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Effects of Fiscal Policy Shocks in Nicaragua: Evidence from a SVAR Analysis*

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Abstract

In the past few years, the economic performance of Nicaragua demonstrated dynamism. Nonetheless, the Nicaraguan Institute of Social Security (INSS) went into a deficit position. The government implemented major fiscal reforms, which in turn triggered widespread protests, social instability, and an economic downturn. Consequently, tax revenues fell dramatically, revealing the recessive process in which the country's public finances underwent. To surmount this situation, the government has taken major policy measures, including public spending adjustments, tax policy changes, and new amendments to social security. Employing principles drawn from fiscal policy insights, this research aims at providing evidence, in the case of Nicaragua, on the effects fiscal policy shocks have on output. It uses a structural vector autoregressive (SVAR) model, with quarterly data for 2006Q1-2020Q1. Results are analyzed and quantified through impulse-response functions, suggesting that under the current context, the implementation of fiscal policy changes is subject to internal and external factors that may hinder accomplishment of policy goals.

JEL Codes: B52, C54, E62.

Keywords: Nicaragua, Fiscal policy, SVAR models, Economic activity.

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1 Introduction

Over the last decade, the economic performance of Nicaragua demonstrated an impressive dynamism with respect to other Central American countries. From 2010 to 2017, for instance, the economy witnessed sustained growth rates of 5.1 percent in average (BCN 2018a, p. 20). Furthermore, the management of public finances was prudent, reaching a cumulative result of 1.11 percent growth in Gross Domestic Product (GDP, hereinafter). The financial sector proved to be robust, as both gross loan portfolio and deposits grew in interannual terms of 18.4 percent and 14.2 percent, respectively. This economic dynamism took place in a context of low inflation, with interannual average rates of 5.98 percent in the abovementioned period (BCN 2018b, p. 46).

However, the Nicaraguan Institute of Social Security (INSS, in its Spanish acronyms) has run a deficit since 2013, which has been financed by INSS reserve fund (Mesa-Lago 2020, p. 55). Thus, the share of liquid assets of the reserve fund has been reduced significantly, jeopardising the viability of the social security system (Mesa-Lago 2020, p. 60). To counteract this situation, the central government implemented major changes in fiscal policy, passed in April 2018. This decision triggered widespread social protests, affecting the economy and stability of the country, with implications that continue to this day. As a result, GDP fell to minus 3.8 percent, consumption fell 4.5 percent, and investment fell 23.6 percent (BCN 2018a, p. 7). This had significant consequences on public finances due to the resulting shortfall in tax revenues, affecting the financing of the General Budget of the Republic (GBR onwards) in about USD367.7 million, revealing the recessive process in which the country's public finances underwent (BCN 2018b, p. 157).

To overcome this situation, the government of Nicaragua has taken major new fiscal policy measures, including a draft bill aimed at reviewing and adjusting the GBR, a tax policy change, and new amendments of the social security program. However, identifying when and how to implement new fiscal policy measures is quite challenging, since success will depend on the prevailing social context and economic measures underway (Boiciuc 2015, p. 1132). It has been also claimed that political and institutional factors play significant roles in determining the probabilities of achieving fiscal goals and maintaining good fiscal policy over time i.e., avoiding fiscal crises (Lavigne 2006, p. 3).

Recognizing the significance of sound fiscal policy, this paper aims to provide evidence for the case of Nicaragua on the effects of fiscal policy shocks on output for the period 2006Q1 to 2020Q1. To this end, a four-variable SVAR model is used as a benchmark, including per capita government spending (g_t), per capita real output (y_t), the inflation rate of Consumer Price Index (CPI, hereinafter), represented by (π_t), and per capita net taxes (τ_t). For the sake of clarity, all variables are expressed as a percentage of real output. Results are analysed and quantified through impulse-response functions, employing principles drawn from fiscal policy insights.

The rest of the paper is organized as follows. Section 2 provides an overview of literature review regarding fiscal policy. Section 3 describes the method and outlines the specification of the SVAR model. Section 4 presents both the data and the variables used in the model. Section 5 goes through the empirical results and the discussion. Returning to the objective of this paper, Section 6 concludes.

