards the existence of cointegrating relationships among the variables. In order to achieve a complete analysis, they carried out the SVAR and SVEC estimations for both countries without significant differences in the results. They found that, when the public finances are under strict control, the Chilean case, fiscal policy seems to be more effective than when there is lack of stability and credibility, as the Colombian case since the mid 90's. Specifically, for Chile, an increase in one Chilean peso of tax income has a transitory negative effect on GDP of 40 cents, while the equivalent increment for government expenditure has a transitory positive effect of 1.9 pesos on GDP, which afterwards is stabilized around 1.37 pesos. For Colombia, an increase in public expenditure in 1 peso has an impact of 12 cents on GDP, and income changes do not seem to impact GDP.

Meanwhile, in another literature example, the research for Chile of Cerda et al. (2005) contradicts the Keynesian theory with a negative expenditure multiplier. The authors argue that the evidence found supports the permanent income theory: individuals decrease their consumption due to the expected increase in future taxes.

Considering Latin America and the Caribbean, the IMF (2018) performed an impact analysis of the fiscal consolidation adopting the fiscal multipliers' approach. The multipliers computation was made with three econometric identification methods: the narrative approach, forecast errors, and SVAR models for individual countries.[4] Based on Jordà (2005) the impact was estimated with local projections, and found that the shock analyzed with the narrative approach was in a lower range and variability compared to shocks identified with the other two methods, the SVAR and forecast errors. The obtained expenditure fiscal multipliers for the region were between 0.5 and 1.1, where the lower multipliers turned to be from countries with a higher sovereign risk.

Estevão and Samaké (2013) found that lower income countries experience a temporal negative effect on growth, while the output increases in the medium run after a public

[4]Given data availability, Costa Rica was excluded from the SVAR analysis

expenditure shock. And Ilzetzki et al. (2013) found that key country characteristics as the level of development, the exchange regime, the trade openness degree, and the public debt level had a significant impact on the result of the multiplier. Hence, the economies' heterogeneity determine the estimations. With information for 44 countries their estimations show that the effect on GDP is greater for developed economies that developing ones, the multipliers are relatively higher for economies with predetermined exchange rates and turn to be zero for the ones with flexible exchange regime. Also, they are lower for open economies, and even negative for countries with high public debt levels.

For open developing countries, Gualu (2013) used a SVAR with sign restrictions for the identification process. This framework intends to separate the impact of a shock on government expenditure from changes in GDP, deficit, and tax income. With data for nine countries, the author's results show that an increase in government expenditure leads to a short expansion of output and consumption, an immediate deterioration of net exports, and an appreciation or zero effect on the exchange rate. All multipliers were larger than one, with the exception of one country for the impact effect. The author also considers the procyclicality of fiscal policy in developing countries, which describes is due to a lack of financial integration with the global economy, or weak institutions. With a panel of 109 countries, he includes different states of the economy, financial openness, and the institutional framework to define the country's ability to implement counter-cyclical fiscal policy. The analysis evidenced that for good times the institutional quality has a dominant role, while in bad times the financial integration is also significant.[5]

Despite, both Neoclassical and Neokeynesian models have shown that procyclical fiscal policy is not optimal. The optimal fiscal policy in Neoclassical models is acyclical (Barro, 1979) or countercyclical (Baxter and King, 1993), while for Neokeynesian models the optimal fiscal policy is essentially countercyclical due to the presence of rigid prices and wages (Christiano et al., 2011).

The revised evidence, show in sum, that when analyzing the effectiveness of fiscal policy, country specific conditions must be included. For Costa Rica there are few studies, among them, the doctoral thesis of Mouhamadou (2011) who concluded for a panel SVAR that the government expenditure shock has a positive and persistent effect over output, the working paper from Contreras and Battelle (2014), who used the GMM, with the lags of the dependent variable as instruments, and found that a fiscal expansion has a larger impact in developing countries (including Costa Rica) than the one for high income countries.

Additionally, Estevão and Samaké (2013) state they are the first ones to estimate fiscal

[5]Several other authors have found that fiscal policy is procyclical in developing countries, to name some ((Gavin, 1997), (Kaminsky et al., 2004), (Talvi and Végh, 2000), (Ilzetzki and Végh, 2008), (Gualu, 2013)).

multipliers of short and medium run for Central American countries. Based on Blanchard and Perotti (2002) but considering the data limitations,[6] they used cointegration techniques to define key inputs for the VAR's variance-covariance matrix; more specifically, they estimated a structural error correction model, and concluded that fiscal consolidation affects output in the short run (one year). Their expenditure fiscal multipliers resulted in a range from -0.01 for Nicaragua to -0.44 for Panama. For Costa Rica, the output impact response due to a current expenditure shock turned to be -0.04, and the accumulated multiplier for the first year, 0.76.

The macroeconomic report by the Inter-American Development Bank, IADB (2017), shows that an increase of two percentage points in the aggregated value tax has a negative multiplier effect of 1.5% on output. In conformity with the non-linearity theory,[7] the results change given the initial tax level. For countries with a low tax level as Costa Rica, where it is 13%, the impact is expected to be low or even null, but it is the opposite for countries where the initial tax proportion is high (Gunter et al., 2018).

Lastly, Garry and Rivas-Valdivia (2017) estimated the multipliers, with a SVAR, for the Central American countries, Dominican Republic, and Mexico. They found that the current and capital expenditure multipliers are within a range of 0.7 and 1.4. For Costa Rica, the result was 2.6 for their sum in the long run.

Because this research intends to estimate the fiscal multipliers and analyze their behaviour for different conditions, we start with the three variables model proposed by Blanchard and Perotti (2002) as baseline. As expressed by Borg et al. (2014), this is an accepted starting point for the fiscal multipliers estimation in countries where there is no much literature on the topic, which is the Costa Rican case. This model includes real output, government expenditures, and public income net of transfers. The suggested methodology is widely used in the literature given it solved methodologically the identification problem associated with the joint movement of expenditures, tax income, and output (Kuckuck and Westermann, 2014), with a minimum number of assumptions.

Blanchard and Perotti (2002) used quarterly data and assume the government expenditure does not respond to the economic cycle. Also they estimated in advanced the tax income elasticity in order to consider the response to the economic cycle.

Still, their method is not faultless. Garry and Rivas-Valdivia (2017) point out that the VAR and SVAR approach, for multipliers estimation, usually fail to capture exogenous changes in public policy.[8] There is also an inherent risk of omitting relevant variables from the

[6] They use annual data.

[7] For more details see Gunter et al. (2018)

[8] For a detail review, see Appendix 9.1

model, due to the limited information for the identification process and the elasticities used in the computation. Other challenges lie in the availability of appropriate data, especially in developing countries, as quarterly frequency series are relatively short, and the aggregated variable components are not available in most cases. Lastly, the greater limitation in the SVAR models is the assumption that shocks are unexpected by the economic agents who, in the case of expected fiscal policy changes, could vary their behavior in advanced so the results of the estimations would not be accurate or wrongly interpreted.

As mentioned previously, the narrative approach based on government actions, which uses budget documents and forecasts, is an alternative methodology to identify exogenous fiscal shocks. But for Costa Rica there have been few changes on the tax base during the last three decades, limiting the scope of this analysis. Equally, dynamic stochastic general equilibrium models or macroeconomic Neokeynesian models are another option to study this topic, but they present methodological difficulties, as the struggle to model fiscal policies and non-linearities. As a matter of fact, there is no fiscal rule widely accepted to be included in this kind of models. Moreover, these models show susceptibility to parameters' size, as example the price and wage rigidity degree, habit formation, investment adjustment costs, and structural settings.

3 Costa Rica's fiscal context

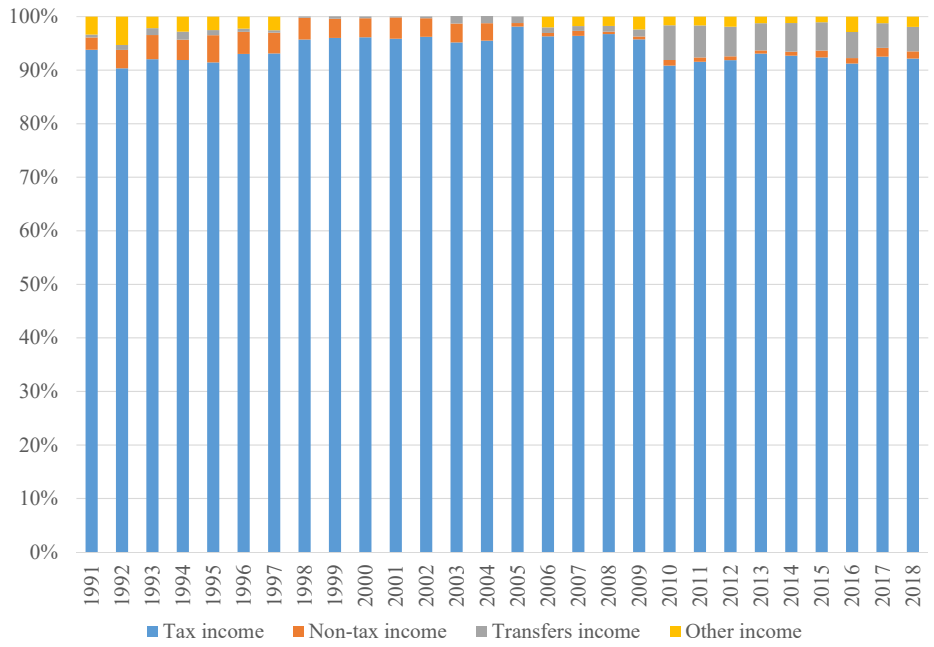
It is necessary to understand the context of Costa Rica's public finances to circumscribe our research, have a better understanding of the identification process of the structural model, and interpret accordingly our estimations. Thus, this section characterizes the fiscal variables, public income, expenditures and debt level.[9]

Public income comes from taxes, non-tax entries, cash/current transfers, and capital income. Among its components, the distribution has maintained stable, as more than 95% comes from taxes, as shown in figure 1. Tax total income strongly depends on the economic cycle, therefore, it is evident from figure 2 that the behavior of 2009 corresponds to the impact the financial crisis had on this variable. This effect was translated in a contraction of government income of 2.1% as GDP percentage, year over year. For the sample considered in this research the average of total income as percentage of GDP is 13.6%. For 2018 its result was above average, 14.3%, but below the level before the crisis, 15.4%.

There are a number of different taxes, but in terms of the portion of income they represent, the most important are the general sales tax and the income tax on income, as appreciated

[9]The evolution of other relevant variables as output and its components, prices, interest rates, exchange rate, and others are shown in Appendix 9.2.

Figure 1: Central Government Income Distribution, 1991 - 2018



Source: own elaboration with data from Treasury.

in figure 3. Both have increased the collection through time; in 2017 it represented 9% of GDP. The other components together sum up to 1% of GDP approximately by year.

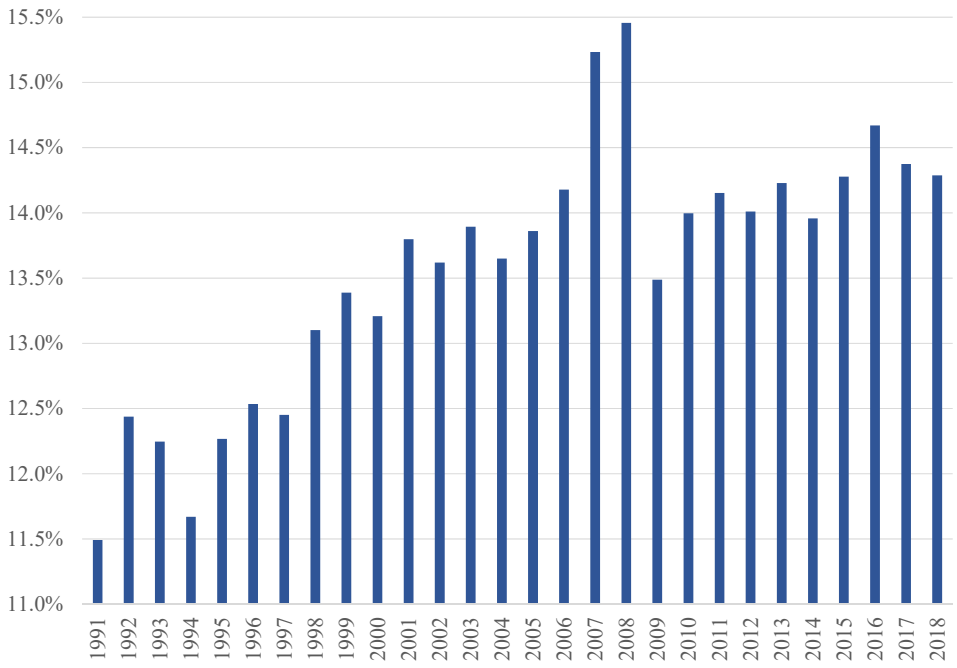
For the time span considered in this research, the sales tax has changed twice. In 1991, its rate increased 3%, from 10% to 13%, with the caveat of a gradual decrease of 1% per year during the next three years, to end in 1995 at a rate of 10%. However, during that year, a new transitory increment was approved; the rate increased from 10% to 15% for 18 months, and then was lowered to 13%, which is the current rate.

Another change in tax collection within this time period, was the decision taken in 1992 were one of the state owned banks, Banco Popular y de Desarrollo Comunal (BPDC), created by special law, which was exempt, was taxed with with a 15% on its net rent (law N°7722).

In terms of tax non-compliance and in accordance with MH (2015), Costa Rica had a rate of 8.22% of GDP in 2013, similar to the result of 2010 which was 8.21%. Only the income tax's avoidance was more than 5% of GDP for the period 2010-2013, double of the non-compliance rate from the general sales tax.

Another important fact, is the tax gap estimated recently has a value between 1.7%

Figure 2: Central Government Total Income as GDP percentage, 1991 - 2018



Source: own elaboration with data from Treasury.

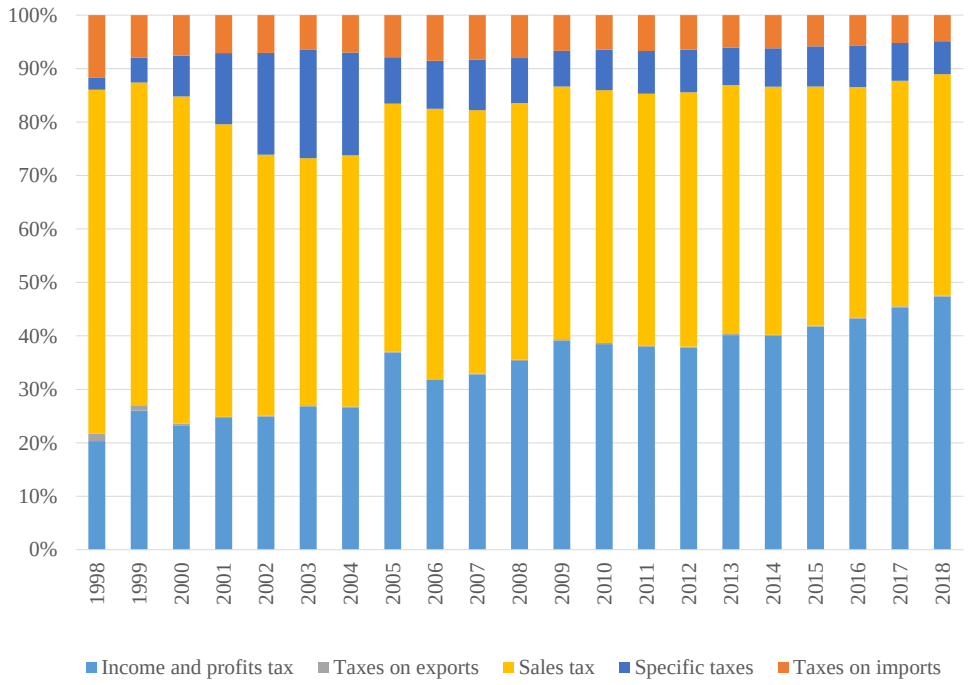
and 2% of GDP. Ueda and Pecho (2018) made this analysis with data from 2012 until 2016 by implementing the RA-GAP methodology.[10] As a response, in December 2016, law N°9416 was approved to lower the fiscal fraud, which involves a technological improvement in collection and inspection systems. Also, Ueda and Pecho (2018) points out that tax expenses or not perceived tax income, given by exoneration or special tax regimes,[11] was 5.34% of GDP in 2016, the highest rate since 2009.

As mentioned, there have been few changes in the tax burden during the last three decades but no structural reform has taken place. This result is not because there have been no efforts in this direction, but because they have been unsuccessful in Congress. For example, in 2004 the law project "Ley de Pacto Fiscal" proposed to change the sales tax to a aggregated value estimation, and to adopt the system for global rent, was never voted in Congress. During

[10]Consists in estimating the potential tax income, with the normative framework for the aggregated value of each economic sector. The model works through the supply and use tables from the Central Bank. The gap is computed as the difference between this potential income and the income effectively collected.

[11]Such as import taxes,"Depósito Libre de Golfito", free trade zones, and fuels. The "Depósito Libre de Golfito" is a zone free of taxes in the Canton of Golfito from the Puntarenas Province.

Figure 3: Tax Revenue distribution, 1998 - 2018



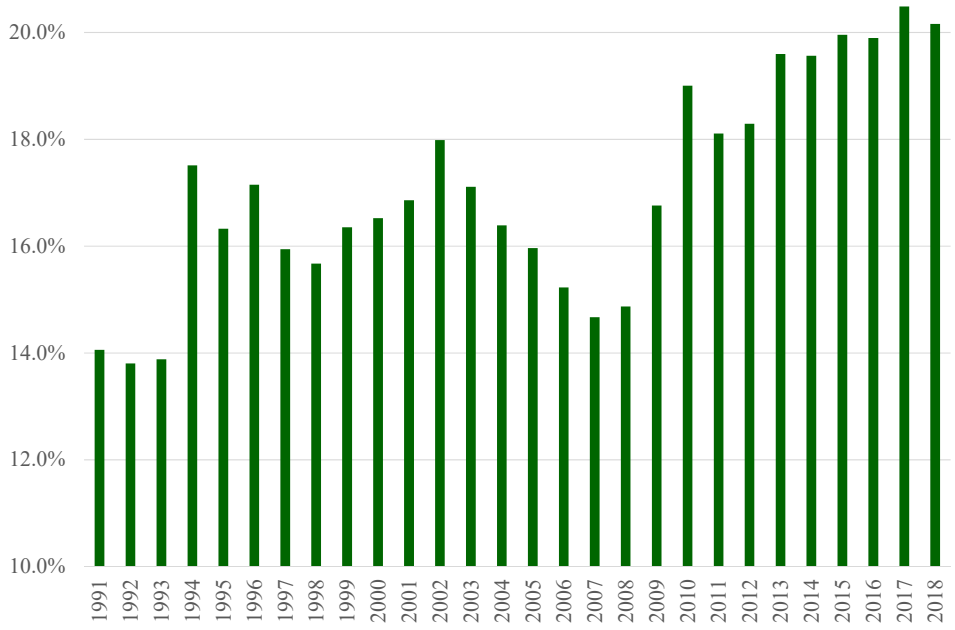
Source: own elaboration with data from Treasury.

the presidency Chinchilla-Miranda, 2010-2014, another effort was promoted, the law project "Proyecto de Solidaridad Tributaria". It suggested to collect from the passive rents and the capital gains a uniformed tax of 15%, and to transform the general sales tax into an aggregated one. This project was approved in the legislature process, but was rejected by the Constitutional Court, ruling it as invalid.

Then, for the time window of this research, there were no major changes in taxes. It was until December 2018, that a structural public finances reform, was passed by Congress and approved by the Constitutional Court. The law N°9635, "Ley para el Fortalecimiento de las Finanzas Públicas", modified the income tax, the general sales tax (law N°6826), included a fiscal rule for current expenditure, and considered wage caps for the public sector (law N°2166).

This reform has been necessary for quite a while, as the growth in public expenses have a faster pace than that of income (figure 4), mainly because of the expansionary fiscal measures

Figure 4: Central Government expenditure as GDP percentage, 1998 - 2018



Source: own elaboration with data from Treasury.

taken after the financial crisis. In 2009, among other policies[12], the incumbent decided to raise public wages by implementing a fifty-percentile policy to level the wages between the central government professionals and the non-financial autonomous public sector, who perceived higher remunerations. All measures were permanent, increasing the rate of growth of public expenditure significantly without a balance in income; before the crisis total expenditure was 14.9% of GDP, and by 2015 it was already 20% of GDP, being the largest of the last three decades.

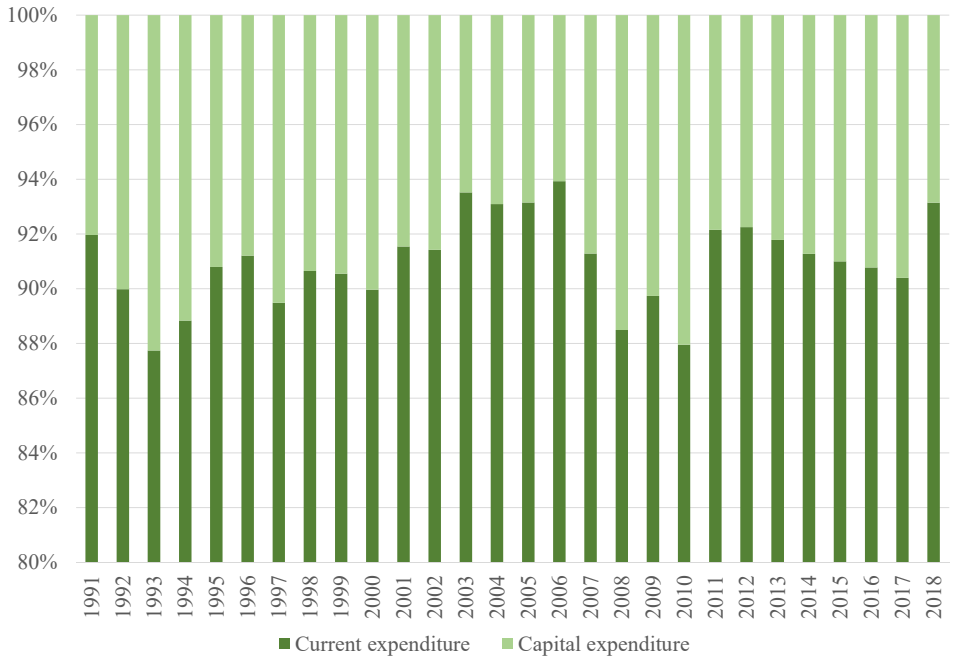
There is another historic event that should be explained as a transitory increase in government expenditure. In 1994, the year over year change was of 32% because of the closure of one of the state owned banks, Banco Anglo.

On average, current expenditure represents more than 90% of total expenses as seen in figure 5,[13] which comprehends salaries, public debt interest, and transfers to the public,

[12]Such as an increment to a 15% in the non-contributing retirement regime of the "Caja Costarricense del Seguro Social" (The Costa Rican social security), and the destination of 5% of GDP to investment in order to stimulate the economy

[13]There are few exceptions, 1997, 2008, and 2010 where it was 89%, 86% and 88% respectively.

Figure 5: Costa Rica: Public Expenditure Distribution, 1991 - 2018



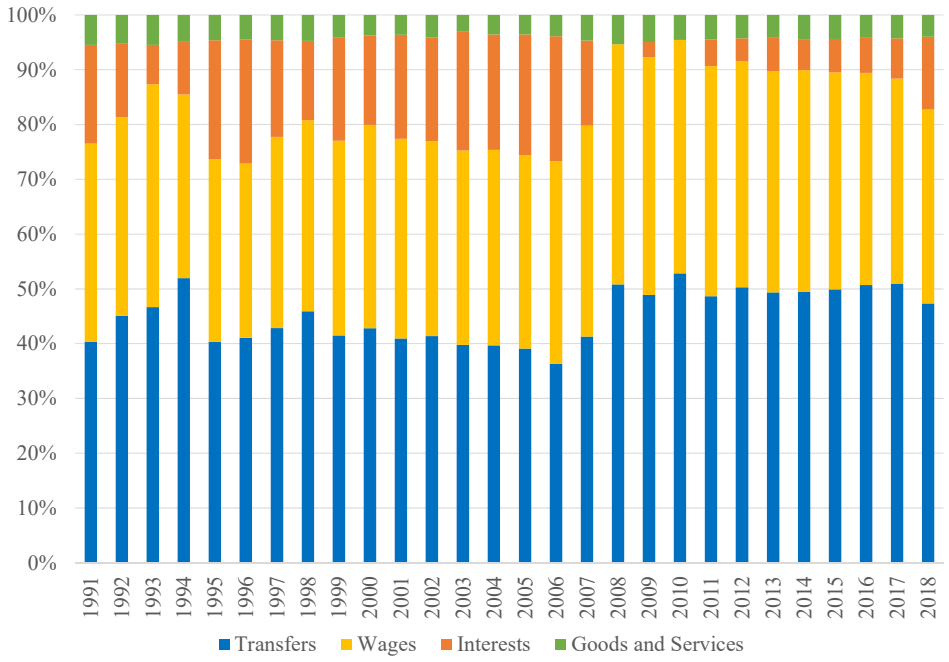
Source: own elaboration with data from Treasury.

private, and external sectors. Figure 6 shows the relative weight of each of these expenditure components.

Given the weight of current expenditure, spending on capital is relatively low; it has represented approximately 10% of total expenditure on average. For 2006, 2007 and 2008, there was a great economic growth by 7%, 8%, and 5% respectively, it joined with the 2007 and 2008 fiscal surplus of 0.6% and 0.2% respectively entailed the Treasury with the decision to increase the capital expenditure, both in order to foster economic activity and the acquisition of public assets.

As seen in figure 7, for the time considered, the government's balance has been negative with the two exceptions mentioned before. These deficits have been financed with public debt, internal and external, as shown in figure 8. It seems as if the behaviour of debt could be described by dividing the sample in three periods: 1991 - 2004, 2005 - 2008, and 2009 - 2018. The first, shows an upward trend for ten years and then seem to have reached a constant level in terms of GDP. In 2004 the government renegotiated a percentage of its debt changing the slope of the trend to a negative one for the next four years. This momentum

Figure 6: Costa Rica: Current Expenditure Components, 1991 - 2018



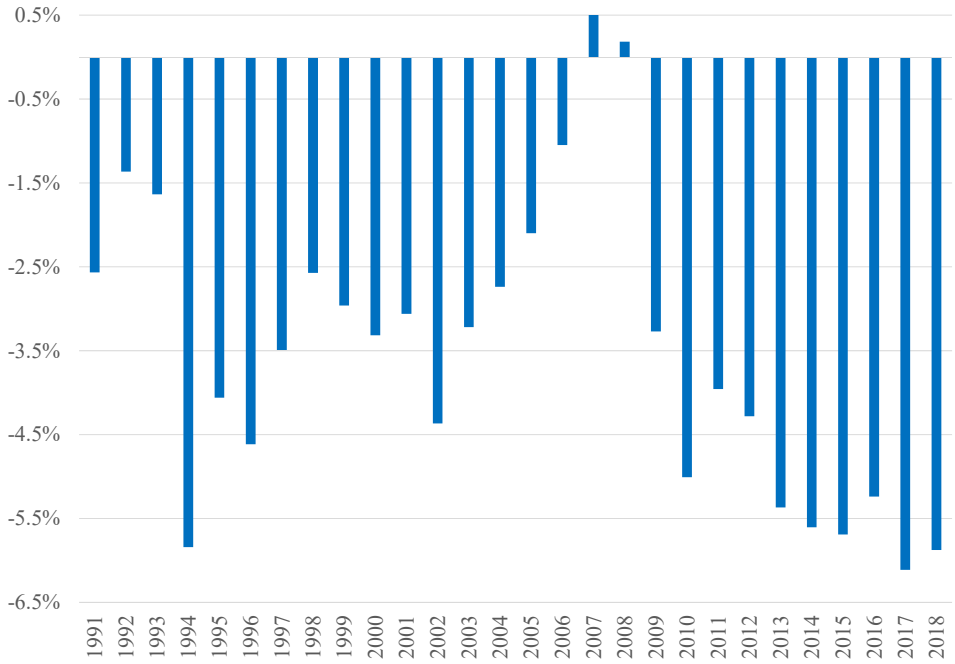
Source: own elaboration with data from Treasury.

was the starting point for the change in fiscal policy as response of the financial crisis after 2008 explained before. It is evident from figures 7 and 8 that this policy acted as a structural change in the series. And as time has passed, the crowding out effect has affected interest rates and consequently, credit demand, private investment and disposable income[14].

As we know, despite there is no consensus in the fiscal multipliers' literature results, there is some evidence on certain patterns that may affect them. The IMF (2014) technical note mentions structural characteristics that have an impact on the multiplier. For example, an increase in liquidity restrictions, a low degree of effectiveness in the response to monetary policy, and low debt levels are factors which tend to increase the multiplier in emerging economies and low income countries. On the other side, inefficiencies in the public expenditure management and revenue administration, lasting positive output gaps due to supply constraints,

[14]Between 2005-2008 when public debt was falling the average real interest rate for loans also fell from 8.7% to 2.5%. After the public debt increase in 2008, this rate increased to 16.9% in 2009, and it has been over 10% since then. We can see the consequences of the interest rate increase when comparing the median increase between 2005-2008 and after 2008 for investment, household private consumption, and total credit of the financial system. Namely, the median investment growth fell from 8.7% to 3.3% between these periods, for the private household consumption it decreased from 5.5% to 3.4%, whereas for the total credit it diminished from 31% to 12%.

Figure 7: Costa Rica: Fiscal Balance

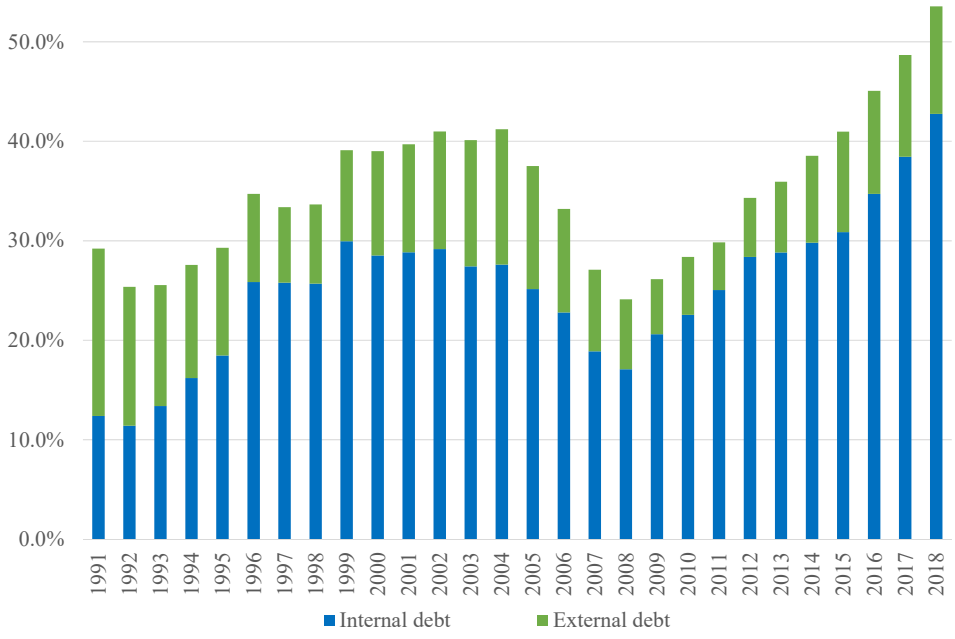


Source: own elaboration with data from Treasury.

and a high openness degree contribute to diminishing multipliers' size.

Specifically, trade openness affects as countries with a lower propensity to import tend to have larger fiscal multipliers as there is less demand leakage through imports. Second, countries with more rigid labor markets (i.e. stronger unions, and/or stronger market regulations) have larger fiscal multipliers if such rigidity reduces wage flexibility, as they tend to amplify the response of output to demand shocks. Third, the size of automatic stabilizers have an effect, for example, if they are large, they reduce the size of the multiplier since mechanically the automatic response of transfers and taxes offsets a portion of the fiscal shock, lowering its effect on GDP. Fourth, countries with flexible exchange rate regimes tend to have smaller multipliers due to the offset effect the exchange rate has on discretionary fiscal policy. Fifth, high indebted countries generally have lower multipliers; fiscal consolidations (stimulus) are likely to have positive (negative) credibility and confidence effect on private demand and the interest rate risk premium. Finally, multipliers are expected to be smaller

Figure 8: Costa Rica: Central Government Debt



Source: own elaboration with data from Treasury.

when there are difficulties to collect taxes and expenditure inefficiencies.[15]

Therefore, we briefly characterize these variables for Costa Rica in a general manner, which in sum are (their effect in parenthesis):

- Liquidity constraints in the financial market (+): in their liquidity analysis for Central America, Panama and Dominican Republic, Deléchat et al. (2014), with data from 2006 to 2010, report that the liquidity assets/deposits coefficient is close to 22%, with an excess liquidity (above the regulatory requirement) near 7%, considered as high. Moreover, they found the banks' liquidity preventive demand is positively related with the deposits' high dollarization degree. This excess liquidity improves financial stability, but lessens the financial deepening and the transmission of the monetary and fiscal policy.

- Low transmission of monetary policy (+): in Costa Rica, the monetary policy rate (TPM) is the principal tool of the Central Bank (BCCR) for policy. Romero and

[15]The report from CEPAL (2017) also highlights some of these factors such as the labor market rigidity, and the flexible exchange rate regime to contribute to low multipliers.

Guerrero (2015) estimated the TPM's pass-through effect to the bank system's interest rates to last on average, from eight to twelve months.

- Low debt level (+): since 2008 the central government's debt trajectory changed significantly, as shown figure 8. In 2018 the total public debt was 54% of GDP, an increase close to 100% in comparison with the decade's beginning (28% in 2010).

- Public expenditure management and revenue administration (-): the government's budget is highly inflexible, as more than two thirds of it, are determined by law or constitution, therefore, are unavoidable. Moreover, if the payment of interest is included, the rigid percentage becomes 90% approximately. In the overall, for the incumbent is possible to decide only on what represents 5% of total expenditures, CGR (2018).

- Trade openness (-): The trade openness index according to Beverinotti et al. (2014) was 74% in 2014, similar to the one found in 1991 (71%); defined as high. When using the ratio of exports plus imports over GDP, the openness degree is above 60% for all the sample period.

- Labor market rigidity (-): Ibarra (2010) performed a comparative analysis of the labor market flexibility in Ibero-America. With a synthetic index of labor rigidity, developed using the OECD methodology of factor analysis, he determined that Costa Rica had a medium-low position of labor rigidity, with a result of 1.34 given that the median value for the sample was 1.68. It is then interpreted, that Costa Rica's labor market is not rigid, but neither flexible.

- Flexible exchange rate regime (-): For the time interval of this research, the exchange rate began as crawling peg, which is considered almost fixed, then changed to a band system by the end of 2006, where the Central Bank would only intervene if the exchange was negotiated outside the announced interval, and by February 2015, Costa Rica adopted a managed floating exchange regime, where the Central Bank has discretionary power to intervene and the rate is negotiated freely.

These context variables, among others, may give some a priori intuition on how effective fiscal policy in Costa Rica might be. Overall, all the previous evidence is negative for fiscal multipliers size. Still it is necessary to determine its magnitude and direction, thus, the next section explains in detail the econometric strategy followed to estimate the dynamic effects of unexpected shocks in fiscal policy and the fiscal multipliers computation.

4 Empirical Methodology

This research follows on a first stage the three equations SVAR model proposed by Blanchard and Perotti (2002) with production, GDP, the government "flexible" expenditure, and the net tax income (i.e. without transfers). As expressed by Borg et al. (2014), this methodology has almost become the benchmark and starting point for research on fiscal policy.

Blanchard and Perotti (2002) used quarterly data and assumed the government expenditures do not react to the economic cycle. Also they estimated the tax income to GDP elasticity beforehand, to define its response to the outcome cycle. For the case of Costa Rica, this is done considering each tax that forms the tax income.[16] Additionally, because Costa Rica is a small open economy, we include the terms of trade to control for external demand factors, all of which could affect the relationship between output and fiscal variables.

On a second stage, we follow the model proposed by Perotti (2007), which is a SVAR that includes GDP, government flexible expenditure, net tax income, inflation, interest rate, and exchange rate. Perotti (2007) following Blanchard and Perotti (2002) used quarterly data, assumed the government expenditure does not respond to the economic cycle, and estimated the tax income to GDP elasticities.

We extend his model in two aspects: i) we consider the external sector with an explicit equation for the exchange rate, and control for trade openness and terms of trade; and ii) we include the contemporaneous effects of prices, interest rates, and exchange rate on the fiscal variables and output. The latter to clear the effect of the fiscal variables on GDP from any other influence of the economic activity.

Finally, to complete the analysis, we apply the methodology used by Auerbach and Gorodnichenko (2012) to estimate the dynamics of fiscal policy conditional on the state of the economy for the first time in Costa Rica, contributing to the literature on developing, small, and open economies. For this, i) we use the VAR model with smooth regime changes, from now on denoted as STVAR, for the model specification of the first stage, and ii) the regime changes are defined by the gap between real GDP growth and potential GDP growth.

Next we analyze the series' characteristics, to present afterwards the econometric approximation and estimation method for the three equation SVAR,[17] and the computation of the fiscal multipliers.

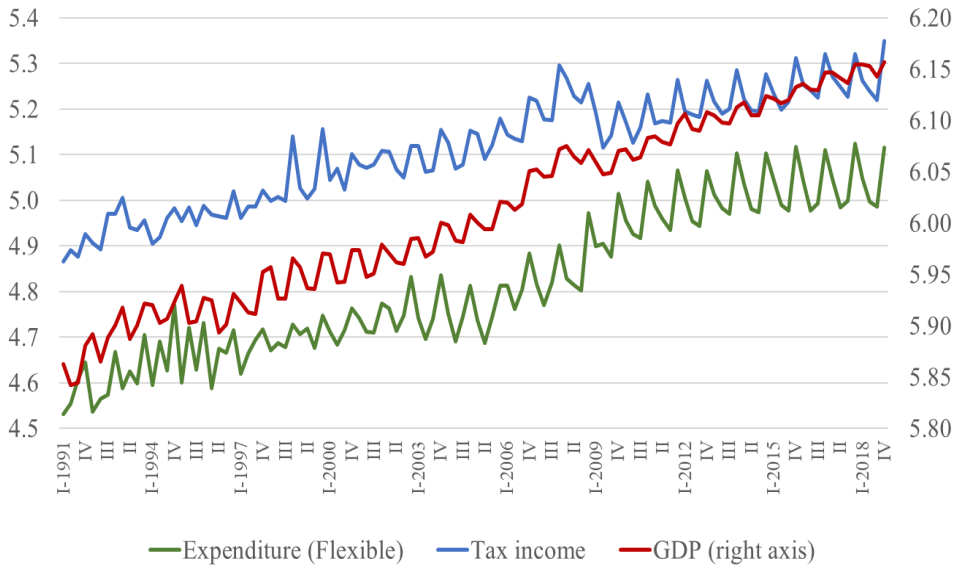
[16] Refer to Appendix 9.3 for a detailed explanation and results.

[17] The details of the six equation SVAR can be consulted in Appendix 9.4)

4.1 Analysis of the series

The variables included in the model are government income, expenditure and GDP, with quarterly frequency from 1991 until 2018. The official data sources are the Treasury, Ministerio de Hacienda, and the Central Bank of Costa Rica, BCCR, which publish their statistics on an accrual basis.[18] Additionally, we included the GDP deflator, and population, in order to have the series in real per capita terms.

Figure 9: Series in logs: GDP, government expenditure and tax income



Source: own elaboration with data from BCCR and Treasury.

For the extensions of the model, and robustness tests, we use two GDP components, households final consumption as proxy for private consumption, and gross fixed capital formation as proxy for private investment. We also include a reference interest rate, the basic passive rate,[19] given that the weighted average public debt rates have only been published by the Treasury since 2009,[20] the nominal exchange rate as the average between bid and offer, the consumer price index, the terms of trade, and trade openness (rate of exports and imports over GDP).

As the central government's income we only include tax income, which considers direct

[18]The accrual basis was adopted in 2006, before it was cash based, therefore, we had to made them comparable by revising each reported item.

[19]It is a weighted average of savings rates from the financial system, computed weekly by the BCCR. Its methodology can be reviewed in the BCCR's webpage.

[20]When comparing both (interest rate) series, there is evidence of a cointegrating relationship. For more detail, refer to Appendix 9.2 and Appendix 9.6

(earnings and income), indirect and specific taxes.[21] For expenditure, we add wages, salaries and social security payments, consumption on goods and services, and investment in non-financial assets. We define this series as "flexible" expenditure, given the legal rigidity of Costa Rica's public expenditure.[22] Figure 9 shows the series included in the model, all in quarterly frequency and in logs of real per capita terms.

All three series show an upward trend with a seasonal component on the fourth quarter. Some specific events on expenditure are the closure of the state bank, Banco Anglo on the fourth quarter of 1994, and the change in trend after 2008 given a permanent change in wages, because of the expansionary fiscal policy as response of the international financial crisis. From figure 9, it is also evident the co-movement between tax income and GDP.