2 Literature Review

Both fiscal policy and monetary policy have major effects on economic agents' decisions and on economic activity in general (cf. Boiciuc 2015, Burnside 2005, p. 30). However, it has been said that in comparison with the latter, fiscal policy deserves special attention, mainly due to its ability to influence economic activity (Martner et al. 2013, Daniel et al. 2006, Doménech 2004, p. 1). Fiscal policy seeks to ensure a balanced budget to keep public finances robust and contribute to macroeconomic stability (Villagómez 2014, p. 21). Fiscal policy instruments, including targeted government spending and taxation, are one of the two main sets of macroeconomic tools available to governments to enhance growth, improve macroeconomic stability, and shape sustainable social outcomes (cf. Garry & Rivas 2017, Shahid et al. 2010, Ravnik & Žilić 2011, p. 26).

Research in this field, however, has pointed out that short-term and long-term effects of fiscal policy are still diverse (e.g., Auerbach & Gorodnichenko 2012, Giordano et al. 2007, De-Castro & Hernández de Cos 2006, p. 5). As elaborated in this section, this heterogeneity is in line with two major and divergent theoretical foundations in the economic literature i.e., New Keynesian theory and Neoclassical theory (cf. Boiciuc 2015, Jemec et al. 2011, p. 4).

The New Keynesian approach explains fiscal policy as a tool to counteract crises or economic downturns through expansionary fiscal policies i.e., increases in government expenditure, which according to the fundamentals of the theory have a positive effect on aggregate demand function and labour demand so that both consumption and wages will rise (cf. Blanchard & Perotti 2002, p. 1329). The Neoclassical approach, in turn, suggests that a positive fiscal policy shock is regarded as a negative wealth shock because either now or in the future, the increase in government expenditure will need to be financed by higher taxes (cf. Boiciuc 2015, Ramey 2011, p. 1). According to this assumption, expansionary fiscal policy boosts output in the short-term, with major costs in the long-term that results in policy measures that affect the components of consumption and private investment (Botero et al. 2012, p. 2).

It has also been claimed that in neoclassical economic thinking, fiscal policy has no effect on determining long-term economic growth rates, since these are determined by population growth and technological progress, both assumed to be exogenous (cf. Nafziger 2012, p. 156). In endogenous growth models, by contrast, the engine for economic growth is the formation of human capital (Lucas 1988), knowledge development (Romer 1986), and technology (Grossman & Helpman 1991, Aghion & Howitt 1992). Under this perspective, the accumulation of any of these assets is a result of mindful decision-making by economic actors. This makes it possible for fiscal policy to affect long-term growth rates, either through fiscal shocks or tax shocks, which influence the decisions of private enterprises to invest in human capital, knowledge development, research, and development (cf. Chamorro 2017, p. 80).

This theoretical debate has encouraged scholars to investigate the dynamic effects of changes in government spending and taxes on output in both developed and emergent economies. Using a SVAR approach, Blanchard & Perotti (2002), find that positive government spending shocks in the USA economy have a positive effect on output, while positive tax shocks i.e., an increase in tax burden, have a negative effect (Blanchard & Perotti 2002, pp. 1330-1331). Although, the signs of these findings are consistent for each estimated model, the magnitude and persistence over time depends upon considerations and assumptions about the model e.g., the use of deterministic or stochastic time trends (Ibid, p. 1331). Regarding the effects on output components, it is also found that, although private consumption responds the same as the output, private investment usually presents a crowding out effect either due to increases in government spending or to taxes, clashing with Keynesian theory.

In their study on the economic effects of fiscal shocks in Spain, De-Castro & Hernández de Cos (2006), arrive to similar results. These authors argue that fiscal policy is able to stimulate economic activity through expenditure expansions at the cost of higher inflation and public deficits and lower output in the medium term. Likewise, they find that attempts to achieve fiscal consolidation by increasing the tax burden might fail and, given the dynamic interrelations between public revenues and expenditure, are likely to imply even higher deficits in the future (cf. De-Castro & Hernández de Cos 2006, p. 6). In addition to this, such policy instruments may slow economic activity down in the medium term (Ibid). Thus, expansionary fiscal policies may cause inflation, offset the private sector, create uncertainty and volatility, constraining economic growth as posited by Clements et al. (2004, p. 1).