Table 1: Unit root tests' results

Variable	Unit root presence*				
Real per capita	Specification**				
	1	2	3	4	5
Flexible expenditure	Yes	Yes	No	No	No, 2008q4
Gross domestic product	Yes	Yes	Yes	No	No, 1994q1
Tax income	Yes	Yes	No	No	No, 1994q2

Note: * Phillips-Perron tests (PP). **1: Without intercept nor trend; 2: With intercept without trend; 3: With intercept and trend; 4: First differences; 5: No first differences, and with structural break. Source: own elaboration with BCCR and Treasury data.

Another aspect in the series analysis is their statistical behavior. In terms of stationarity, the results of the usual unit roots tests are summarized in table 1.[23] As shown, the results of these tests are not conclusive as there is evidence of non-stationarity,[24] but when controlling for a deterministic trend, the real per capita series tend to reject the hypothesis of a unit root.

[21] Examples of specific taxes are those on coffee and banana exports.

[22] We also consider the current and capital expenditure for robustness in section 6.1. For more details on the fiscal series composition see Appendix 9.7

[23] Other variables unit root tests' results are in Appendix 9.8.

[24] We also performed the augmented Dickey-Fuller (ADF) test with the same specifications. All results were similar, but table 1 shows the PP test as we consider its specification is better for series with heteroscedastic characteristics.

Also, most of the series in real per capita terms are stationary when structural breaks are included.[25] Therefore, for the VAR model, we control for deterministic trends and structural breaks.[26]

4.2 Econometric approach: SVAR

The reduced form VAR is the following

$$X_t = A(L,q)X_{t-1} + U_t \tag{1}$$

where $X_t \equiv [G_t, T_t, Y_t]'$ is the three-dimensional vector in the logarithms of quarterly spending, taxes and GDP, all in real, per capita terms. $A(L,q)$ is a lag polynomial that shows the coefficient's relationship for each quarter, and $U_t \equiv [u_t^g, u_t^t, u_t^y]'$ is the corresponding vector of reduced-form VAR residuals, which in general will have nonzero cross correlations.

The reduced form residuals for expenditure and income equations (u_t^g and u_t^t) allow us to estimate the dynamic fiscal policy effects, and is defined by the linear combination from three types of unexpected shocks, specified in the following system

$$u_t^g = \alpha_{gy}u_t^y + \beta_{gt}e_t^t + e_t^g \tag{2}$$

$$u_t^t = \alpha_{ty}u_t^y + \beta_{tg}e_t^g + e_t^t \tag{3}$$

$$u_t^y = \gamma_{yt}u_t^t + \gamma_{yg}u_t^g + e_t^y \tag{4}$$

where e_t^g, e_t^t, and e_t^y represent the structural shock for expenditure, income, and GDP respectively, and they are uncorrelated among them; u_t^t and u_t^g depict the unexpected movements in income and expenditure; $\alpha_{gy}u_t^y$ and $\alpha_{ty}u_t^y$ define the fiscal variables' responses to unexpected movements on GDP; and $\beta_{gt}e_t^t$ and $\beta_{tg}e_t^g$ capture the expenditure and taxes' responses to structural shocks on the other fiscal variable. Finally, $\gamma_{yt}u_t^t$ and $\gamma_{yg}u_t^g$ represent

[25] With the exception of the consumer price index (CPI) and GDP deflator, which are considered in the six equation SVAR.

[26] Blanchard and Perotti (2002) obtained similar results after using the Dickey-Fuller and Phillips-Perron unit root tests with deterministic trend, they estimated the SVAR with two alternative assumptions: the first, with a deterministic trend, and the second, with a stochastic trend using the variables' first difference in the reduced form VAR. To consider the drift term, they subtracted a geometric average of the past first differences, with a 2.5% decay parameter per quarter. The results they obtained with both methods were similar. For this research, we only use the deterministic trend assumption and control for the structural breaks of each variable. As an informal model stability test for our results, we obtained the impulse responses converge to a long run value, validating our results and specification used.

the GDP's response to shocks in expenditure or income.

4.2.1 Identification

As stated by Lutkepohl (2005:364), a simultaneous equation system is formulated for the errors of the reduced form model rather than the observable variables directly. Thereby, the model accounts for the shift from specifying directly the observables to formulate relations for the innovations. Following Blanchard and Perotti's (2002:1333) identification methodology, we have from the equation system (2-4), that some parameters can be approximated before resolving the system of equations. This subsection intends to explain the assumptions and considerations for each of them.

Given that we use quarterly data, and that it takes more than a quarter to observe, decide, and implement a discretionary change in fiscal policy, the systematic discretionary component of u_t^t and u_t^g is assumed to be zero. Therefore, the automatic response to economic activity is estimated through the coefficients α_{gy} in equation 2 and α_{ty} in equation 3.

With annual data, it is difficult to differentiate the effects of public expenditure shocks as policy adjustments are possible within the year, an entire budget cycle, meaning both economic activity and expenditure could react to each other, leading to inverse causality problems. If the frequency is monthly, there is also an identification problem, as the reaction to fiscal variable's shocks may not be evident in that time unit. For example, taxes to companies' income are declared and paid every quarter or even once a year at the third or fourth quarter; thus a change in economic activity or in taxes today would be reflected several months later, or even this effect could be lost if the economic conditions came back to normal quickly, offsetting possible effects. This means monthly data also provide problems to identify the causal relationship between output and taxes. Overall, as proposed by Blanchard and Perotti (2002), the use of quarterly data is ideal to eliminate reverse causality problems between the economic activity and the fiscal variables.

The previous could be of little help if we need to estimate the parameters α_{jk}, because e_t^g and e_t^t are correlated with the reduced form of the residuals in the right hand side of equations equation 2 and equation 3. Nevertheless, we have independent information about the α_{jk}, which construction and estimation is presented in Appendix 9.3. With those elasticities, we could defined the cyclically adjusted fiscal shocks as:

$$u_t^{t,CA} \equiv u_t^t - \alpha_{ty} u_t^y = \beta_{tg} e_t^g + e_t^t \tag{5}$$

$$u_t^{g,CA} \equiv u_t^g - \alpha_{gy} u_t^y = \beta_{gt} e_t^t + e_t^g \tag{6}$$

This is the first identification step. In the second step, the structural shocks e_t^g and e_t^t must be identified. For this we need to decide the relative order of the two cyclically adjusted fiscal shocks. We can assume the expenditure shocks go first; in this case $\beta_{gt} = 0$ in equation 2 and equation 6 and β_{tg} could be estimated in equation 3 and equation 5 with OLS of the cyclically adjusted tax residual $u_t^{t,CA}$ on the cyclically adjusted expenditure residual $u_t^{g,CA} = u_t^g$. The procedure is symmetric if the income shocks go first.[27]

Under any order, the result of this two step procedure are estimated series for e_t^g and e_t^t. Both are orthogonal to the other structural shocks of the economy.

With the previous argument, the use of quarterly data implies $\alpha_{gy} = 0$, then it is necessary to estimate α_{ty} only. The within quarter elasticity of net taxes with respect to output is built as:

$$\alpha_{ty} = \sum_i \eta_{T_i,B_i} \eta_{B_i,y} \frac{\tilde{T}_i}{\tilde{T}} \tag{7}$$

where η_{T_i,B_i} is the elasticity of type i taxes with respect to its respective tax base; $\eta_{B_i,y}$ is the elasticity of the tax base i with respect to GDP; and $\frac{\tilde{T}_i}{\tilde{T}}$ is the proportion of tax i on the total of taxes. We estimate the respective long run elasticities and built the α_{ty} parameter for Costa Rica in the Appendix 9.3.

Also as mentioned, to identify the parameters β_{gt} and β_{tg} we assume the expenditure decisions come first, implying $\beta_{gt} = 0$ and then estimate β_{tg}. Thus the parameters β_{tg}, γ_{yt} and γ_{yg} are estimated using the information of the given SVAR model system, with restrictions on the respective matrices with the parameter values commented previously.[28] We estimate multiple specifications including different lags of the endogenous variables (the optimal lag given the statistical tests is four lags, i.e. a year), linear trend, dummy variables to control for seasonality (the base specification uses the seasonally adjusted variables with the TRAMO-SEATS routine), other dummies for structural breaks (as example the 2008 financial crisis and the expansionary fiscal policy), and specific relevant events (closure of Banco Anglo). Additionally the corresponding statistical tests show the used SVAR model

[27] Blanchard and Perotti (2002) argued that while the correlation between the two reduced form fiscal shocks is sufficiently low, the order of the shocks does not affect the results. Here this is the case. The robustness check of changing the expenditure shocks after the tax shocks bring the same results.

[28] We choose to estimate the parameters β_{tg}, γ_{yt} and γ_{yg} through the whole system to impose the less quantity of restrictions as possible. However, Blanchard and Perotti (2002) used an alternative method. With the α_{ty} and α_{gy} estimates they built the cyclically adjusted reduced form residuals for income and expenditure, commented previously, $u_t^t - \alpha_{ty} u_t^y$ and $u_t^g - \alpha_{gy} u_t^y$. Those were taken as the unexpected movements in the fiscal variables, which could be correlated among them, but not with the e_t^y term. Therefore those variables were used as instruments to estimate γ_{yt} and γ_{yg} in a linear regression. Later the respective parameters were imposed as additional restrictions in the system and β_{gt} (as tax decisions were first for them) was estimated. As a robustness check, both estimation methods are used in this paper and they are equivalent.

is stable. A summary of the models characteristics could be seeing in Appendix 9.9.

4.3 Fiscal multipliers

With the estimated coefficients, the impact and cumulative fiscal multipliers are computed following a standard methodology.[29] The first, reflects the GDP variation at the moment of the fiscal variable shock considering the contemporaneous coefficients, estimated in the equation system 2, 3, and 4, and is given by

$$\frac{\Delta Y_t}{\Delta X_t} \tag{8}$$

The second, the cumulative impact, is computed with the impulse response functions from the specified model,

$$\frac{\sum_{j=0}^{n} \Delta Y_{t+j}}{\sum_{j=0}^{n} \Delta X_{t+j}} \tag{9}$$

In both cases, ΔX_t represents the change in the fiscal variable, expenses or income, in a given time. For the impulse response functions the shock is specified as a change of a standard deviation from the correspondent structural error. Therefore, for the interpretation of the multipliers as elasticities, we divide equation 9 by the standard deviation of the structural error. The fact the structural shocks e_t^g, e_t^t, e_t^y are not correlated allows a direct interpretation: a shock to e^X is equivalent to a shock in variable X. Thus the computed multipliers refer exclusively to the impact of variable X, holding everything else constant.

This simple computation is not free from critics, even more as there is no standardized form for such calculation in the empirical literature. As expressed by Ramey (2016), a lot of researchers have followed the methodology of Blanchard and Perotti (2002), computing multipliers by comparing the peak output response with the initial impact, which may be useful to compare impulse responses but it is not a good method to obtain the multipliers. As argued by Mountford and Uhlig (2009), Uhlig (2010), and Fisher and Peters (2010) the multipliers should be computed as an integral (or present value) of the output response over the integral of the respective fiscal variable. The integral multipliers succeed in measure the cumulative GDP gain relative to the cumulative gain in the fiscal variable during a determine period.

As mentioned by Ramey (2016), most research on multipliers which involve variables in logs and a VAR model, usually multiply their estimates by the average sample ratio of GDP

[29] Others that use the same methodological approach, for example, are Puig (2014), Estevão and Samaké (2013), Cebi (2016), and Mitra and Poghosyan (2015).

to fiscal variable to obtain the multipliers. But, this could lead to bias in samples with trends in the GDP fiscal variable ratio, as found by Owyang et al. (2013), since this method generally yields multipliers higher than unity.

In this paper we use the cumulative response of growth to the fiscal variables shocks, as an approximation to the integral computation mentioned. Despite the multipliers are obtained as an elasticity, to facilitate their interpretation and use by policy makers, we divide them by the ratio of the fiscal variable to GDP, following Hamer-Adams et al. (2018), in order to interpret them as the 1% change in the fiscal variable as proportion to GDP and its impact on GDP in percentage.[30] We consider that this estimation minimizes the bias magnitude as the multipliers are below unity and converge to a long run value, main characteristic of the stable (stationary) VAR models.

4.4 Econometric approach: STVAR

We know that the economy may react differently given the stage of the economic cycle when fiscal changes are implemented, hence, we include in our analysis a non-linear methodology which allows to distinguish between the effectiveness of fiscal policy in expansions or recessions. This methodological subsection pretends to explain broadly the followed approach where the VAR model changes as proposed by Auerbach and Gorodnichenko (2012): the smooth transition VAR model (STVAR).[31]

This approach is preferred over the autoregressive models with thresholds (STAR), because it allows to obtain different responses and its contemporaneous effect for structural shocks. Also, given that the aggregate economic dynamics, in general, do not have sharp changes but, smooth transitions, the STVAR model is a better approximation; STAR models may have few observations for each regime, finding unstable and inaccurate estimates.

For example, unexpected changes in taxes could result from its relation with the aggregate activity; at the same time it is expected the tax policy acts through the tax structure, i.e. the marginal tax rates, not through the level of tax income. Besides, the tax shocks' identification depend on the ability to clear income innovations from automatic responses on output, where the key aspect is the income elasticity with respect to GDP. But still, this elasticity tends to vary with the economic cycle, which introduces a bias of unknown magnitude and direction for the specific estimates in each regime. All these are minimized with the STVAR model, as it admits the regime to be chosen endogenously. This model has the following specification:

[30] The computation follows Hamer-Adams et al. (2018), for example their footnote 19. Suppose we have a flexible expenditure shock of 1%, since the share of this government expenditure to GDP is 6%, the 1% government shock corresponds to 0.06% of GDP. After this shock, assume output increases by 0.01%. The corresponding multiplier, would be 0.2% ($\frac{0.01}{0.06} \approx 0.2$).

[31] For a more detailed explanation refer to Appendix 9.5

$$X_t = (1 - F(z_{t-1}))\Pi_E(L)X_{t-1} + F(z_{t-1})\Pi_R(L)X_{t-1} + u_t \tag{10}$$

$$u_t \sim N(0, \Omega_t) \tag{11}$$

$$\Omega_t = \Omega_E(1 - F(z_{t-1})) + \Omega_R F(z_{t-1}) \tag{12}$$

$$F(z_t) = \frac{exp(-\gamma z_t)}{1 + exp(-\gamma z_t)}, \gamma > 0 \tag{13}$$

$$var(z_t) = 1, E(z_t) = 0 \tag{14}$$

where $X_t \equiv [g_t, t_t, y_t]'$ and $u_t \equiv [u_t^g, u_t^t, u_t^y]'$. γ is known as the smoothing parameter. The order arrangement of X_t implies shocks to income and output do not have a contemporaneous effect on expenditures. Furthermore, STVAR models, allow the propagation of the structural shocks in two ways: i) contemporaneous, through the different error covariance matrices Ω_R and Ω_E; and ii) dynamically, with different lag polynomials $\Pi_E(L)$ and $\Pi_R(L)$. In our specification, z is an index of economic conditions; when positive, it indicates an expansion. This variable is normalized in order to obtain unit variance and zero mean.

From convention, $\gamma > 0$ and thus the system's behavior in a sufficiently strong recession ($F(z_t) \approx 1$) can be described with Ω_R and $\Pi_R(L)$, while Ω_E and $\Pi_E(L)$ describe the behavior in a sufficiently strong expansion ($1 - F(z_t) \approx 1$). We consider the z index in $t-1$ to avoid contemporaneous feedback of fiscal policy conditional of the state of the economy, in other words, the policy actions today do not depend on today's state of the economy, so the government authorities know the state of the economy and implement the respective actions with a lag.

As signalled by Auerbach and Gorodnichenko (2012), the index z selection is not a trivial one. Here we use the quarterly potential real GDP computation as in Álvarez (2017) and its growth is compared with the inter-annual quarterly real GDP growth rate. Thus negative values signal a negative output gap, whereas positive values indicate positive output gap. This measure is intuitive as it is an empirical indicator for the economic cycle. Then a threshold is defined with the first quantile of output gaps meaning the recession regime are times when the output gap is among the most negatives (below the threshold), while the

expansion regime would be the rest of the time.[32]

Due to the quarterly frequency of the data, we could exploit the advantages commented by Auerbach and Gorodnichenko (2012) with the z use: i) we can use the complete sample for estimation, with the resulting accuracy and robustness of the estimates; and ii) we could consider easily the dynamic feedback of policy changes to the state of each regime, namely we can incorporate the fact the policy shocks could alter the regime.

With respect to the estimation, to avoid the sensitivity of γ in small samples, we follow the suggestion of Granger et al. (1993) to impose different fixed values for γ, until finding the estimates of $\Pi_R(L), \Pi_E(L), \Omega_R, \Omega_E$ are not sensible to changes in γ. We calibrate $\gamma = 1$ so the economy is near 25% of the time in the recession regime (think of the threshold mentioned previously), that is $P(F(z_t) > 0.75 \approx 0.25)$, where the economy is defined to be in a recession if $F(z_t) > 0.75$, meaning at the end we have a threshold for the recession probability and its classification. This allows to construct the dates to which we could consider the Costa Rican economy to be in recession and expansion.[33]

Given the system highly non-liner nature describe in the equations 10-14, we use the Monte Carlo Markov Chain (MCMC) developed by Chernozhukov and Hong (2003) for estimation and inference (see Appendix 9.5 for more details). In summary, under standard conditions this approach finds a global optima in fitting terms, including the parameter estimates and the standard errors could be computed directly from the generated chains.

For the impulse response computation, we ignore initially any feedback of changes in z inside the dynamics of the macroeconomic variables. That is, we assume the system could stay in a particular regime for long time. The advantage is that, once the regime has been fixed, the model is linear and the impulse responses are not functions of history (see Koop et al. (1996) and potter 1996 for more details). As Auerbach and Gorodnichenko (2012) the impulse responses are based on local projections from Jordà (2005).

[32]This is just an intuitive simplification. Nonetheless, this threshold is effectively used to compute probabilities for the recession regime, and thus to estimate impulse response functions conditional on the state of the economy. Further details are in appendix 9.5.

[33]As mentioned, we followed Álvarez (2017) to compute the output gap. With the Holdrick-Prescott (HP) filter and $\lambda = 26$, specific for the Costa Rican business cycle. To obtain this λ value, the author uses the methodology from Marcet and Ravn (2003). We acknowledge the shortcomings of the HP filter use as stated by Hamilton (2018). Nevertheless, with quarterly data and the short sample size it is difficult to use other approach, for example, the Kalman Filter with precision. We choose the HP filter given its simplicity. Also, the low λ parameter value of 26 comes from Álvarez (2017) exhaustive work published by the Central Bank of Costa Rica on the optimal λ value when using the HP filter for the country. The Costa Rican economic cycles behave differently relative to the United States case (the common λ value of 100 is due to the US cycle), they are less pronounced and of shorter length, thus our preference for the lower value.

5 Results

This section shows the results of the flexible expenditure and tax income effects on production. First, the corresponding to the baseline 3 equation SVAR.[34] Second, the effects on an open economy, with the 6 equations SVAR. Finally, we present the differences of fiscal policy effects conditional on the economic cycle. It is important to note all the dynamic cumulative responses where computed for 16 or more quarters after the shock, given the electoral cycle in Costa Rica which in principle could affect the behavior of the fiscal variables, but as the results showed this does not seem to affect the results.

5.1 Short run dynamics and fiscal multipliers: 3 equations SVAR

Table 2 shows the contemporaneous coefficients results. As an usual elasticity, they measure the production response at the same time the tax income and expenditure shocks occur. They are respectively 0.05 and -0.09 for the flexible expenditure and the tax income, the first one not statistically significant, but the second one is. Both coefficients γ_{yg} and γ_{yt} are according to the economic intuition: expenditure increases have a positive impact on output and increases in tax a negative one. However, these are not the dynamic short term effects, only the impact effects. To obtain the short run response, for example in a year, it is necessary the estimation of the impulse response functions, of widely use in the VAR and SVAR models. Here, as a difference with the simple VAR models which use the reduced form residuals for computation, we use the structural form residuals, i.e we shock the structural residual series obtained. Because the structural errors are uncorrelated, there is a direct interpretation: a shock to e_t^g (respectively to e_t^t) is equivalent to an exogenous shock to the flexible expenditure (income tax) and the consequent output response. In other words, the impulse responses are clean from the influence of third variables, so the output evolution is entirely explained by the particular fiscal shock.

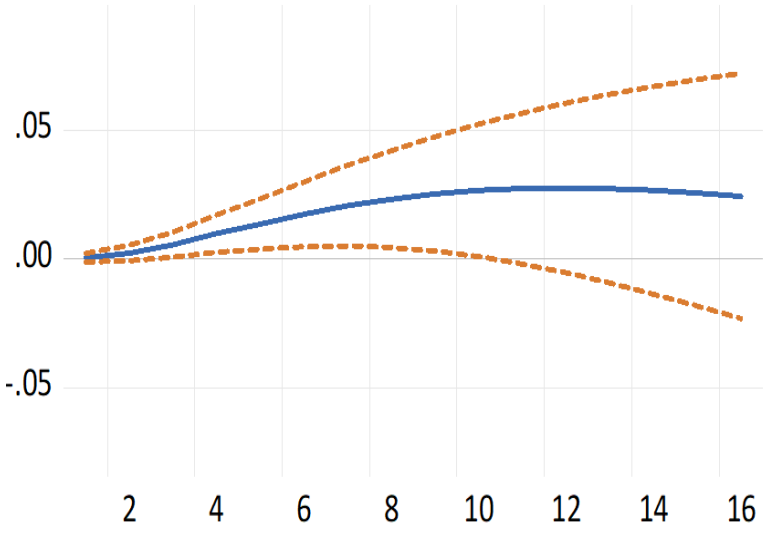
[34] We also estimate VAR and VEC models. In both we obtained a particular result: increases in taxes lead to increases in production. This result, even though it had been argued as possible, here is considered to not be the Costa Rican case, mainly because in this type of models we do not identify the structural shocks. As point out by Perotti (2007) in a critique to the work of M'Amanja and Morrissey (2005), the positive tax income effect is related to a reverse causality effect. Basically, when there is a positive shock to output, the tax income increases; a Granger causality analysis cannot resolve this problem. Due to this we omit those results for the VAR and VEC models and show only the SVAR ones, which allow an exhaustive identification of the structural shocks needed for the estimation of the dynamic fiscal policy effects.

Table 2: Contemporaneous coefficients 3 equations SVAR

Coefficient	Estimate	Standard error	Probability
γ_{yg}	0.05	0.05	0.37
γ_{yt}	-0.09	0.03	0.01

Note: the coefficient γ_{yg} refers to the flexible expenditure contemporaneous impact; γ_{yt} is the respective of tax income. Source: own elaboration.

Figure 10: Cumulative GDP response to flexible expenditure

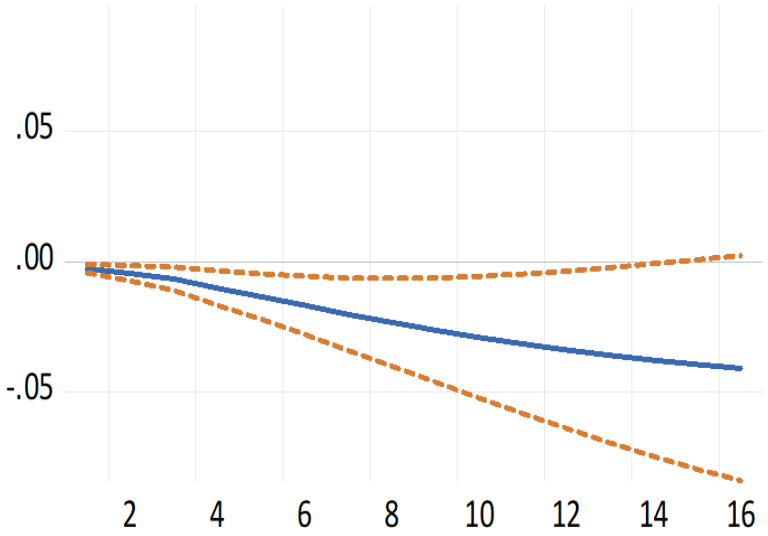


Note: GDP cumulative response to a structural shock (one standard deviation of the structural error) in flexible expenditure. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Three equation SVAR model.

In the figure 10 and figure 11 we can observe the cumulative responses have the expected impact on production. Specifically, an unexpected structural shock to the flexible expenditure would lead to a positive GDP response, which is statistically significant from the third quarter after the shock to the tenth. The unexpected structural shock on taxes would be associated with a negative GDP response, with statistical significance from the first quarter to the to the fourteenth quarter, that is three years and a half, after which the effect would dissipate.

The validity of the impulse responses depends on the model characteristics. The Appendix 9.9 shows the diverse statistical tests and their results for the three equations model. In

Figure 11: Cumulative GDP response to tax income



Note: GDP cumulative response to a structural shock (one standard deviation of the structural error) in tax income. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Three equation SVAR model.

summary the model not only is stable, but also does not reject the no serial correlation and homoscedasticity hypothesis for its residuals, neither their normality at 5% of significance. The model was estimated with the optimal lag of four periods. Additionally, as the informal stability test and validity of the results, the 32 periods impulse responses converge (not shown here).

Often it is necessary a direct interpretation for the dynamics between output and fiscal variables in monetary terms. For that, as it is usual in the literature, we compute the fiscal multipliers. This are obtained from the impulse responses from figures 10 and 11. The responses are divided by the standard deviation of the respective structural error, in order to measure the impact of 1% changes in fiscal policy (expenditures or income) on GDP in percentage (i.e an usual elasticity). Moreover, we divide this value by the ratio fiscal variable to GDP, for the multipliers to be interpreted as percentage GDP change due to a 1% change in the fiscal variables to GDP ratio. Table 3 shows the cumulative multipliers by quarter.

An increase in 1% of the flexible expenditure to GDP ratio is associated with an cumulative increase of 0.2% in production in one year, 0.46% in two years, and 0.53% in two years and a half, after which the effect would dissipate. Putting in other words, if we expect output to growth at 3% for the next year, the mentioned increase in expenditure would imply the

Table 3: Cumulative multipliers by quarter, 3 equations SVAR

Quarter	Flexible expenditure	Tax income
4	0.20	-0.08
6	0.34	-0.14
8	0.46	-0.20
10	0.53	-0.24
14	0.53	-0.32

Note: A 1% increase in the fiscal variable as GDP proportion is associated with the presented GDP cumulative percentage change, by quarter. Red values are not statistically significant. Source: own elaboration.

output will growth at 3.2% next year. Analogously a 1% increase in the taxes to GDP ratio would lead to a decrease in output of 0.08% in a year, which would accumulate to 0.2% in two years, and 0.32% in three years and a half.

This estimated multipliers are an additional reference to define the direction and magnitude of fiscal policy impact. However, these results should be taken with caution mainly for two reasons. First, fiscal policy shocks modelled here are, by definition, unexpected to the private sector. This is a key implicit assumption important in the context of the recent fiscal reform approval in Costa Rica, that has been clearly anticipated by the private sector with enough time (at least one quarter). From this, the use of the results for forecasting scenarios under the fiscal reform must take into account this limitation.[35] Second, there exists multiple forms to compute the multipliers, the majority look for a monetary interpretation. Those are based on the impulse response functions use that at the same time use logarithm form, with the corresponding debate on its correct formulation (some mentioned earlier). In order

[35]The literature had mentioned the existence of lags in fiscal policy, key assumption for the SVAR econometric specification. The existing lags in fiscal policy are of two kinds: decision lags imply some time is necessary to discover and decide policy changes are needed in response to shocks; and implementation lags imply some time passes for the decided policy changes to be implemented. The first type helps with the identification assumption. The second one involves an ignored problem in the paper, particularly what the econometrician identifies as fiscal shocks could be the result of previous policy changes, and thus those are anticipated by the private sector. Blanchard and Perotti (2002) bring more details in the econometric domain.
To have an idea why in the empirical domain the anticipated fiscal policy is a problem for modelling, let us assume the agents behave as in Neoclassical basic model. An anticipated increase today in public expenditure would lead to a diminish in private consumption today, because the agents increase savings to tackle the future increases in taxes. With that, although the policy change is not present in the data, the private consumption has already reacted.

to minimized the possible bias sources in the multipliers computation, we used the simple calculation detailed previously. This one allows us to interpret the multipliers as elasticities and in monetary terms, in what is called the integral approach.

5.2 Short run dynamics and fiscal multipliers: 6 equations SVAR

To model the open economy explicitly we include additional equations corresponding to the price level, interest rate, and the nominal exchange rate. This allows the interactions among all the variables through the lag polynomial in the reduced form, which implies not only possible changes in the coefficient's values, but also the existence of new relationships; for example increases of the exchange or interest rates and their effects on output, and how the fiscal variables affect the exchange rate, interest rates and prices. The results for the open economy are obtained with the estimation of the system in matrix form presented in Appendix 9.4. This model assumes the expenditure decisions come first.

Table 4 shows the contemporaneous coefficient results for the flexible expenditure and tax income on GDP.

Table 4: Contemporaneous coefficients 6 equations SVAR

Coefficient	Estimate	Standard error	Probability
γ_{yg}	0.08	0.04	0.06
γ_{yt}	-0.07	0.03	0.03

Note: The coefficients refer to elasticities. As an example, γ_{yg} is interpreted as follows: an increase in 1% of the flexible expenditure is associated with an increase of 0.08% on output at the impact period (contemporaneous effect). Source: own elaboration.

In general this models results are similar to the previous one. The contemporaneous effects are according to the economic intuition. Increases in the flexible expenditure and the tax income of 1% would lead to contemporaneous GDP changes of 0.08% and -0.07% respectively. This effect is statistically significant for both variables (at 10% for expenditure).

Again we point out this coefficients are not the short run dynamics, only refer to the impact effect of the fiscal variables. The impulse response graphs for quarter up to eight years show the respective short run dynamics.

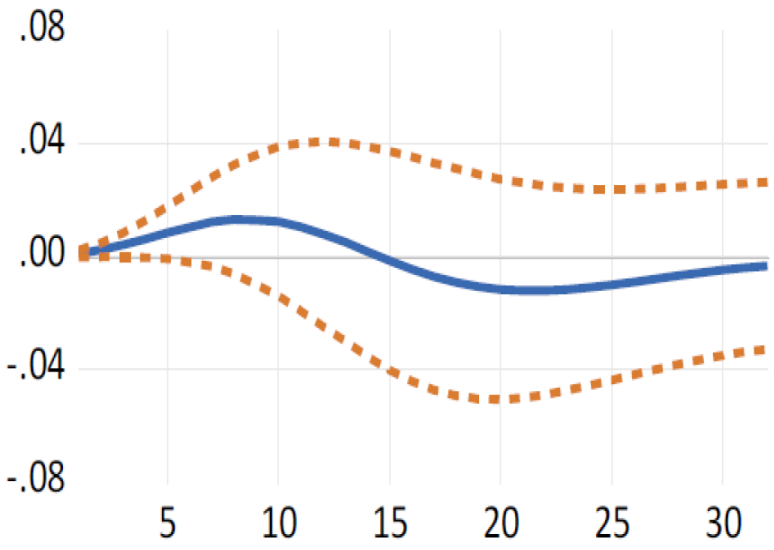
The same as in the 3 equation case, the validity of the impulse responses depends on the model's characteristics. The Appendix 9.4 shows the statistical tests used and their results for the open economy. Again as a summary the model is stable, there is no strong

evidence against the hypothesis of no serial correlation, homoscedasticity, and normality of the residuals a 5%. The model is estimated with the optimal lag of five periods, which helped with the serial correlation correction. Moreover, the informal stability and validity test show the impulse responses to 32 periods converge for the open economy model.

The fiscal variables effects is as expected. In figure 12 we observe the output response to flexible expenditure increases. It remains to be positive, but now it is not statistically significant for any quarter, which could suggest effects on production of fiscal policy through expenditure is diluted across the price variables in the economy, namely the inclusion of prices, interest rate, and exchange rate; as well as the influence of the external sector, in accordance with the literature for developing, small, and highly open economies (Ilzetzki et al., 2013). On its part, increases in tax income affect negatively the output, with a significant effect from the first quarter to the quarter sixteen after the shock, i.e. with four years of persistence, as shows figure 13.

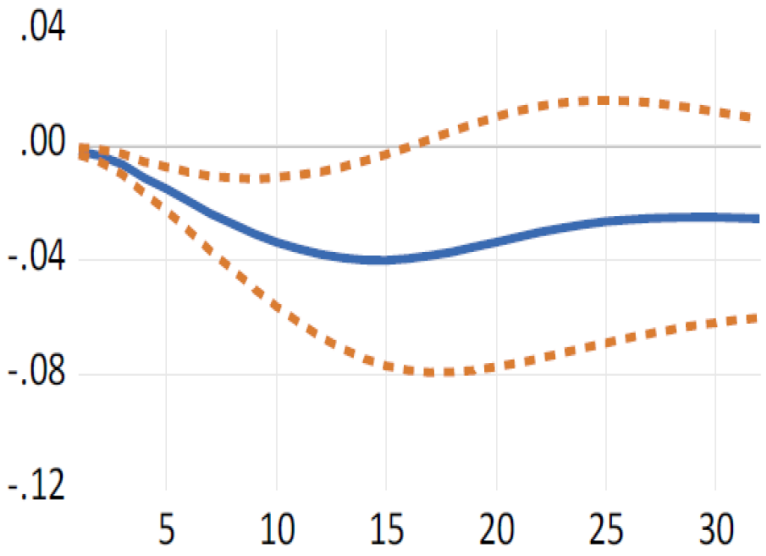
Again we compute the fiscal multipliers for the six equations model. As observed in table 5, the signs and magnitudes are really similar to the previous model. However, there is not statistical significant in any quarter for the flexible expenditure multiplier.

Figure 12: Cumulative GDP response to flexible expenditure



Note: GDP cumulative response to a structural shock (one standard deviation of the structural error) in flexible expenditure. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Six equation SVAR model.

Figure 13: Cumulative GDP response to a structural shock in tax income



Note: GDP cumulative response to a structural shock (one standard deviation of the structural error) in tax income. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Six equation SVAR model.

Table 5: Cumulative multipliers by quarter, 6 equations SVAR

Quarter	Flexible expenditure	Tax income
1	0.02	-0.02
4	0.15	-0.12
8	0.32	-0.29
12	0.19	-0.40
16	0.11	-0.41

Note: values in red are not statistically significant. Changes in flexible expenditure and tax income refer to 1% as GDP proportion. The multipliers are interpreted as the GDP cumulative response in percentage change, at the given quarter. Source: own elaboration.

5.3 Short run dynamics in expansions and recessions: STVAR

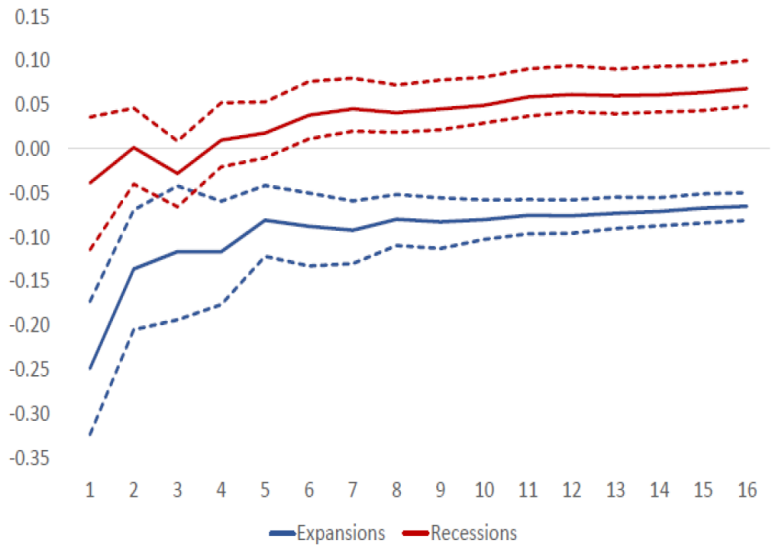
We estimate a regime switching VAR specification to answer the question: Is the dynamic fiscal policy effect invariant to the Costa Rica's state of the economy, or is it different if the economy is in recession or expansion? That allows to observe if the output response to unexpected expenditure and tax changes are different according to the economic cycle. In that case, it is possible that fiscal policy could be more effective during recessions, common result in the literature, so that expansive fiscal policies would be an useful tool to move out of a crisis in Costa Rica.

Although this specification is based on the considerations and uses the same variables as the 3 equation model, it is not directly comparable with those results for three reasons. First, despite both specifications possess contemporaneous responses according with the unexpected and exogenous impact in fiscal policy, in the SVAR model a part of those effects are obtained outside the system, with the tax income elasticities, while the STVAR model estimate them inside the system for both regimes through the allocation of probabilities with a bayesian method. Second, the SVAR model, with the use of tax income elasticities accomplish to eliminate the reverse causality problem between taxes and output, namely tax increases are associated with GDP increases. By not doing it the direct way, this problem could persists in the STVAR model. Third, the use of the tax income elasticity assumes a strong supposition on production and taxes dynamics: the tax income elasticities are constant and independent of the economic cycle. This is a point in favor of the STVAR over the SVAR model, in the sense it allows to estimate the tax-output relationship conditional on the state of the economy.

Even so, both models usefulness is obvious. On one side, the SVAR allows to have an approximation of fiscal policy effect in a neutral setting (without economic cycle). On the other side, the STVAR allow to obtain evidence of a diverse effect given by the economic cycle.

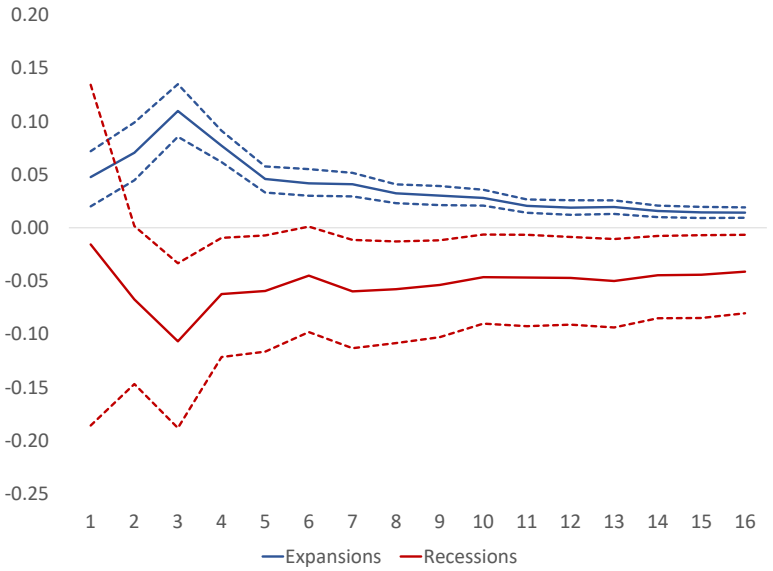
Figure 14 presents a clear history: expenditures have a positive effect in recessions, but a negative one in expansions. Thus, the expenditure could be used as a tool to stabilize the economy in recession times, with the major example the expansionary fiscal policy after the start of the financial crisis in 2008. However the fact expenditures have a negative impact on expansions seems to indicate the economic agents' expectations play against it. Increases in expenditures in expansions could be perceived as increases in public debt or in future taxes, where the first aspect tend to increase the interest rates and diminish the credit availability, whereas the second acts directly on the agents' expected disposable income. Both could explain the negative effect on production.

Figure 14: Cumulative GDP response to flexible expenditure



Note: GDP cumulative response to a 1% in flexible expenditure. Discontinuous lines are 90% confidence intervals. Source: own elaboration.

Figure 15: Cumulative GDP responses to tax income



Note: GDP cumulative response to a 1% in tax income. Discontinuous lines are 90% confidence intervals. Source: own elaboration.

Increases in tax income show a different history. In figure 15 we could see the output response is positive in expansions and negative in recessions. The recessions effect is intuitive: decreases in the disposable income and the business profits lessen aggregate demand and economic activity. But the positive effect on expansions must be taken with caution. Three points emerge as possible interpretations for this effect. First, it is definitive increases in taxes are less harmful for economic activity in expansions, which is intuitive as the overall economy is stronger in those periods. Second, the effect could be due to the reverse causality problem stated previously; the positive output response to increases in taxes in reality are due to the fact tax income depends on economic activity, there is a positive correlation that could be stronger in expansions and it is reflected here (but correctly controlled with the SVAR model for example). Third, the positive effect of taxes on production could be explained by what is known in the literature as the "expansionary fiscal contraction" (for some examples see Hjelm (2006), Hjelm (2002), Afonso (2010), and Hogan (2004)). This argument states economies with high debt levels (as it is the Costa Rica's case) could experience improvements in economic agents' expectations to increases in taxes, as well as the agents consider the new tax income would be used for the public finances betterment and hence it will lead to a greater future macroeconomic stability, which in the end is translated into a greater economic growth.

5.4 Robustness checks: 3 equations SVAR

As the 3 equations SVAR is our base specification, we conduct several robustness checks beyond the 6 equations and STVAR estimates to measure the accuracy of our results. The results do not vary when considering the tax income ($\beta_{tg} = 0$) or expenditure ($\beta_{gt} = 0$) come first. Also the results do not vary importantly when we take different values of the effect of production on tax income (α_{ty}). Changing the value of this elasticity to its lower bound (0.91) or upper one (1.24) does not result in perceptible changes of the taxes effect on output, while the expenditure effect remains the same.