In the case of Croatia, Ravnik & Žilić (2011, p. 43) find that a revenue shock i.e., an increase in tax burden, in the short term, initially increases the rate of inflation and reduces the short-term interest rate, while after one-year stabilization occurs at the initial level. Likewise, an expenditure shock i.e., an increase in public spending, decreases inflation in the short term and, in the medium term, inflation increases above the initial level, while the interest rate acts in the opposite direction (Ibid, p. 44). As outlined above, this is in line with major findings of research carried out by De-Castro & Hernández de Cos (2006) for the case of Spain, where similar responses for both inflation and interest rates occur.

Boiciuc (2015) analyses the effects of a government expenditure shock and tax revenue shock on economic activity by applying a VAR method to Romanian data. She finds that the implementation of fiscal policy is effective and attains fundamental objectives, since fiscal policy shocks stimulate real output (Boiciuc 2015, p. 1136). Nonetheless, fiscal multipliers are found to be smaller if compared with fiscal multipliers obtained for developed economies that are in line with Keynesian theory e.g., the case of fiscal multipliers found by Blanchard & Perotti (2002). Associated with this, Mendieta (2017, p. 20) finds in the case of Nicaragua that fiscal policy shocks may well slow down the economic activity measured by the Monthly Economic Activity Index (IMAE, in its Spanish acronyms). As we have seen, it is clear that fiscal policy affects economic growth. However, the direction and magnitude of the effects of different instruments of fiscal policy are still ambiguous (cf. Shahid et al. 2010, p. 498).

Baum & Koester (2011), apply for the case of Germany a threshold VAR approach, based on output gap as a threshold variable, as it divides economic development in phases of under and overutilization, the two regimes under which they believe the effects of fiscal stimuli differ. Their research shows that short term fiscal multipliers in Germany are, in general, moderate and that the state of the business cycle is a very significant factor in the effects of fiscal policy shocks (Baum & Koester 2011, p. 4). Most notably, they find that fiscal spending multipliers are much larger in times of a negative output gap but have only a very limited effect in times of a positive output gap. Discretionary revenue policies, on the other hand, have generally a more limited effect. With respect to the cycle, their impact is larger in the upper than in the lower output gap regime (Ibid).

According to Baum & Koester (2011), the effect of fiscal policy shocks is not linear i.e., the effect depends on the state of the business cycle in which the shock takes place. For instance, in times of a negative output gap, the implementation of fiscal measures such as government transfers and tax reduction, will stimulate economic activity due to a credit restriction of economic agents. Conversely, in times of a positive output gap, fiscal stimuli tend to generate a crowding out effect on consumption and private investment (Baum & Koester 2011, p. 2). Although these results are in line with those found by Auerbach & Gorodnichenko (2012, p. 18), who conclude that the impact of spending policies for the USA economy is higher when the economy is in recession, it would not be wise to generalize, since the impact size of fiscal spending may vary depending on the country. This means that effects of expansive or contractive fiscal policy vary not only due to the state of the business cycle, but also due to contextual factors prevailing in each country.

For this reason, Amaya (2018, p. 152) suggests that in the case of developing countries, it is indeed important to support the implementation of fiscal policy with strategies that strengthen the consumption of domestic products, transfer resources to households, seize periods of economic expansion and create expectations of economic actors. For other scholars, wide imbalances between government revenues and public spending should be weighed out against economic performance and social welfare in the short and medium term (see Alesina et al. 2019, p. 1). This leads to austerity policies, which indicate that to alleviate the high levels of debt, it is necessary to implement policy measures to cut government spending, increase taxes, or both (cf. Lorca-Susino 2013, pp. 4-5). This has led (Alesina et al. 2019, pp. 3-4), to bring into the discussion two types of austerity through which effects on output can be identified i.e., one based on tax increases and the other based on cuts in expenditures. However, these authors caution that decisions based on tax increases are significantly recessive in the short and medium term, while those based on cuts in expenditures are more effective, since losses in output are insignificant and, on average, tend to be zero (Ibid).