Another interesting robustness check is to corroborate the results from the instrumental variables approach. As mentioned earlier, the parameters β_{tg}, γ_{yg}, and γ_{yt} are estimated using the system's information as a whole, with restrictions on the matrix given by the diverse parameter values. This approach is different from the one used by Blanchard and Perotti (2002), who built the cyclically adjusted reduced form residuals for tax income and expenditures, $u_t^{t,CA} \equiv u_t^t - \alpha_{ty} u_t^y = \beta_{tg} e_t^g + e_t^t$ and $u_t^{g,CA} \equiv u_t^g - \alpha_{gy} u_t^y = \beta_{gt} e_t^t + e_t^g$, with estimates for α_{ty} and α_{gy}. Later they took those as the unexpected movements in the fiscal variables and were used as instruments to estimate γ_{yg} and γ_{yt} in a linear regression with the

GDP reduced form error, u_t^y. Finally, those parameters are imposed as additional constraints to estimate β_{tg}.

Table 6: Contemporaneous coefficients 3 equations SVAR, instrumental variables approach

Coefficient	Estimate	Standard error	Probability
γ_{yg}	0.05	0.05	0.42
γ_{yt}	-0.09	0.03	0.01

Note: the coefficient γ_{yg} refers to flexible expenditure contemporaneous impact, γ_{yt} to the respective one for tax income. Source: own elaboration.

Table 6 shows the results from the system estimation with this alternative approach. As it could be appreciated the contemporaneous coefficients, and hence the impulse responses are the same to our method. This does not only provide confidence about the obtained results, but also shows the equivalence in the estimation through the whole system instead of the two step instrumental variables method.

In the literature, the temporal robustness with respect to the fiscal multipliers results had been an open issue without a concrete answer. Blanchard and Perotti (2002) analyzed the sub-sample stability with the estimates of the GDP responses when a different decade is dismissed in each new estimation. They found the exclusion of the 80's cause a substantial fall in the income multiplier size; while the expenditure multiplier when excluding the 80's is three times higher that when the 70's are excluded. Both authors mentioned they did not possess a convincing explanation on the impulse response changes through time.

This peculiarity is also present in the Costa Rican output responses, where, given the sample limitations, we use as temporal robustness check an estimation with data from 1991 to 2005, and another from 2006 to 2018. Table 7 summarize the contemporaneous coefficients results, while figures 16, 17, 18, and 19 show the respective GDP responses.

From the 1991 to 2005 sample, the GDP response for the flexible expenditure is not statistically significant (figure 16), while the tax income effect is still significant and negative on economic activity (figure 17). Despite that, in the 2006 to 2018 sample, the expenditure continues to have a non-significant effect on economic activity (figure 18), but the tax income impact now is null (figure 19). During this sample period (2006-2018), the Costa Rican economy presented several abrupt changes with respect to economic policy. First since 2006, the exchange rate regime migrated from an adjusted parity to an exchange rate interval regime, and later to floating administration of the exchange rate since 2015. This greater exchange rate flexibility has been documented as a potential factor for low multipliers in

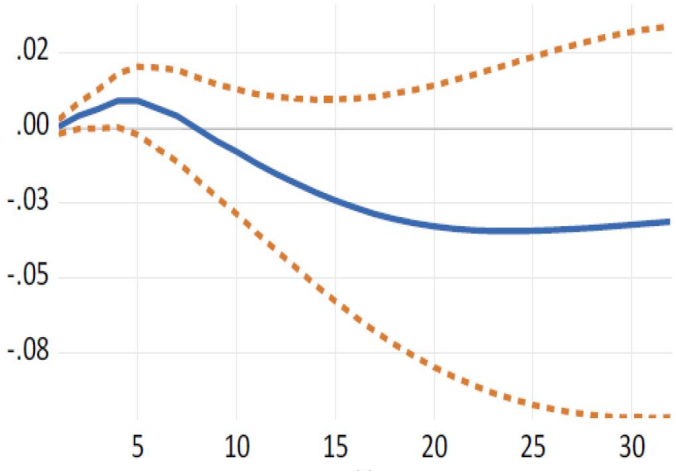
developing countries (Ilzetzki et al., 2013). Second, in 2016 public debt comes to represent 45% of GDP, an increase of almost 100% in comparison with the decade's beginning, an indicative of poor public finance management that could lessen fiscal policy effectiveness.

Table 7: Contemporaneous coefficients 3 equations SVAR, time stability

Coefficient	Estimate	Standard error	Probability
$\gamma_{yg(91-05)}$	-0.01	0.07	0.91
$\gamma_{yt(91-05)}$	-0.14	0.05	0.00
$\gamma_{yg(06-18)}$	-0.04	0.07	0.55
$\gamma_{yt(06-18)}$	-0.01	0.04	0.74

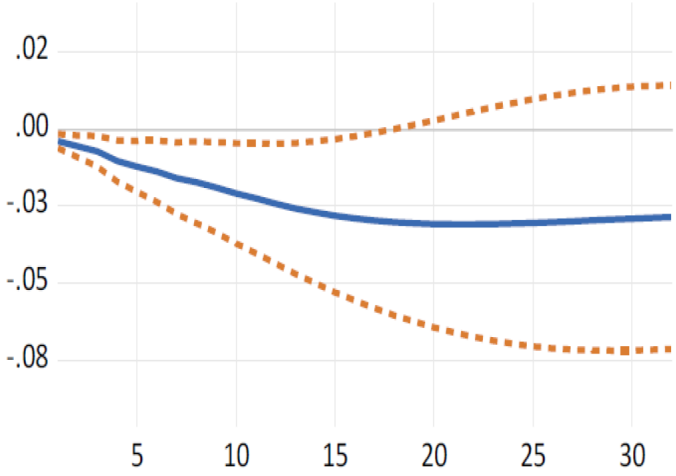
Note: the coefficient γ_{yg} refers to flexible expenditure contemporaneous impact, γ_{yt} to the respective one for tax income. (91-05) corresponds to the 1991 to 2005 sample, (06-18) to the 2006 to 2018 sample. Source: own elaboration.

Figure 16: Cumulative GDP response to flexible expenditure, 1991-2005



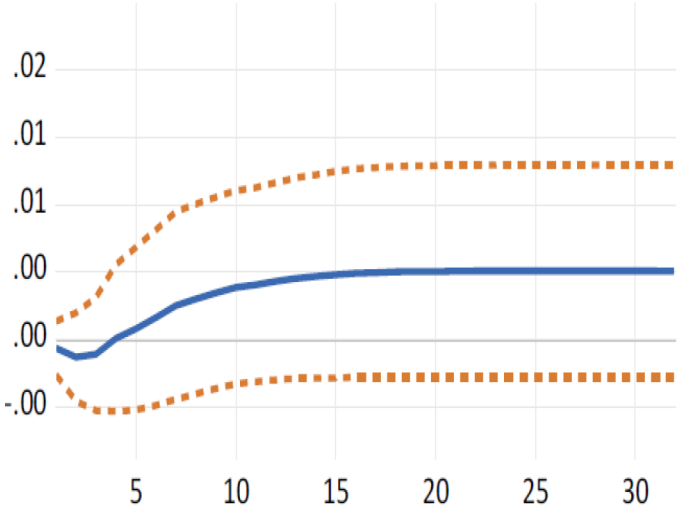
Note: GDP cumulative response to a structural shock (one standard deviation of the error) in flexible expenditure. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Sample 1991-2005. Three equations SVAR model.

Figure 17: Cumulative GDP response to tax income, 1991-2005



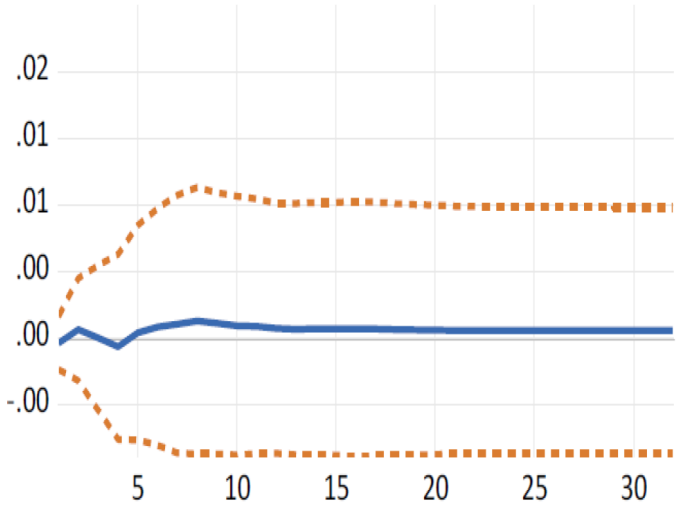
Note: GDP cumulative response to a structural shock (one standard deviation of the error) in tax income. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Sample 1991-2005. Three equations SVAR model.

Figure 18: Cumulative GDP response to flexible expenditure, 2006-2018



Note: GDP cumulative response to a structural shock (one standard deviation of the error) in flexible expenditure. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Sample 2006-2018. Three equations SVAR model.

Figure 19: Cumulative GDP response to tax income, 2006-2018



Note: GDP cumulative response to a structural shock (one standard deviation of the error) in tax income. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Sample 2006-2018. Three equations SVAR model.

In the literature, economies with higher debt levels tend to have low or even negative expenditure multipliers (Ilzetzki et al., 2013). Also Perotti (2007) concluded fiscal policy effects on GDP and its components had become substantially weaker in the last 2 years (2006-2007 for him), with negative multipliers both for income and expenditures in OECD countries.

Sustained by the previous evidence, it could be the case the current context has made fiscal policy less effective. Nevertheless, as we could expect null effects for the 2006-2018 sample, for the 1991-2005 sample the almost null expenditure impact rises doubts of whether both small sample sizes are the main reason for these null effects.

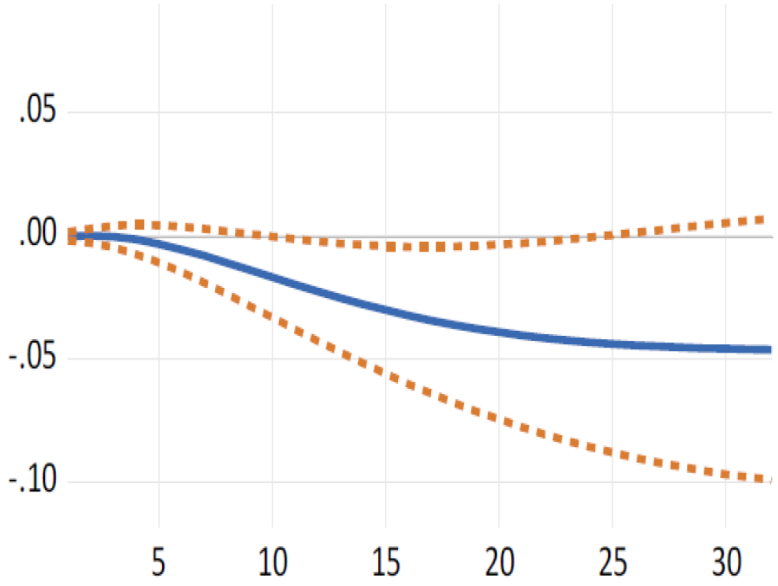
6 Other results

This section will show a summary of multiple relevant results of fiscal policy impact, which will focus on the impulse responses from different specifications. First, we will observe the effect on output of two types of expenditures: current and capital expenditures; with the interest rate channel for the current expenditure effect on output, and a little discussion on the expenditure's flexibility. Second, we will have the effect of flexible expenditure and tax income on private consumption, and private investment.

6.1 Current and capital expenditure

In a wide range of research about fiscal policy impact on economic activity, there has been used diverse public expenditure measures under the statement their productivity, and spillovers to the rest of the economy depends on the specific expenditure type. It is well known one of the most effective expenditures for economic growth is in infrastructure, while expenditures for debt services and interest should not have any direct importance by definition (it is not a productive activity). With the goal to determine if there is a different effect by the type of expenditure, we estimate the GDP response to changes in the current (excluding debt related expenses) and capital expenditures.[36]

Figure 20: Cumulative GDP response to current expenditure

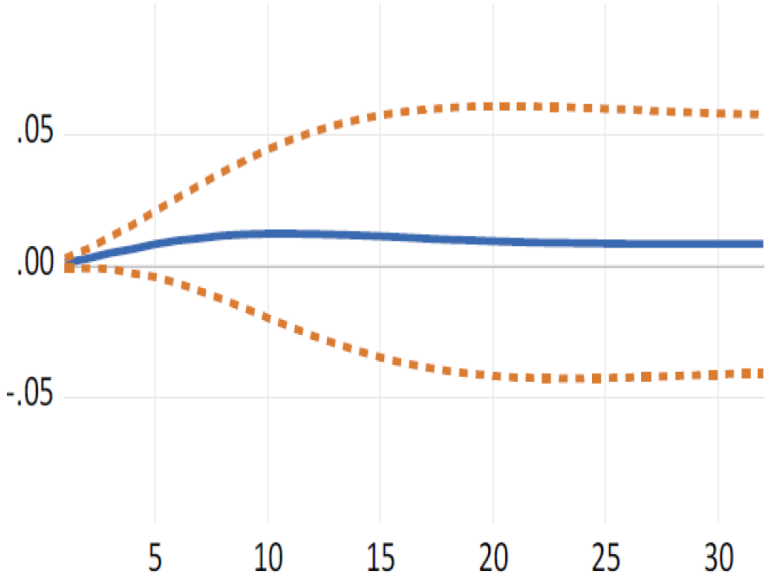


Note: GDP cumulative response to a structural shock (one standard deviation of the error) in current expenditure. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Three equations SVAR model.

In figure 20, the current expenditure shows a significant effect from the tenth quarter to the twenty four quarter after the shock, however the effect is negative on output. Multiple explanations emerge for this negative impact. First the national government budget is highly inflexible. Unavoidable obligations cover near the 95% of the total tax income (67.8% of total budget without the debt service) according to CGR (2018). This tiny action margin implies fiscal policy through expenditures could not only be anticipated by the private sector, who

[36]The capital expenditure is defined as investment in non-financial assets and capital transfers to the public, private, and external sectors. Sadly it was not possible to determine if this data includes infrastructure investment or if it was possible to extract it from the data.

Figure 21: Cumulative GDP response to capital expenditure



Note: GDP cumulative response to a structural shock (one standard deviation of the error) in capital expenditure. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Three equations SVAR model.

could adjust downward consumption to tackle future tax increases; but also the changes in expenditures could obey, endogenously, to budget needs and political process instead to an output stabilization mechanism. Second, as mentioned previously and also said by Ilzetzki et al. (2013), the exchange rate flexibility jointly with high debt levels could lead to low or even negative expenditure multipliers as in this case. The positive effects of expenditure increases are diluted by exchange rate movements, while put upward pressure to the fiscal deficit and thus on public debt, with the corresponding upward pressures on interest rates and the posterior negative effect on the economic activity, hence the large lag of production's response starting at the tenth quarter after the shock.

On its part, increases in capital expenditure have an almost null and non-statistically significant effect on output (figure 21). Although counter-intuitive, it could be due to the low size for this kind of expenditure which represents, on average, only 9% of total public expenditures, and 1.6% of GDP.

The significant results under the flexible expenditure definition used (figure 10), against the other expenditures definition, provide an important conclusion. Greater public expenditure flexibility would have a significant effect as a tool for economic activity stabilization. Recall the flexible expenditure was built with wages and salaries, social charges, goods and services expenditures, and investment in non-financial assets, all of which could be

argued are the best representation of flexible expenditures in Costa Rica and together have provided a positive effect on output. The expansionary fiscal policy implemented by the Arias administration in 2009 meant a change (maybe unexpected) in the expenditure's trend in order to stabilized the economy that, isolated from the funding method, could have considerable explanatory power in the results obtained for the flexible expenditure.

Nevertheless, it is necessary to acknowledge these results for the flexible expenditure do not take into account the funding method. If it is through taxes, the results show taxes have a negative impact on economic activity. If it is through debt, an informal and incomplete test would be given by the results in the 2006-2018 sub-sample, where the flexible expenditure losses the statistically significant impact on GDP, and there is also a considerable increase in public debt (figure 8) mostly due to the permanent changes of the expansionary fiscal policy. It is important to note that for increases in the flexible expenditure to be beneficial for the economic activity, these must be done with full consciousness and an exhaustive analysis for the funding effects on the economic activity.[37]

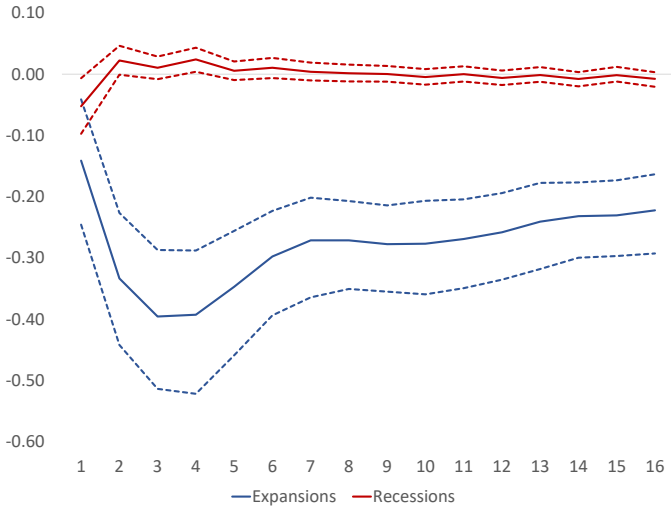
The figures 22 and 23 bring more details on the impact of both types of expenditures. When conditioning on the state of the economy, we observe the current expenditure has a negative effect in expansions, in accordance with previous explanations; but in contrast with the flexible expenditure counterpart, inflexibility could affect its effectiveness to help the economy in recessions as there is no statistically significant effect for any quarter. Instead current expenditure increases harm the economic activity with the generation of negative expectations on the economic agents due to possible increases in debt (hence in interest rates), and in taxes (hence diminishing the disposable income and business profits).

Capital expenditure in the linear model does not have a statistical significant impact, but that changes both in expansions and recessions. The history remains the same in expansions, increases in capital expenditures are perceived by the economic agents as something negative for the economic prospects, and thus the negative impact on production in this regime. Instead, now the output response is clearly positive in recessions, where it seems the economic agents left behind the negative expectations on expenditure increases, and it is successful to impact positively the economic activity, in contrast with current expenditures that had a null effect. An intuitive policy implication is suggested by these results: capital expenditures are effective to help recover the Costa Rican economy during crisis, but it is not true for the

[37] Sadly the main example for the Costa Rican economy seems to be the expansionary fiscal policy. It helped the economy to overcome the 2008 financial crisis, but as the changes were permanent, now it has become into a public debt issue with the corresponding problems in terms of higher interest rates, bad private agent's expectations, and others. We hope the recent approval of the tax reform (which came with several strikes from different economic sector) could help to tackle all those problems and in some years could serve as evidence for interesting research.

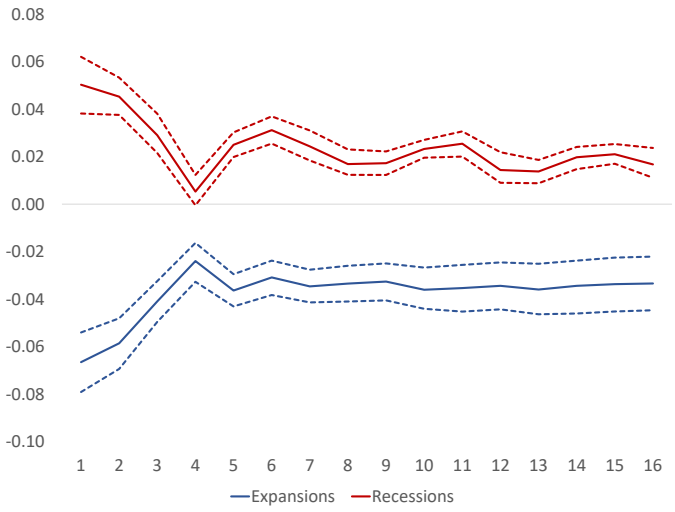
current expenditure.

Figure 22: Cumulative GDP responses to current expenditure



Note: GDP cumulative response to a 1% shock in current expenditure. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Three equations STVAR model.

Figure 23: Cumulative GDP responses to capital expenditure

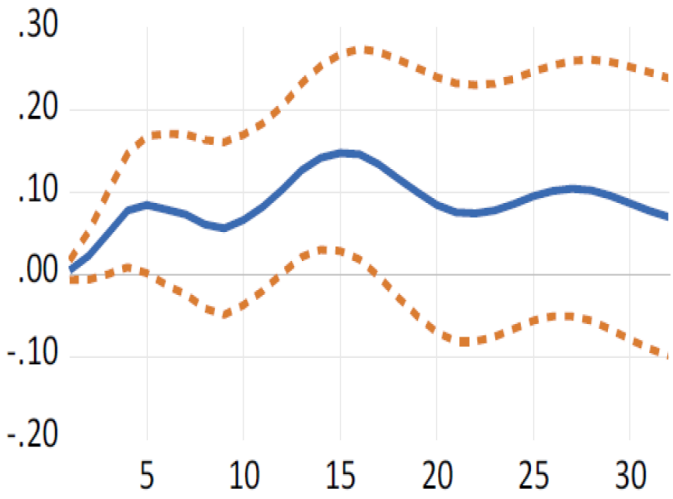


Note: GDP cumulative response to a 1% shock in capital expenditure. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Three equations STVAR model.