Based on the foregoing, these scholars find that output responses differ significantly between austerity plans that rely mostly on tax increases, and austerity plans that rely mostly on cuts of expenditures (Thornton 2019, p. 101). They find that the formers are deeply recessionary in the short and medium term and are ineffective at addressing the problems of debt. In contrast, the latter are not deeply recessionary in the short and medium term and are effective at addressing the problems of debt and can even lead to an economic expansion (Ibid, p. 102). Likewise, it was found that, regardless of whether these plans are implemented in times of recession or expansion, the difference between these two types remains. This means that it is far better and more cost effective to implement austerity plans aimed at cutting government spending if we want to cause the least possible effect on output and reduce potential risks of debt crisis.

3 Data

This research uses quarterly data over the period 2006Q1-2020Q1. The baseline model is a four-variables VAR that includes real per capita public spending (g_t); real per capita GDP (y_t); Consumer Price Index (CPI) inflation rate (π_t), and real per capita tax revenues (τ_t)[1]. In line with related literature (e.g., Blanchard & Perotti 2002, Perotti 2005, Caldara & Kamps 2008), net taxes include current government revenues minus current transfers and interest payments. The same applies for the case of fiscal spending. Fiscal variables, income and net expenses, are those of the Central Government of Nicaragua. All series, except inflation, are expressed in logarithmic terms. Thus, the logarithm of real per capita tax revenue is referred to as tax revenue or income onwards. The same applies for the case of logarithm of per capita real public spending and the logarithm of real per

[1]The set of variables used in this research is in line with the related literature (e.g., Blanchard & Perotti 2002, Perotti 2005, Caldara & Kamps 2008). To convert fiscal variables and GDP in per capita terms, we have used the Nicaraguan population series published by the World Bank 2020 (https://data.worldbank.org/indicator/SP.POP.TOTL). This data was transformed in quarterly terms considering an equivalent quarterly linear change, for annual population change.

capita GDP.

All series come from the database of the Central Bank of Nicaragua[2], and all variables used in this research, except the inflation rate, are expressed in real Cordoba, since GDP deflator[3] is used to adjust nominal data. In order to carry out the estimations of the model, variables were seasonally adjusted[4] and transformed into logarithm terms, following the related literature (e.g., Blanchard & Perotti 2002, Wolff et al. 2006, Caldara & Kamps 2008). To analyse how social protests triggered in April 2018 could affect the way in which fiscal movements (e.g., an increase-decrease in spending or taxes) affect output, this research also assessed the reactions of output to fiscal shocks before and after April 2018. These results are further discussed in the next sections.

3.1 Descriptive Analysis

Figure (1) shows the evolution of the ratio of spending and taxes over GDP for the period 2006Q1-2020Q1. As can be seen, since 2006 the ratio, in both cases, has increased steadily. Most notably, Nicaragua was the only country in Central America in which tax revenues increased after the international financial crisis (cf. Garry & Rivas 2017, p.11). This shows the strong dynamism of the Nicaraguan economy in recent years. In the case of public spending, as share of output has been 15.6 percent in average, while the share of taxes has been 15.1 percent in average[5]. Nonetheless, these ratios are under the proportions of spending and taxes over GDP in developed countries, as shown by Ilzetzki et al. (2013). The variance of spending over GDP (2.9 in the sample), is lower than the variance of taxes over GDP (4.9 in the sample). The latter was exacerbated after the social protests of April 2018, since the economic activity was seriously impacted, directly affecting tax collection (see Figure 2). The low ratio of spending and taxes over GDP might indicate that results of different shocks on these fiscal variables could be reduced, as shown in the related literature (e.g., Ilzetzki et al. 2013, Estevão & Samaké 2013).

4 Methodological Issues

Since the seminal work of Sims (1980), the use of vector autoregressive (VARs) models has become a popular tool for macroeconomic analysis. However, while there is abundant literature concerning monetary policy shocks in macroeconomic variables, only a few researchers have investigated the macroeconomic effects of fiscal policy shocks under a VAR perspective (cf. Wolff et al. 2006, p. 330). This section describes the VAR model

[2]Website: www.bcn.gob.ni.

[3]This deflator is based on the 2006 price level.

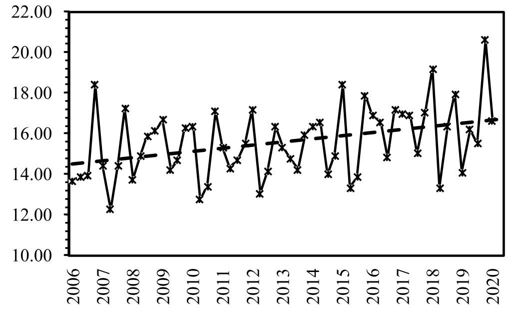
[4]Using the Census X-13 software, as in the related literature.

[5]Despite its low participation as a percentage of GDP, spending and tax revenues in real terms have increased at greater rate than GDP growth rate. See Table (A1) in Appendix for more details.

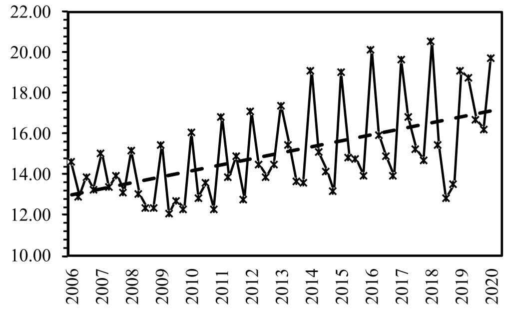
Figure 1: Spending and Taxes, Over GDP

(*percentage*)

(a) Panel A: Spending GDP Ratio



(b) Panel B: Tax Revenues GDP Ratio



Notes: The dotted line indicates a linear trend. Variables are expressed in real terms. Economic indicators according to the balance of Central Government of Nicaragua. Series are not seasonally adjusted. Sources: Own elaboration, based on data from Central Bank of Nicaragua (2020).

used in this research, as well as the identification strategies regarding the effect of shocks on fiscal variables i.e., Recursive Approach and Blanchard-Perotti Approach, considering the previous discussion concerning macroeconomic analysis of fiscal policy.

4.1 The Model

The reduced-form VAR can be expressed as follows:

$$Y_t = \mu_0 + A(L)Y_{t-1} + u_t \qquad t = 1, 2, \ldots, T \tag{1}$$

wherein μ_0 is a vector of constant terms[6], Y_t is a $N \times 1$ vector that includes the following variables: real per capita public spending (g_t); real per capita GDP (y_t); inflation rate (π_t), and real per capita tax revenues (τ_t)[7]. Finally, u_t is a $N \times 1$ innovations vector in its reduced form, which includes independent and identically distributed disturbances, with mean equal to an $N \times 1$ vector of zeros, and variance $\Sigma = E(U_t U_t')$.

Since the disruptions of the VAR in its reduced form are generally correlated, it is necessary to transform the reduced form of the VAR model into a structural (SVAR).

[6]This term includes dummy variables that capture the dependency of each quarter, variables with linear and quadratic trend, as well as dichotomous variables that capture the effect of the 2008-2009 international financial crisis and the socio-political crisis experienced in Nicaragua as of April 2018.

[7]We choose a fourth-order lag polynomial, considering that the likelihood function of three out of five informative criteria are optimized with this number of lags (for more details refers to Table (A2) in Appendix). The choice of a fourth-order lag polynomial may be discretionary considering that we are working with quarterly data, as suggested by Blanchard & Perotti (2002, p. 1332): The reason for allowing a fourth-order dependence on coefficients is for controlling the presence of seasonal patterns in response to certain taxes on economic activity.

Multiplying equation (1) by $(k \times k)$ matrix and A_0, the structural form is obtained as follows:

$$A_0 Y_t = A_0 \mu_0 + A_0 A(L) Y_{t-1} + B e_t \tag{2}$$

wherein $Be_t = A_0 u_t$ defines the relationship between the reduced innovations u_t and the structural disruptions e_t. In the structural model, it is assumed that disturbances e_t are not correlated with each other, so that the variance-covariance matrix of structural disturbances is a diagonal matrix. The matrix A_0 describes the contemporaneous relation between variables included in the vector of the endogenous variables Y_t. In the literature this representation of the model in its structural form is often called AB model (Caldara & Kamps 2008, p. 12). Without imposing restrictions to parameters of matrices A_0 and B, it is not possible to identify the model in its structural form. For this reason, the next sections describe the identification strategies used in empirical estimations.