Inside the public debate there are always statements on the government expenditures crowding-out effects on private consumption and investments. Specifically that increases

in the current expenditure are associated with increases in debt, as mentioned previously, implying the channel for the negative impact of current expenditures on output is through increases on the interest rates.[38] Figure 20 shows increases in current expenditure, far from increase production, have a negative effect with a substantial lag. This is not only in accordance with previous results in the literature, specifically in Ilzetzki et al. (2013) mentioned earlier. When the Costa Rica's current expenditure increases, indeed there is an upward pressure on the interest rates (figure 24), which is statistically significant for the first year, and between the third and fourth year after the shock. This pressure emerge from the fact the current expenditure is funded with public debt, so the government competes for the raising of liquidity funds increasing the interest rates, all produced with certain lag when the net savers observe the sovereign debt increases, due to a higher debt level, and demand higher risk premiums. This effect on interest rates could be the transmission channel for the debacle in production, as the impact of the former on the latter is negative and statistically significant from the first quarter to the seventh one after the shock (figure 25).

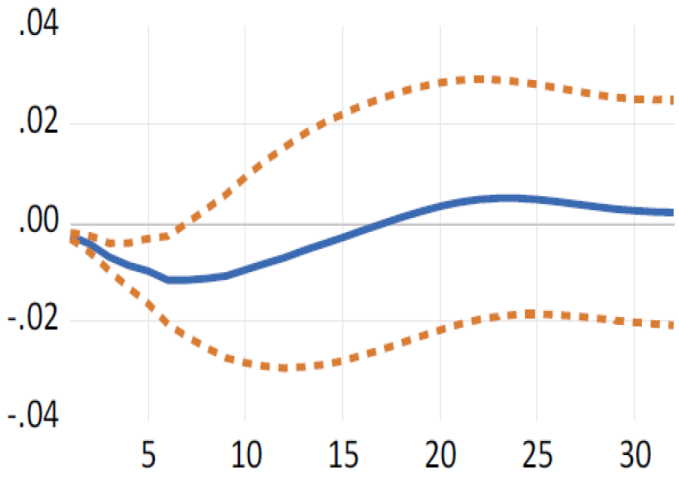
Figure 24: Cumulative response of the basic passive rate to current expenditure



Note: Basic passive rate cumulative response to a structural shock (one standard deviation of the error) in current expenditure. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Six equations SVAR model.

[38]Thought the other channel argued is the expectations on future tax increases, it is more difficult to measure this impact in a convincing way. Blanchard and Perotti (2002) and Auerbach and Gorodnichenko (2012) searched as an additional exercise to control for agent's expectations, aspect mentioned as the principal limitation in this kind of models. However, as there is not a systematic and convincing way for this issue, we preferred to omit controlling for expectations and leave it for future research on the Costa Rican fiscal policy dynamics.

Figure 25: Cumulative GDP response to the basic passive rate

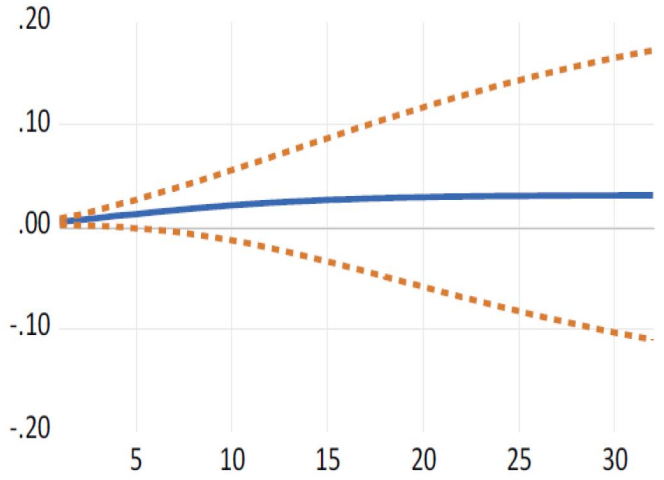


Note: GDP cumulative response to a structural shock (one standard deviation of the error) in the basic passive rate. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Six equations SVAR model.

6.2 Private consumption and investment responses

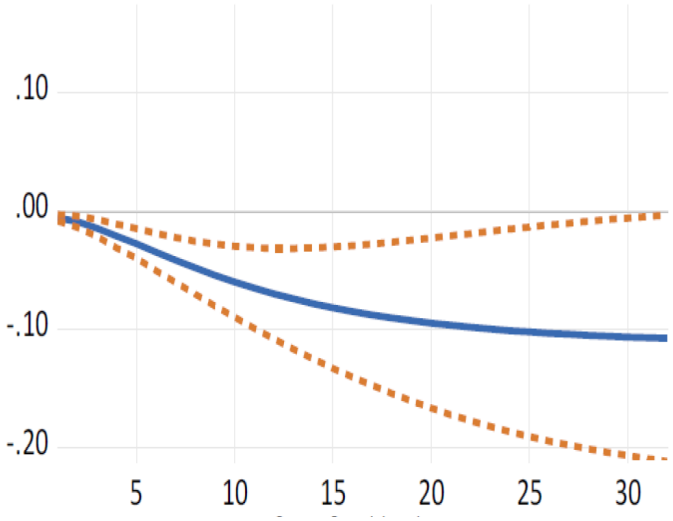
We have determined the effect of increases in flexible expenditure are positive on GDP, whereas increases in tax income have a negative effect. But, what happens with the components in the private sphere? An analysis of fiscal policy impact on private consumption and investment is always relevant. This allows us to obtain an overall impression on the economic theory behind the economic agent's behavior in Costa Rica for changes in fiscal policy. As a example, besides variants to Neoclassical and Neokeynesian models forecast positive output responses to expenditure increases and negative ones to tax increases, the private consumption and investment responses are far away between both theories. Neokeynesian expect public expenditure increases to be translated into private consumption increases, while tax increases will have the contrary effect. The Neoclassics would forecast a null or negative effect on private consumption for increases in both expenditures and/or taxes. With respect to investments, for the Neoclassics there is also a decrease in private investment to both increases in expenditures as well as taxes. Whereas Neokeynesian consider increases in public expenditure could increase or decrease investment depending of the relative strength of the output and interest rates increases; for these theorists, increases in taxes will be totally the opposites to the expenditure ones.

Figure 26: Cumulative response of private consumption to flexible expenditure



Note: Private consumption cumulative response to a structural shock (one standard deviation of the error) in flexible expenditure. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Three equations SVAR model.

Figure 27: Cumulative response of private consumption to tax income



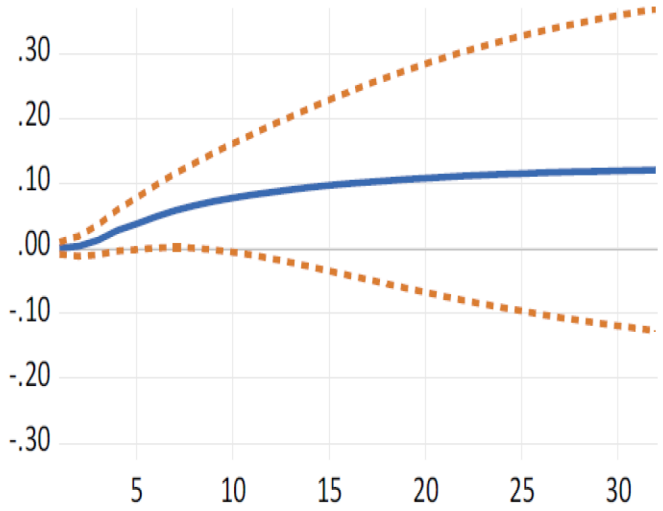
Note: Private consumption cumulative response to a structural shock (one standard deviation of the error) in tax income. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Three equations SVAR model.

The consumption dynamic response to a flexible expenditure shock is positive and statisti-

cally significant only in the first year (figure 26). While the consumption response to a tax income shock is not only negative, but is also statistically significant from the first quarter to 32 quarters after the shock. i.e. eight years after the impact (figure 27).

When the flexible expenditure increases the investment response is not statistically significant (figure 28). But the investment responds negatively to tax income shocks, with a statistically significant effect from the first quarter also to 32 quarters after the shock (figure 29).

Figure 28: Cumulative response of private investment to flexible expenditure

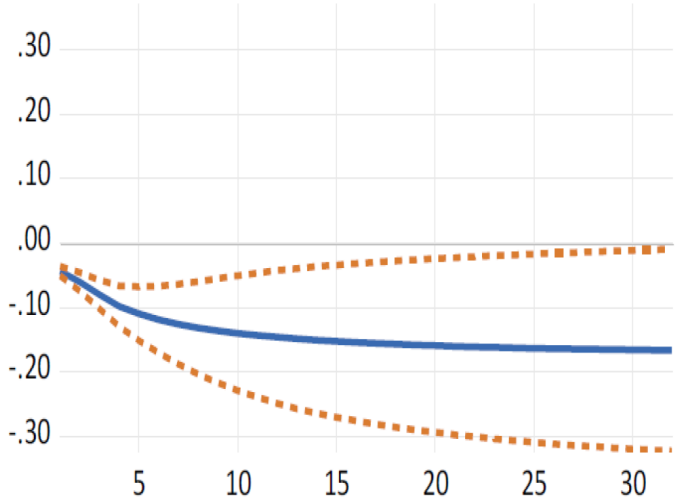


Note: Private investment cumulative response to a structural shock (one standard deviation of the error) in flexible expenditure. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Three equations SVAR model.

This results state private consumption seems to behave as in Neokeynesian theory, but there is some ambiguity in the investment behavior, due to the statistically null effect of public expenditures. Relying only in the impulse response direction, the investment behavior will be in accordance also with Neokeynesian theory. It is important to note the negative effects of tax increases are highly persistent for both private components.

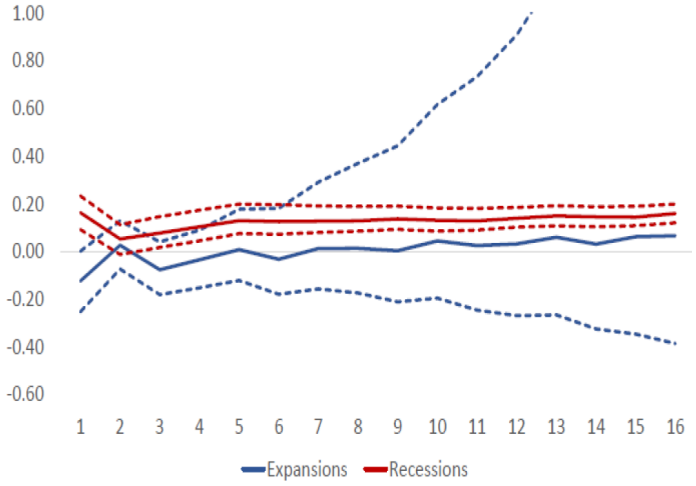
What takes place when we observe the dynamics in recessions and expansions? Figure 30 indicates in expansions the final households' consumption does not vary with the public expenditure; while there is a positive and significant relation in recessions, but the latter response is only statistically significant for the first year (statistically significance difference among both regimes paths). On the other side, the tax income still have a negative impact on private consumption in recessions and null impact on expansions, but they do not seem significantly different among each other (figure 31).

Figure 29: Cumulative response of private investment to tax income



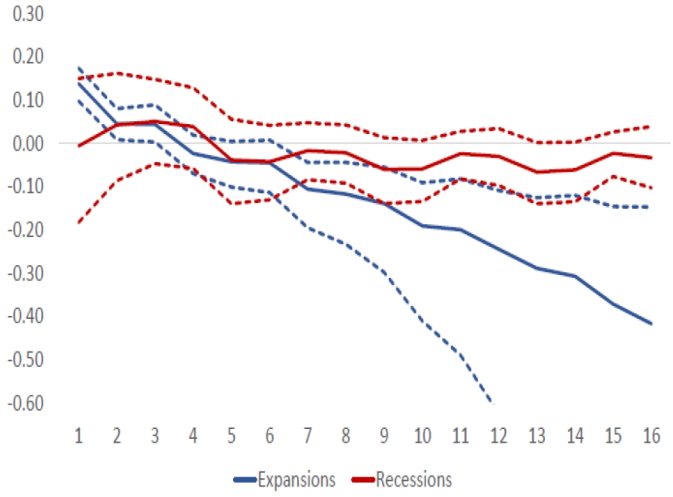
Note: Private investment cumulative response to a structural shock (one standard deviation of the error) in tax income. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Three equations SVAR model.

Figure 30: Cumulative response of private consumption to flexible expenditure



Note: Private consumption cumulative response to a 1% shock in flexible expenditure. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Three equations STVAR model.

Figure 31: Cumulative response of private consumption to tax income

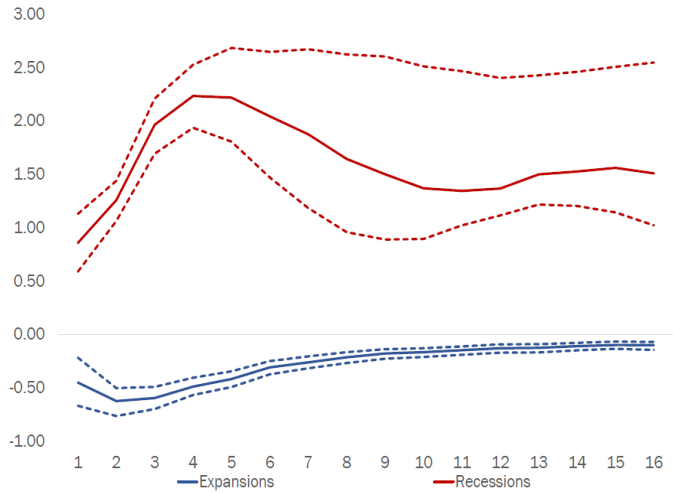


Note: Private consumption cumulative response to a 1% shock in tax income. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Three equations STVAR model.

The response of the brute fixed capital formation is similar in sign to the output's ones, which suggests fiscal policy has more impact in production through its effect on private investment when conditioning on the state of the economy. In figure 32 we appreciate increases in the flexible expenditure have a negative effect on private investments during expansions, mainly in accordance with Neoclassical view, but its response is positive in recessions according to Neokeynesian approach. Again, this suggests the public expenditure directed to capital formation in the Costa Rican economy is really effective and suitable during recession times as a measure for economic activity stabilization.

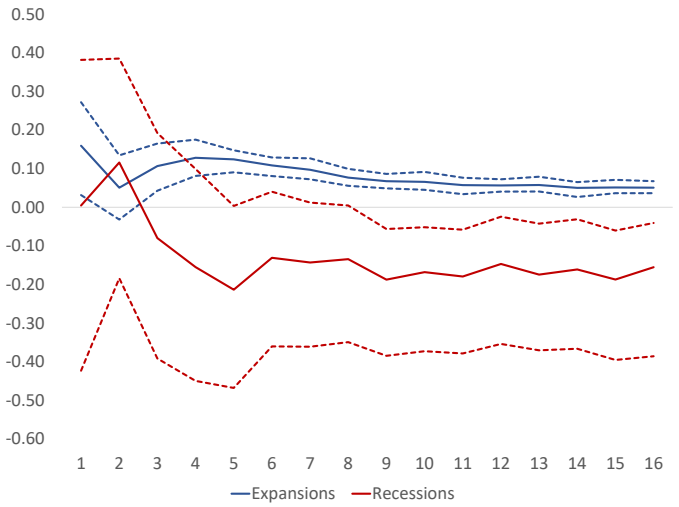
The effect of tax income increases on investment is also according with the ones it has on output (figure 33). The investment response is clearly negative in recessions and appears as positive in expansions. The recessions effect is intuitive and according to both Neoclassical and Neokeynesian views. But as in the production's case, the positive effect in expansions is difficult to reconcile with both Neoclassical and Neokeynesian models, so it should be taken with caution due to the possible reverse causality issue, or maybe some explanation could be brought from the expansionary fiscal contraction approach.

Figure 32: Cumulative response of private investment to flexible expenditure



Note: Private investment cumulative response to a 1% shock (one standard deviation of the error) in flexible expenditure. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Three equations STVAR model.

Figure 33: Cumulative response of private investment to tax income

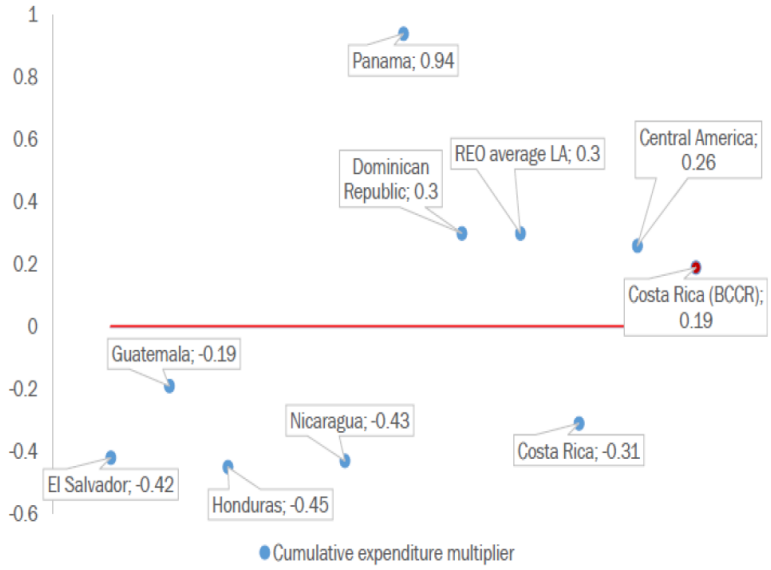


Note: Private investment cumulative response to a 1% shock in tax income. Discontinuous lines are 90% confidence intervals. Source: own elaboration. Three equations STVAR model.

7 Costa Rica's fiscal multipliers size

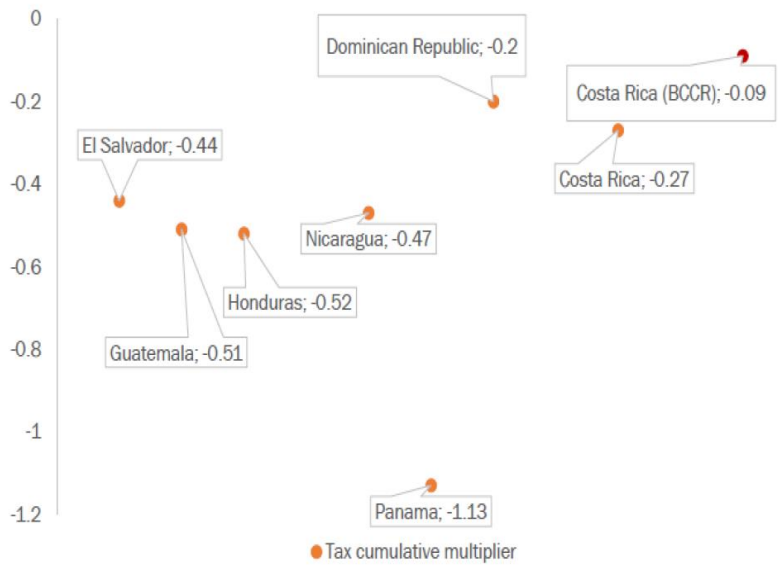
Looking at the size and direction of the fiscal multipliers proposed here, other studies that include Costa Rica, also found similar results. For Estevão and Samaké (2013), the output impact response to a current expenditure shock in Costa Rica resulted in -0.04, and a cumulative multiplier of 0.76. Likewise one of the most recent studies is the macroeconomic report made by the Inter-American Development Bank (IADB). In this report IADB (2017) an increase of two percentage points in the marginal tax rate on the taxes on sales generates a multiplier effect of -1.5 on production. Reaffirming the non-linearity theory, which assumes tax changes in countries with a low initial marginal tax rate (13% in Costa Rica) have a low or null reaction. The figures 34 and 35 show the obtained multipliers for expenditure and tax income respectively, to make a comparison with multiple studies for developing countries, some including Costa Rica.

Figure 34: Expenditure cumulative multipliers for several countries



Note: Cumulative expenditure multipliers up to one year. In red this paper multiplier. Source: own elaboration with results from several studies (Estevão and Samaké, 2013; IMF, 2018; Contreras and Battelle, 2014).

Figure 35: Tax income cumulative multipliers for several countries



Note: Cumulative tax income multipliers up to one year. In red this paper multiplier. Source: own elaboration with results from several studies (Estevão and Samaké, 2013; IMF, 2018; Contreras and Battelle, 2014).