4.2 Recursive Approach

This approach restricts A_0 to a lower triangular matrix with a diagonal of unit vectors, and the B matrix is restricted to a k-dimensional identity matrix. According to Lütkepohl (2005), this means the decomposition of the variance-covariance matrix is $\Sigma_u = A_0^{-1} \Sigma_e (A_0^{-1})'$. This is obtained from Cholesky decomposition, where $\Sigma_u = PP$, by defining a diagonal D matrix that has the same diagonal as P matrix, and also by specifying $A_0^{-1} = PD^{-1}$ and $\Sigma_e = DD$, where the elements on the main diagonal of D and P are the standard deviation of structural shocks. This identification approach implies an ordering based on the "degree of exogeneity" of variables included in the model, therefore, the way in which variables are ordered has different implications[8].

In this research, variables are ordered in the following way: government spending is ordered first, output is ordered second, inflation rate is ordered third, and tax revenues are ordered fourth, similar to what is found in the related literature (e.g., Caldara & Kamps 2008, Boiciuc 2015). Thus, the relation between the reduced-form innovations u_t and the structural disturbances e_t takes the following matrixial form:

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ -\alpha_{yg} & 1 & 0 & 0 \\ -\alpha_{\pi g} & -\alpha_{\pi y} & 1 & 0 \\ -\alpha_{\tau g} & -\alpha_{\tau y} & -\alpha_{\tau \pi} & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^y \\ u_t^\pi \\ u_t^\tau \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^y \\ e_t^\pi \\ e_t^\tau \end{bmatrix} \tag{3}$$

[8]The number of restrictions for identifying the system should be equal to $(k^2 - k)/2$. In this case, 6 restrictions should be set, since there are 4 variables. It can be seen that there is $k!$ different ordering possibilities. The way in which variables are ordered depends on the economic theory or the assumptions about the model.

This ordering assumes that spending variable does not respond contemporaneously to shocks in other variables of the system. Likewise, output responds only to contemporary movements in public spending, but does not respond immediately to movements in taxes or inflation rate. Finally, taxes respond to contemporary shocks in all other variables. It should be noted that after the first quarter, variables can interact freely before a certain shock.

Since spending decisions usually take time, as claimed by Blanchard & Perotti (2002, p. 1332), it is reasonable to think that, contemporaneously, movement in output might not affect government spending, while such movements might affect tax revenues, since these are strongly related to what happens in economic activity. In the same way that economic performance can generate contemporaneous effects on taxes, inflationary shocks could also have similar effects, since inflation can affect the tax base in real terms and consequently tax collection[9].

4.3 Blanchard and Perotti Approach

Apart from so-called recursive identification approach, in the literature, the identification method pioneered and developed by Blanchard & Perotti (2002) has been commonly used. According to these scholars, VAR models are one of the best tools for studying fiscal policy shocks for at least two reasons. First, unlike monetary variables, fiscal variables change for many reasons, where stabilization of output rarely prevails, indicating the presence of exogenous fiscal shocks to movements in output. Second, decision making, and implementation delays of fiscal policy imply that, very often, let say within a quarter, there is little or no discretionary response of fiscal policy to unexpected contemporary movements in economic activity (cf. Blanchard & Perotti 2002, p. 1330). The idea is to take advantage of delays in fiscal policy decision making to assess the impact of discretionary shocks of such policy, which are not affected by macroeconomic variables of the VAR model, to obtain the pure macroeconomic effects of fiscal shocks (cf. Wolff et al. 2006, p. 4).

Blanchard & Perotti (2002), argues that governments cannot react within the same quarter to macroeconomic movements, since fiscal policy decisions take some time to fall into effect, for example, involving many agents of parliament, and the participation of private sector and civil society. This means that, as Wolff et al. (2006) argue, fiscal policy reactions are only the result of so-called automatic responses. Thus, the performance of fiscal policy in a given quarter that does not reflect automatic responses is considered a structural shock, which is exogenous to the economy. This makes possible to study a

[9]A well elaborated discussion in this topic can be found in Caldara & Kamps (2008).

pure impact of these fiscal shocks on major macroeconomic indicators, namely GDP or inflation. Following the identification strategy posited by Blanchard & Perotti (2002), and adapting this to the case at hand, the relation between the reduced-form innovations u_t and the structural disturbances e_t can be represented as:

$$u_t^g = \alpha_{gy} u_t^y + \alpha_{g\pi} u_t^\pi + \beta_{g\tau} e_t^\tau + e_t^g \tag{4}$$

$$u_t^y = \alpha_{yg} u_t^g + \alpha_{y\tau} u_t^\tau + e_t^y \tag{5}$$

$$u_t^\pi = \alpha_{\pi g} u_t^g + \alpha_{\pi y} u_t^y + \alpha_{\pi\tau} u_t^\tau + e_t^\pi \tag{6}$$

$$u_t^\tau = \alpha_{\tau y} u_t^y + \alpha_{\tau\pi} u_t^\pi + \beta_{\tau g} e_t^g + e_t^\tau \tag{7}$$

According to Blanchard & Perotti (2002) and Caldara & Kamps (2008), e_t^g, e_t^y, e_t^π and e_t^τ are structural shocks that are not correlated with each other. Accordingly, the goal is to capture these shocks to assess the potential impact of a pure exogenous shock of public spending on output, for instance. Equation (7) above indicates that unexpected movements in tax revenues can be attributed to: (i) unexpected movements in output, which are captured by coefficient $\alpha_{\tau y}$; (ii) unexpected movements in inflation $\alpha_{\tau\pi}$; (iii) unexpected movements in public spending $\beta_{\tau g}$; and (iv) structural shocks in taxes themselves. The same interpretation can be made for the other equations. In line with Blanchard & Perotti (2002) and Caldara & Kamps (2008), in equation (5) above it is assumed that unexpected movements in output can be attributed to unexpected movements in public spending (α_{yg}) and unexpected movements in taxes ($\alpha_{y\tau}$). Under some assumptions discussed later, these two coefficients represent the public spending multiplier and the tax revenue multiplier.

Before imposing restrictions, the system is not yet identified because this requires only 6 parameters; however, there are 11. In this case, unlike the so-called recursive approach, one cannot solely impose zero restrictions on five parameters to identify the system as claimed by Caldara & Kamps (2008). For this reason, one should follow the strategy posited by Blanchard & Perotti (2002) to estimate α_{yg} and $\alpha_{y\tau}$. According to these scholars, α_{gy} represents the elasticity of output with respect to government spending. Blanchard & Perotti (2002) observe that, in the same quarter, output does not affect government spending because the spending decision takes some time to occur, thus $\alpha_{gy} = 0$ under this assumption[10]. To estimate α_{yg} and α_{gy} it is necessary to use instrumental variables because there is a problem of simultaneous equations, as can be

[10]This study uses the value $\alpha_y = 2.08$, as in Blanchard & Perotti (2002). The values for $\alpha_{\tau\pi}$ and $\alpha_{g\pi}$ follows Caldara & Kamps (2008). Notably, a value of $\alpha_{\tau\pi} = 1.25$ and $\alpha_{g\pi} = -0.5$ is included. In line with these scholars, the coefficient that relates spending and inflation is negative, arguing that inflationary shocks reduce wages of public employees in real terms (36% of spending in this case), which do not adjust contemporaneously to inflationary changes. For the sake of clarity, changes do not vary before changes in these parameters.

noted in equation 5 above. As in Blanchard & Perotti (2002), the instruments (cyclically adjusted) for tax revenues and public spending are defined as follows:

$$u_t^{g'} = u_t^g - (\alpha_{gy} \cdot u_t^y + \alpha_{g\pi} \cdot u_t^\pi) = u_t^g - (\alpha_{g\pi} \cdot u_t^\pi) \tag{8}$$

$$u_t^{\tau'} = u_t^\tau - (\alpha_{\tau y} \cdot u_t^y + \alpha_{\tau\pi} \cdot u_t^\pi) = u_t^\tau - (\alpha_{\tau y} \cdot u_t^y + \alpha_{\tau\pi} \cdot u_t^\pi) \tag{9}$$