Given the Costa Rica's context and the different aspects described by CEPAL (2017) and IMF (2014) as factors for the multipliers size, the low Costa Rica's fiscal multipliers size is expected. Despite the low liquidity restrictions in the financial market (in part due to the degree of deposits dollarization), and a reasonable response to monetary policy (the pass-through effect of the monetary policy rate to the other interest rates in the bank system last on average eight to twelve months), it has an increasing public debt level, a high inflexible expenditure (unavoidable obligations are near 95% of tax income), a high openness degree (above 60%), little labour inflexibility (Ibarra, 2010), and a flexible exchange rate (floating administration).

8 Final Remarks

The impact fiscal policy could have on output has been the center of debate when considering governmental actions to reactivate the economy. Therefore, having a quantitative sense of its behavior is of great importance; Costa Rica is no exception. As a matter of fact, its actual context of weak public finances, a recent fiscal reform approval, and an economic slowdown, accentuates the need of estimating fiscal multipliers that consider particular characteristics of their corresponding economy.

Hence, the goal of this research was to contribute to the literature on the topic for small, open economies, and to aid on the debate of the dynamism of multipliers in Costa Rica. For this, we estimated SVAR models based on Blanchard and Perotti (2002) and Perotti (2007), in addition to a STVAR model as in Auerbach and Gorodnichenko (2012). To our knowledge, there are few other estimates for this country, but none which consider a change in regime or have quarterly data since 1991.

According to the results obtained, the flexible expenditure effect on output, measured by the multiplier is positive and statistically significant. An increase of 1% in the ratio of flexible expenditure to GDP is associated with an increase of 0.20% in production on year later. Moreover, this expenditure has a positive effect in recessions, so it could be used as a tool to stabilize the economy during slowdown periods. However, in expansions its impact is negative, where it seems agent's expectations play against it. Expenditure increases in expansions could be perceived as increases in public debt or future taxes, the former increasing interest rates and credit availability through the crowding-out effect, and the latter diminishing the expected disposable income of agents. Both effects could explain the negative impact on production. Thought it is difficult to measure the expectations channel, it was possible to find evidence in favor of the interest rate channel, as current expenditure increases put upward pressures on interest rates and this have a negative effect on output, evidence in favor of the crowding-out effect of the public sector.

The results for the tax income multiplier show a negative and statistically significant effect on GDP. An increase of 1% in the ratio tax income to GDP is associated with a reduction of 0.08% in output a year later. This effect is highly persistent through time, more than the flexible expenditure. When observing the effect conditional on the state of the economy, we found the response of output is positive in expansions and negative in recessions. The recessions effect is in accordance with economic intuition: decreases in disposable income and business profits lessens aggregate demand and thus the economic activity. Instead, the positive effect in expansions must be taken with caution. Three points arise as possible interpretations. First, it is definitely the case increases in taxes are less harmful for the economic activity in expansions than in recessions. Second, this effect could be due to a reverse causality problem given the positive correlation between economic activity and tax income (which seems to be isolated effectively in the SVAR model). Third, the positive effect of tax increases on production could be explain by what is known in the literature as the "expansionary fiscal contraction". This approach states economies with high public debt levels, the Costa Rican case, could experience improvements in the agents' expectations due to the tax increases, as long as those are considered to be used for the public finances betterment, leading to a greater future macroeconomic stability, and hence to a higher

economic growth.

By expenditure type, the current expenditure shows a negative effect on output. Multiple explanations emerge for the effect. First, the government budget is highly inflexible. The unavoidable obligations cover near 95% of tax income (67.8% of the total budget without the debt service). This tiny action margin implies fiscal policy through expenditures could be not only anticipated by the private sector, who could adjust downwards their consumption to tackle future taxes, but also the expenditure changes could be endogenous to budget needs and the political process, not used as an stabilization tool for the economic activity. Second, as argued by Ilzetzki et al. (2013), the exchange rate flexibility and the high debt levels, both Costa Rican aspects, could lead to low or even negative expenditure multipliers. The possible positive effects of increases in the current expenditure are diluted by the exchange rate movements, while the pressure on the fiscal deficit and hence on public debt tends to increase the interest rates, and thus it has a negative effect on output, an explanation for the large lag in the output's negative response.

The significance of the results under the flexible expenditure definition, in contrast to the current expenditure, brings an important conclusion. Higher public expenditures flexibility could have a positive and statistically significance effect as a tool to stabilize the economic activity. Even when conditioning on the state of the economy the current expenditure increases are harmful for output in recessions and have null impact in expansions, implying the expenditures inflexibility diminish the expenditure effectiveness even in recessions.

When there is a shock in the government capital expenditure, the output response in the linear model is almost null. Although this is counter-intuitive, it could be due to the low size in this kind of expenditure, it represents only 9% of total expenditures and 1.6% of GDP. Even thought the capital expenditure has statistically significant effects both in recessions and expansions, the history is similar in the expansions case; increases in the capital expenditures are perceived as something negative by the economic agents and thus it results in the negative impact on output in this regime. Instead the output response is clearly positive in recessions, where it seems the economic agents leave behind the negative expectations about government capital expenditures, and thus it achieves a positive impact on output, in contrast to the current expenditure and its null effect in this regime. An intuitive policy implication is: higher expenditure flexibility and capital expenditures are effective to help the Costa Rican economy overcome a crisis, but it is not true for the current expenditure.

The responses of the private components to changes in fiscal policy are also relevant. Private consumption is negatively and persistently affected by taxes (even 8 years after the shock), while the flexible expenditure effect is positive only in the first year. Conditioning

on the state of the economy, in expansions private consumption does not vary with public expenditures, whereas it has a positive and significant response in recessions, though it is statistically different from the one of expansions only in the first year. On the other side, tax income maintains the negative impact on private consumption, both in recessions and expansions.

On the private investment side we have an equivalent situation: taxes effect is negative, statistically significant, and highly persistent (until 8 years after the shock); and the expenditure shocks have a positive impact, but not statistically significant in the linear model. Instead, when considering economic cycles, the investment response is similar to the output responses, which suggests fiscal policy has more impact on production through its effect on private investment. Increases in the flexible government expenditure have a negative impact on investments in expansions, according to Neoclassical theory, but the response is positive in recessions in line with Neokeynesian theory. As in the case of output and public capital expenditure, this suggests public expenditures directed to investments in Costa Rica is really effective and suitable in slowdown periods as a stabilization tool of the economic activity. On the same line, the tax income effects on private investments are similar to the ones on output. The response is clearly negative in recessions and it turns positive in expansions. As with output, the latter effect must be taken with caution due to possible reverse causality problems.

Given the analysis, we conclude that fiscal policy through higher flexible expenditure and on capital investment is effective to stabilize the economic activity in recessions. Nevertheless, this expenditure funding requires special attention. For tax income, the multipliers showed to be consistently negative and with a highly persistent effect on GDP, on private consumption and mainly on investment. Additionally, the debt level could provoke negative effects on production, as observed with the negative GDP response to current expenditure shocks, and the crowding-out evidence. Thus, the debate on the optimal use of public resources is still open, and requires an exhaustive revision.

The evidence on low multipliers, as the ones obtained, are not an empirical rarity. Several are the results of this kind for the fiscal multipliers in income and expenditure, in the theoretical and empirical domains. On the theory side, Sutherland (1997) pointed out a high default probability of the public sector leads to negative multipliers, as economic agents save because they perceive tax increments are imminent.

In fact, the linear (SVAR) model results suggest the economic agents in Costa Rica behave under Neokeynesian theory, when using the flexible expenditure, and the tax effects are negative and highly persistent. Besides that, the expenditure inflexibility and the high debt level, as proxy of high default probability, proved to be harmful for the effectiveness of

fiscal policy, as agents behave according to the Neoclassical theory.

The model with changing regime goes beyond. It allows to suggest that Costa Ricans behave under Neoclassical theory in expansions, where expectations of tax and interest rates increments (the latter due to public debt) make expenditure policy damaging. But in recessions, it is Neokeynesian theory what seems to rule, which opens the possibility to expenditure policies, well designed, well implemented, and well financed to stabilize the economic activity when in recession.

Even so, the results must be taken with caution as there are multiple limitations in the analysis. First, fiscal policy changes could not be completely unexpected. Agents could change their behavior when anticipating government policy changes (Yang, 2005). Here, the estimation of fiscal policy effects on output requires the policy changes to be unexpected. For further research, it is relevant to estimate fiscal policy dynamic effects when we relax this assumption. Also, the definition and calibration of DSGE models could bring a more holistic and complete comparison for the jointly economic activity dynamics, and the transmission channels.

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9 Appendix

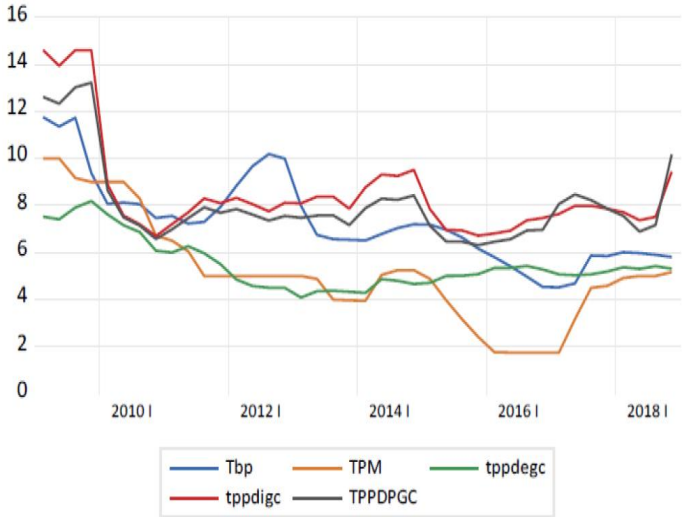
9.1 Appendix 1: Comparison of strengths and limitations of fiscal multipliers estimation techniques

	SVAR models	DSGE models
Summary	• Variables of interest (tax income, expenditures, output, interest rates, and inflation) are interrelated and there are multiple potential causal relationships. • It uses elasticities of tax income and expenditures with respect to output to rule out the effects of the automatic stabilizers. • It isolates exogenous fiscal shocks and estimate its impact on GDP using diverse identification assumptions. • Commonly available for the United States and G20 countries.	• It is based on the current economic characteristics. • It describes the economic system as a whole through the analysis of multiple microeconomic decisions. • They use the general government instead of the central government. • The majority of studies includes the OECD countries.
Strengths	• Uses specific country data for few macroeconomic variables.	• Holistic description of the economy. • When the same model is used in different countries the results have lower dispersion. • Reflects unusual conditions, and conditions with few historical precedents.
Limitations	• Fail to measure purely exogenous fiscal shocks. • If there had existed a structural change for a determine country, the average output response to an exogenous fiscal shock would not capture the effect it could have today, as the method uses historical information. • SVAR as a linear model does not capture the multipliers could be conditional on the respective state. • It do not consider when the interest rate is near the zero lower bound.	• No consensus about fiscal policy modeling (i.e. fiscal rules). • Linear equations, there could not be obtained state dependent fiscal multipliers. • Multipliers depend on model assumptions (calibration versus estimation). • Results are sensible to the selection of certain parameters.

Source: Taken from Garry and Rivas-Valdivia (2017)

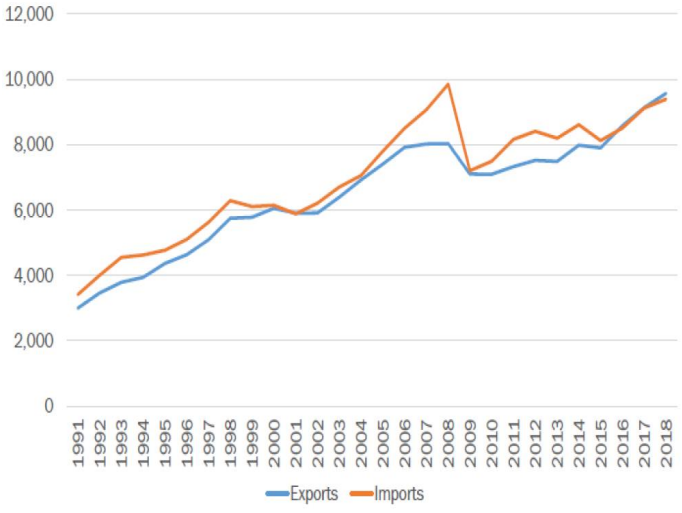
9.2 Appendix 2: Series used

Figure 36: Costa Rica: Interest rates



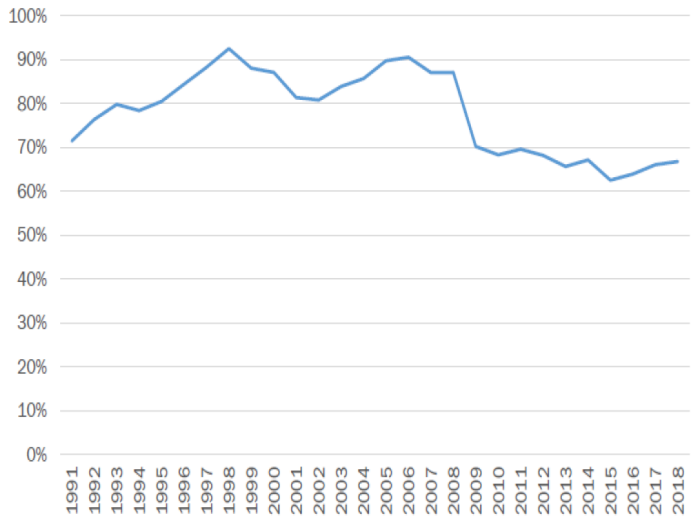
Note: Quarterly data. Each unit represents a hundred base points (i.e. 1%). The basic passive rate and the monetary policy rate are the average of daily data. The debt interest rates are the weighted average gave by Treasury, with monthly frequency, we compute the quarterly average. TBP: basic passive rate. TPM: monetary policy rate. TPPDEGC: weighted average of Central Government foreign debt. TPPDIGC: weighted average of Central Government domestic debt. TPPDPGC: weighted average of Central Government total debt. Source: own elaboration with BCCR and Treasury data.

Figure 37: Costa Rica: Exports and imports



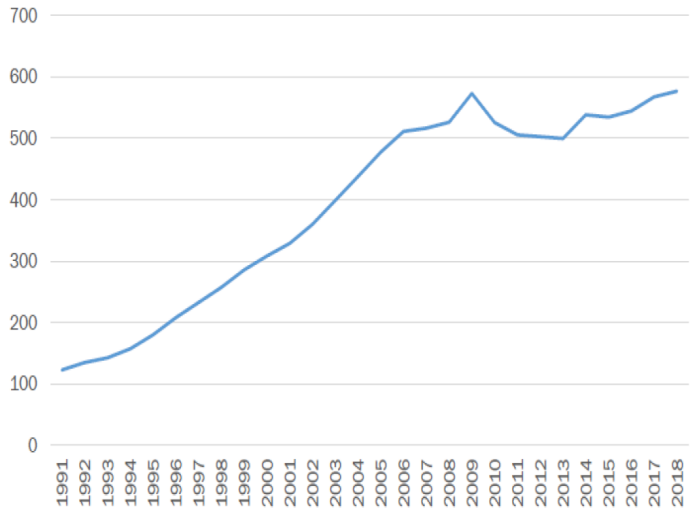
Note: in thousands of millions of real colones. Source: own elaboration with data from BCCR.

Figure 38: Costa Rica: Openness degree



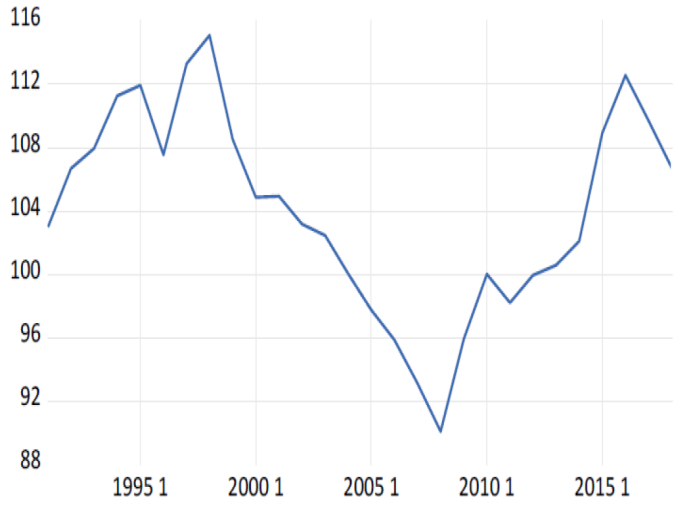
Note: it is the proportion of the sum of exports and imports on GDP, in percentage. Source: own elaboration with data from BCCR.

Figure 39: Costa Rica: Nominal exchange rate



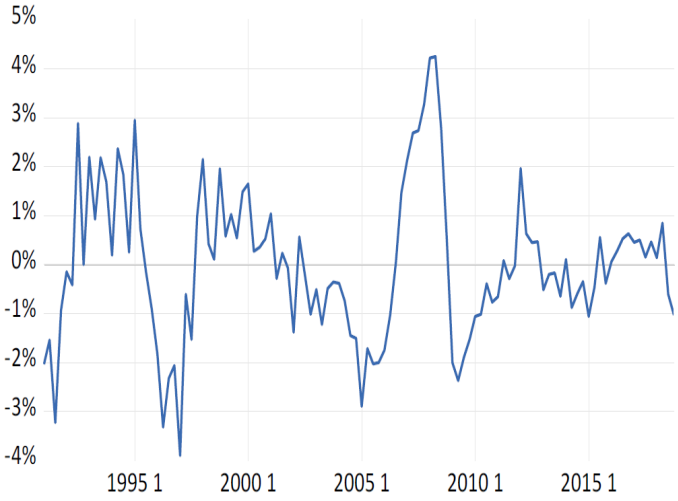
Note: Buy and sell average. It refers to how many units in domestic currency (colones) are needed to obtain one US dollar. Source: own elaboration with data from BCCR.

Figure 40: Costa Rica: Terms of trade



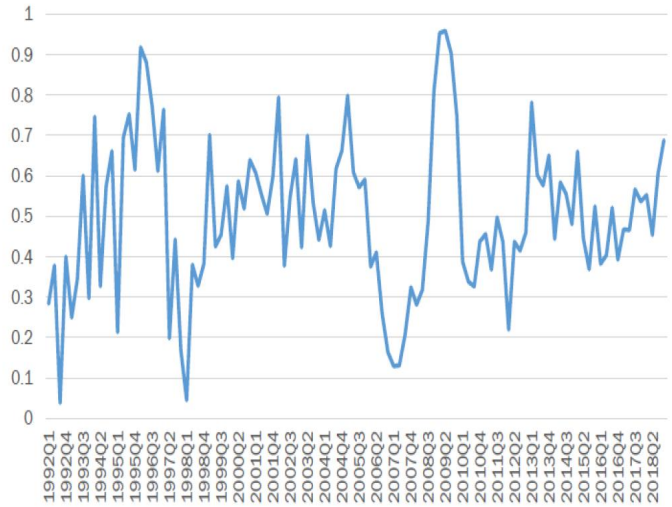
Note: It is an index of the price of exports over the price of imports, so higher values mean Costa Rica's exports are more expensive relative to its imports. Source: own elaboration with data from BCCR.

Figure 41: Costa Rica: Real output gap



Note: Compute as follows. First we seasonally adjust the real GDP. Second we estimate the potential GDP with the Hodrick-Prescott filter. Third we compute the growth rates of the real GDP and potential GDP. Fourth we compute the difference of real GDP growth minus potential GDP growth, and divide the result by potential GDP growth. Source: own elaboration with data from BCCR.

Figure 42: Costa Rica: Probability of recession regime



Note: it is the probability of being in a recession regime in that particular period. Source: own elaboration with data from BCCR. Computed from the STVAR model.

9.3 Appendix 3: Tax income elasticity estimation

The quarterly income taxes elasticity with respect to output is constructed as:

$$\alpha_{ty} = \sum_i \eta_{T_i,B_i} \eta_{B_i,y} \frac{\tilde{T}_i}{\tilde{T}} \tag{A1}$$

where η_{T_i,B_i} is the elasticity of type i taxes with respect to its respective tax base; $\eta_{B_i,y}$ is the elasticity of the tax base i with respect to GDP; and $\frac{\tilde{T}_i}{\tilde{T}}$ is the proportion of tax i on the total of taxes. The results showed in this appendix and used for the fiscal multipliers computation are taken from Lankester-Campos and Loaiza-Marín (2020).

The computation of the income tax elasticities to GDP requires several estimations: i) the income tax elasticity with respect to its tax base; ii) the tax base's elasticity with respect to GDP; and in case of not having an approximation of the tax base; iii) the elasticity of the tax income with respect to GDP (the latter has been used as a robustness check). Due to the cointegration evidence between the variables, we estimate the long-run elasticities. Multiple specifications were used including lags of the variables and possible structural changes (obtained through CUSUM and squared CUSUM tests), such that we selected the estimations with highest fit and that passed all the statistical tests. Table 8 shows the 12 relevant elasticities for the present paper. In all cases the standard errors were corrected by the HAC estimator, and for residuals there is no evidence to reject they are normally

distributed. For more details on tax elasticities computation and further results please refer to Lankester-Campos and Loaiza-Marín (2020).

Table 8: Tax income elasticities used for α_{ty}

Dependent variable	Independent variable	Annual long-run elasticity	Quarterly long-run elasticity
Consumption taxes	Final consumption expenditure	0,69*** (0,00)	0,69*** (0,01)
Final consumption expenditure	GDP	0,99*** (0,00)	0,99*** (0,00)
Consumption taxes	GDP	0,70*** (0,02)	0,66*** (0,00)
Taxes to exports	Exports	0,56** (0,07)	0,56*** (0,01)
Exports	GDP	0,94*** (0,01)	1,13*** (0,06)
Taxes to exports	GDP	0,53*** (0,10)	0,53*** (0,01)
Taxes to imports	Imports	1,05*** (0,15)	0,73*** (0,00)
Imports	GDP	0,94*** (0,01)	1,12*** (0,06)
Taxes to imports	GDP	4,75*** (1,21)	0,69*** (0,00)
Taxes to income and profits	GDP	2,06*** (0,14)	2,25*** (0,10)
Sales tax	Final consumption expenditure	0,83*** (0,00)	1,05*** (0,07)
Sales tax	GDP	1,12*** (0,13)	1,07*** (0,06)

Note: elasticity refers to 1% change in the independent variable and the associated change in the dependent variable by the coefficient's size.*, **, *** are 10%, 5%, and 1% statistical significance respectively. Standar errors in parenthesis. Source: taken from Lankester-Campos and Loaiza-Marín (2020).

9.4 Appendix 4: 6 equations SVAR estimation method

The six equations economy modelling use the same exogenous variables and assumptions as the three equations model (expenditure decisions come first). The system has the following form (excluding exogenous variables for simplicity):

$$u_t^g = \alpha_{gy}u_t^y + \alpha_{gtc}u_t^{tc} + \alpha_{gp}u_t^p + \alpha_{gi}u_t^i + \beta_{gt}e_t^t + e_t^g$$

$$u_t^t = \alpha_{ty}u_t^y + \alpha_{ttc}u_t^{tc} + \alpha_{tp}u_t^p + \alpha_{ti}u_t^i + \beta_{tg}e_t^g + e_t^t$$

$$u_t^y = \gamma_{yg}u_t^g + \gamma_{yt}u_t^t + \alpha_{ytc}u_t^{tc} + \alpha_{yp}u_t^p + \alpha_{yi}u_t^i + e_t^y$$

$$u_t^{tc} = \gamma_{tcy}u_t^y + \gamma_{tcg}u_t^g + \gamma_{ttc}u_t^t + \alpha_{tcp}u_t^p + \alpha_{tci}u_t^i + e_t^{tc}$$

$$u_t^p = \gamma_{py}u_t^y + \gamma_{pg}u_t^g + \gamma_{pt}u_t^t + \gamma_{ptc}u_t^{tc} + \alpha_{pi}u_t^i + e_t^p$$

$$u_t^i = \gamma_{iy}u_t^y + \gamma_{tc}u_t^{tc} + \gamma_{ip}u_t^p + \gamma_{ig}e_t^g + \gamma_{it}e_t^t + e_t^i$$

which could be rewritten in matrix form as:

$$\begin{pmatrix} 1 & 0 & -\alpha_{gy} & -\alpha_{gtc} & -\alpha_{gp} & -\alpha_{gi} \\ 0 & 1 & -\alpha_{ty} & -\alpha_{ttc} & -\alpha_{tp} & -\alpha_{ti} \\ -\gamma_{yg} & -\gamma_{yt} & 1 & -\alpha_{ytc} & -\alpha_{yp} & -\alpha_{yi} \\ -\gamma_{tcy} & -\gamma_{tcg} & -\gamma_{ttc} & 1 & -\alpha_{tcp} & -\alpha_{tci} \\ -\gamma_{py} & -\gamma_{pg} & -\gamma_{pt} & -\gamma_{ptc} & 1 & -\alpha_{pi} \\ -\gamma_{iy} & -\gamma_{itc} & -\gamma_{ip} & -\gamma_{ig} & -\gamma_{it} & 1 \end{pmatrix} \begin{pmatrix} u_t^g \\ u_t^t \\ u_t^y \\ u_t^{tc} \\ u_t^p \\ u_t^i \end{pmatrix} = \begin{pmatrix} se_1 & \beta_{gt} & 0 & 0 & 0 & 0 \\ \beta_{tg} & se_2 & 0 & 0 & 0 & 0 \\ 0 & 0 & se_3 & 0 & 0 & 0 \\ 0 & 0 & 0 & se_4 & 0 & 0 \\ 0 & 0 & 0 & 0 & se_5 & 0 \\ 0 & 0 & 0 & 0 & 0 & se_6 \end{pmatrix} \begin{pmatrix} e_t^g \\ e_t^t \\ e_t^y \\ e_t^{tc} \\ e_t^p \\ e_t^i \end{pmatrix} \quad \text{(A2)}$$

The different α_{jk} parameters were estimated beforehand in the same way as the income elasticities described in Appendix 9.3, and with the assumptions of the three equations model. Only the contemporaneous coefficients between the exchange rate, the interest rate, and the price level were managed according to the Cholesky decomposition with the exchange rate first and the interest rate last. We obtained the complete system A2 and estimate the rest of the coefficients, the structural errors, and the respective impulse responses. The whole system A2 is as follows:

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0.97 & 0.003 \\ 0 & 1 & -1.24 & -0.22 & 0.57 & 0.11 \\ -\gamma_{yg} & -\gamma_{yt} & 1 & 0 & 0.06 & 0.06 \\ -\gamma_{tcy} & -\gamma_{tcg} & -\gamma_{ttc} & 1 & 0 & 0 \\ -\gamma_{py} & -\gamma_{pg} & -\gamma_{pt} & -\gamma_{ptc} & 1 & 0 \\ -\gamma_{iy} & -\gamma_{tc} & -\gamma_{ip} & -\gamma_{ig} & -\gamma_{it} & 1 \end{pmatrix} \begin{pmatrix} u_t^g \\ u_t^t \\ u_t^y \\ u_t^{tc} \\ u_t^p \\ u_t^i \end{pmatrix} = \begin{pmatrix} se_1 & \beta_{gt} & 0 & 0 & 0 & 0 \\ \beta_{tg} & se_2 & 0 & 0 & 0 & 0 \\ 0 & 0 & se_3 & 0 & 0 & 0 \\ 0 & 0 & 0 & se_4 & 0 & 0 \\ 0 & 0 & 0 & 0 & se_5 & 0 \\ 0 & 0 & 0 & 0 & 0 & se_6 \end{pmatrix} \begin{pmatrix} e_t^g \\ e_t^t \\ e_t^y \\ e_t^{tc} \\ e_t^p \\ e_t^i \end{pmatrix} \quad \text{(A3)}$$

9.5 Appendix 5: STVAR model estimation procedure

The model is estimated with Maximum Likelihood, given the procedure followed by Auerbach and Gorodnichenko (2012). The logarithm likelihood for the model 10-14 is given by:

$$log(L) = const - \frac{1}{2}\sum_{t=1}^{T} log|\Omega_t| - \frac{1}{2}\sum_{t=1}^{T} u_t^{'}\Omega_t^{-1}u_t, \tag{A4}$$

Where $u_t = X_t - (1 - F(z_{t-1}))\Pi_E(L)X_{t-1} - F(z_{t-1})\Pi_R(L)X_{t-1}$. Because the model is highly non-linear a has several parameters $\Psi = \gamma, \Omega_R, \Omega_E, \Pi_R(L), \Pi E(L)$, the use of standard optimization methods is problematic, so we use the following procedure.

We can see that conditional on $\gamma, \Omega_R, \Omega_E$ the model is lineal in the lag polymonial $\Pi_R(L), \Pi E(L)$. Hence, for a given conjecture $\gamma, \Omega_R, \Omega_E$, we could estimate by weighted least squares where the weights are given by Ω_t^{-1} and the estimators of $\Pi_R(L), \Pi E(L)$ must minimize $\frac{1}{2}\sum_{t=1}^{T} u_t^{'}\Omega_t^{-1}u_t$. Define

$$W_t = [(1 - F(z_{t-1}))X_{t-1}F(z_{t-1})X_{t-1}...(1 - F(z_{t-1}))X_{t-p}F(z_{t-1})X_{t-p}]$$

be the extended vector of regressors and $\Pi = [\Pi_R \Pi_E]$, such that $u_t = X_t - \Pi W_t^{'}$. The objective function is

$$\frac{1}{2}\sum_{t=1}^{T}(X_t - \Pi W_t^{'})\Omega_t^{-1}(X_t - \Pi W_t^{'}) \tag{A5}$$

Note that A5 can be rewritten as

$$\frac{1}{2}\sum_{t=1}^{T}(X_t - \Pi W_t^{'})\Omega_t^{-1}(X_t - \Pi W_t^{'}) = trace\left[\frac{1}{2}\sum_{t=1}^{T}(X_t - \Pi W_t^{'})\Omega_t^{-1}(X_t - \Pi W_t^{'})\right] = \frac{1}{2}\sum_{t=1}^{T} trace[(X_t - \Pi W_t^{'})\Omega_t^{-1}(X_t - \Pi W_t^{'})].$$

The first order condition with respect to Π is $\sum_{t=1}^{T}(W_t^{'}X_t\Omega_t^{-1} - W_t^{'}W_t\Pi^{'}\Omega_t^{-1}) = 0$. Now using the vector operator *vec* we have

$$vec\left(\sum_{t=1}^{T} W_t^{'} X_t \Omega_t^{-1}\right) = vec\left[\sum_{t=1}^{T} W_t^{'} W_t \Pi^{'} \Omega_t^{-1}\right] = \sum_{t=1}^{T} [W_t^{'} W_t \Pi^{'} \Omega_t^{-1}] =$$
$$\sum_{t=1}^{T} [vec\Pi^{'}][\Omega_t^{-1} \otimes W_t^{'} W_t] = vec\Pi^{'} \sum_{t=1}^{T} [\Omega_t^{'} \otimes W_t^{'} W_t],$$

which results in

$$vec\Pi^{'} = \left(\sum_{t=1}^{T} [\Omega_t^{-1} \otimes W_t^{-1} W_t]\right)^{-1} vec\left(\sum_{t=1}^{T} W_t^{'} X_t \Omega_t^{'}\right). \tag{A6}$$

The procedure iterates in $\gamma, \Omega_R, \Omega_E$, which bring Π and the likelihood until the optimum is achieved. If the errors were homoscedastic ($\Omega_t = const$) we would obtain the standard VAR estimators.

As the model is highly non-linear in its parameters, it is possible to have multiple local optima meaning we must try different starting values for $\gamma, \Omega_R, \Omega_E$. In order to be sure Ω_R and Ω_E are both positive definite, we use $\Psi = \gamma, chol(\Omega_R), chol(\Omega_E), \Pi_E, \Pi_R$, where $chol$ is the operator for the Cholesky decomposition. Additionally, due to the problem's non-linearity, it is difficult to construct analytically the confidence intervals for the estimated parameters as well as the respective impulse responses. As a solution we use the Markov Chain with Monte Carlo method (MCMC) developed by Chernozhukov and Hong (2003) from now on denoted CH. The method does not only bring a global optima but also distributions for the estimated parameters.

We use the Hasting-Metropolis algorithm to implement the CH's estimation method. This procedure to construct chains of size N could be summarize as follows:

Step 1: Take $\Theta^{(n)}$ as a candidate for the vector of parameter values for the chain in the $n+1$ state. As $\Theta^{(n)} = \Psi^{(n)} + \psi^{(n)}$ where $\Psi^{(n)}$ is the actual state n of the parameter values in the chain, $\psi^{(n)}$ is the vector of *i.i.d.* shocks taken from $N(0, \Omega_\Psi)$ and Ω_Ψ is a diagonal matrix.

Step 2: Take the $n+1$ state of the chain as

$$\Psi^{(n+1)} = \begin{cases} \Theta^{(n)} \; with \; probability \; \min\{1, exp[logL(\Theta^{(n)}) - logL(\Psi^{(n)})]\}, \\ \Psi^{(n)} \; if \; not \end{cases}$$

Where $L(\Psi^{(n)})$ is the value of the objective function in the actual state of the chain and $L(\Theta^{(n)})$ is the value of the objective function with the candidate vector of parameter values.

The initial value $\Psi^{(0)}$ is computed as follows. We approximate the model 10-14 as it could be rewritten as the regression of X_t on the lags of $X_t, X_t z_t, X_t z_t^2$. Then we take this regression residuals and adjust equation 12 with Maximum Likelihood to estimate Ω_R and Ω_E. This estimators are used as initial values. Given Ω_R and Ω_E and the fact the model is linear conditional on Ω_R and Ω_E, we construct the initial values for the lag polynomial $\Pi_R(L), \Pi_E(L)$ using equation A6.

The initial matrix Ω_Ψ is calibrated around one percent of the parameter value and then it is adjusted on the fly for the first 20,000 iterations to generate an acceptance rate of 0.3 for the candidates in each iteration, as proposed by Gelman et al. (2013). We used 100,000 iterations for the base model and the different analysis, and drop the first 20,000 iterations which will count as the "burn-in" period. We performed diagnostics checks about the properties of the generated chain resulting distributions. We found the simulated chains converge to stationary distributions and the simulated parameter values are consistent with a good parameter identification.

CH showed that $\bar{\Psi} = \frac{1}{N}\sum_{n=1}^{N} \Psi^{(n)}$ is a consistent estimator for Ψ under the standard regularity assumptions of the maximum likelihood estimators. CH also showed the estimator covariance matrix of Ψ is given by $V = \frac{1}{N}\sum_{n=1}^{N}\left(\Psi^{(n)} - \bar{\Psi}\right)^2 = var(\Psi^{(n)})$ is an estimator matrix of the generated chain.

Additionally we can use the generated chain of the parameter values ${\Psi^{(n)}}_{n=1}^{N}$ to construct confidence intervals for the impulse responses. Specifically, we run 1,000 iterations of ${\Psi^{(n)}}_{n=1}^{N}$ with replacement, and for each iteration we compute the impulse response. As the columns of $chol(\Omega_R)$ and $chol(\Omega_E)$ in ${\Psi^{(n)}}_{n=1}^{N}$ are identified except their sign, the generated chains for $chol(\Omega_R)$ and $chol(\Omega_E)$ could change signs. Besides this sign changes are not a problem for estimation, they could be sometimes a problem for impulse response analysis. In particular, when there is a sign change in the entries of $chol(\Omega_R)$ and $chol(\Omega_E)$ that correspond to the variance of the government expenditure shocks, these entries could be really close to zero. Given we compute responses to an unitary government expenditure shock, and the respective entries of $chol(\Omega_R)$ and $chol(\Omega_E)$ must be divided by the respective standard deviation, the obtained confidence intervals could be really wide. To attack this numerical problem, when we construct the impulse responses, we take $\Pi_R(L), \Pi_E(L)$ directly from ${\Psi^{(n)}}_{n=1}^{N}$ while the covariance matrix of the residuals in the regime s is taken from $N(vec(\Omega_s), \Sigma_s)$, where

$$\Sigma_s = 2[(D_n' D_n)^{-1} D_n] var(vec(\Omega_s)) \otimes var(vec(\Omega_s))[(D_n' D_n)^{-1} D_n]',$$

D_n is the duplication matrix and $var(vec(\Omega_s))$ is computed from ${\Psi^{(n)}}_{n=1}^{N}$ (see Hamilton (1994) for more details). The confidence 90 percent interval is computed with the 5 and 95

percentiles of the generated impulse responses.

9.6 Appendix 6: Cointegration tests for interest rates

Table 9: Interest rates cointegration tests

Series*	Data trend	None	None	Linear	Linear	Quadratic
	Test type	Without intercept	With intercept	With intercept	With intercept	With intercept
		Without trend	Without trend	Without trend	With trend	With trend
TBP-TPPDIGC	Trace	0	1	2	2	2
	Max-Eig	0	1	2	2	2
TBP-TPPDEGC	Trace	0	1	2	1	2
	Max-Eig	0	1	2	1	2
TBP-TPPDPGC	Trace	1	1	2	2	2
	Max-Eig	0	1	2	2	2

Note: quarterly data. We used Johansen cointegration tests of the basic passive rate with each of the debt rates individually. The optimal lags were 2 for all rates. The debt rate are the weighted average gave by Treasury, with monthly frequency, we compute the quarterly average. 0: zero cointegrating relations; 1: one cointegrating relation; 2: stationary relation among the interest rates. *TBP: basic passive rate; TPPDIGC: Central Government domestic debt weighted average interest rate; TPPDIEGC: Central Government foreign debt weighted average interest rate; TPPDPGC: Central Government total debt weighted average interest rate. Source: own elaboration with BCCR and Treasury data.

9.7 Appendix 7: Fiscal series composition

The tax income variables included in the data base are the following:

- Total income
- Current income
  - Income and profits taxes
  - Imports taxes
  - Exports taxes
  - General taxes on sales
  - Selected taxes on production and goods consumption
- Non-tax income
- Transfers

The expenditure variables are:

- Total expenditure
- Current expenditure
  - Remunerations
  - Wages and salaries
  - Social charges
  - Expenditure on goods and services
  - Interests: Domestic and foreign debt
  - Current transfers: private sector, public sector, external sector, with external resources.
- Capital expenditures
  - Investment in non-financial assets
  - Capital transfers: public sector, private sector, external sector, with external resources

9.8 Appendix 8: Unit root tests

Table 10: Unit root tests' results

Variable	Unit root presence*				
Real per capita	Specification**				
	1	2	3	4	5
Selective tax on production and goods consumption	Yes	Yes	No	No	No, 2004q4
Exports	Yes	Yes	Yes	No	No, 1994q2
Exports taxes	No	No	No	No	No, 1999q4
Final household consumption	Yes	Yes	Yes	No	No, 1993q4
Brute fixed capital formation	Yes	Yes	No	No	No, 2005q3
Current expenditure	Yes	Yes	Yes	No	No, 1994q4
Taxes on income and profits	Yes	Yes	No	No	No, 2001q1
Imports	Yes	Yes	Yes	No	No, 2008q3
Imports taxes	Yes	Yes	No	No	No, 1998q4
Consumer price index	Yes	Yes	Yes	No	Without break
General tax on sales	Yes	Yes	No	No	No, 2006q3
Primary expenditure	Yes	Yes	Yes	No	No, 1994q2
Capital expenditure	Yes	No	No	No	No, 1994q2
Basic passive rate	No	Yes	No	No	No, 1995q2
GDP deflator	Yes	Yes	Yes	No	Without break
Nominal exchange rate	Yes	Yes	Yes	No	No, 2009q3

Note: XXXXqX represents the year and quarter of the structural break respectively. * Augmented Dickey-Fuller and Phillips-Perron tests. **1: Without intercept nor trend; 2: With intercept without trend; 3: With intercept and trend; 4: First differences; 5: With structural break. Source: own elaboration with BCCR and Treasury data.

9.9 Appendix 9: SVAR models characteristics

Table 11: Three equations SVAR characteristics

Null hypothesis	Rejected	Test type	Comments
No residuals serial correlation (up to two lags)	No	LM with two lags	The null hypothesis is rejected for the first lag at 10% significance level.
Residuals are homoscedastic	No	White	We used as dependent variables the squared residuals of each VAR equation and their cross multiplications.
Model stability	No	Characteristic polynomial's roots	The highest module among the roots is 0.89.
Residuals have normal distribution	No	Cholesky	The orthogonalization was made according to Cholesky (Lutkepohl).
Optimal lag is four	No	AIC	Besides SC and HQ say 1 and 2 lags respectively, we chose 4 lags to correct serial correlation.

Note: Source: own elaboration.

Table 12: Six equations SVAR characteristics

Null hypothesis	Rejected	Test type	Comments
No residuals serial correlation (up to two lags)	No	LM with two lags	The null hypothesis is rejected for the first lag at 10% significance level.
Residuals are homoscedastic	No	White	We used as dependent variables the squared residuals of each VAR equation and their cross multiplications.
Model stability	No	Characteristic polynomial's roots	The highest module among the roots is 0.98.
Residuals have normal distribution	No	Cholesky	The orthogonalization was made according to Cholesky (Lutkepohl).
Optimal lag is five	No	AIC	Besides SC and HQ say 1 and 2 lags respectively, we chose 5 lags to correct serial correlation.

Note: Source: own elaboration.