If considering the non-existence of a contemporary relationship between output and public spending in the same quarter ($\alpha_{gy} = 0$), the structural and uncorrelated shock of public spending is similar to the shock in its reduced form as presented in equation (8) above. When considering a tax revenue shock, as in Blanchard & Perotti (2002), it is not reasonable to think that public spending would respond in the same quarter to a shock of this nature, thus $\beta_{\tau g} = 0$ and $\beta_{g\tau}$ is estimated. Conversely, if we want to assess the effect of public spending shock on output, it is assumed that $\beta_{g\tau} = 0$, and $\beta_{\tau g}$ is estimated. Results indicate that $\alpha_{y\tau} = -0.07$ with a $p - value = 0.19$. On the other hand, it is found that $\alpha_{yg} = 0.08$ with a $p - value = 0.00$. Coming to the matrix form, under Blanchard-Perotti approach, the following representation is obtained:

$$\begin{bmatrix} 1 & 0 & -\alpha_{g\pi} & 0 \\ -\alpha_{yg} & 1 & 0 & -\alpha_{y\tau} \\ -\alpha_{\pi g} & -\alpha_{\pi y} & 1 & -\alpha_{\pi\tau} \\ 0 & -\alpha_{\tau y} & -\alpha_{\tau\pi} & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^y \\ u_t^\pi \\ u_t^\tau \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ \beta_{\tau g} & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^y \\ e_t^\pi \\ e_t^\tau \end{bmatrix} \tag{10}$$

4.4 Series properties

Table 1: Unit root test

Variable	Probability	$t - statistic$	Critical value		
			1%	5%	10%
GDP	0.816	0.484	-2.614	-1.948	-1.612
Expenditure	1.000	3.746	-2.609	-1.947	-1.613
Taxes	0.850	0.636	-2.615	-1.948	-1.612
Dif. (GDP)	0.016	-2.427	-2.610	-1.947	-1.613
Dif. (Expenditure)	0.000	-10.087	-2.608	-1.947	-1.613
Dif. (Taxes)	0.000	-11.985	-2.608	-1.947	-1.613

Notes: Using estimates of Augmented Dickey-Fuller test (ADF). Null hypothesis indicates the presence of unit root in the series. Does not include trend and intercept. Source: Own elaboration.

Because the series has a unit root in levels (see Table 1 above), and there is no evidence of cointegration[11], the SVAR estimates are carried out in first logarithmic differences with stationary transformed series. This ensures stability of results with respect to both estimates in levels and differences in levels[12].

5 Results

Before moving to the analysis of the impact of different fiscal policy shocks on major macroeconomic indicators considered in this study i.e., GDP and inflation, the causal effect of the protest triggered in April 2018 is presented here, with the aim of revealing the magnitude of this effect. Likewise, since the magnitude of the shock and the structural break caused in economic activity (see Figure 2) may bias the results stemming from this research, it is imperative to consider the sensitivity analysis of such results.

5.1 The Effect of Protests

This section briefly unveils some estimates of the causal effects of protests triggered in April 2018 on GDP per capita in real terms. The causal effect is estimated using so-called synthetic control method posited by Abadie & Gardeazabal (2003), Abadie et al. (2010, 2015). This method makes it possible to simulate a counterfactual of what would have happened in the absence of such protests.

Results in Figure (2) show that social protests actually had a significant effect on GDP per capita (see Panel A). Notably, it is found that, in the absence of protests, GDP per capita in real terms would have grown in average 1.7 and 1.8 in 2018 and 2019, respectively. When contrasted with the observed growth rate of GDP per capita in real terms, the estimated difference is close to 7.0 percentage points (see Panel B). This indicates that the shock caused to real economic activity was, certainly, significant.

5.2 Spending Shock

Using the recursive approach, Figure (3) here below shows the response of variables in the system before a pure shock of 1 per cent increase in public spending. Panel C of Figure (3) shows the response of output to this shock. It is observed that the contemporary impact on GDP is positive and significant (with a confidence level of 95 percent). In the first quarter, an increase of 1 percent in spending, produces an increase

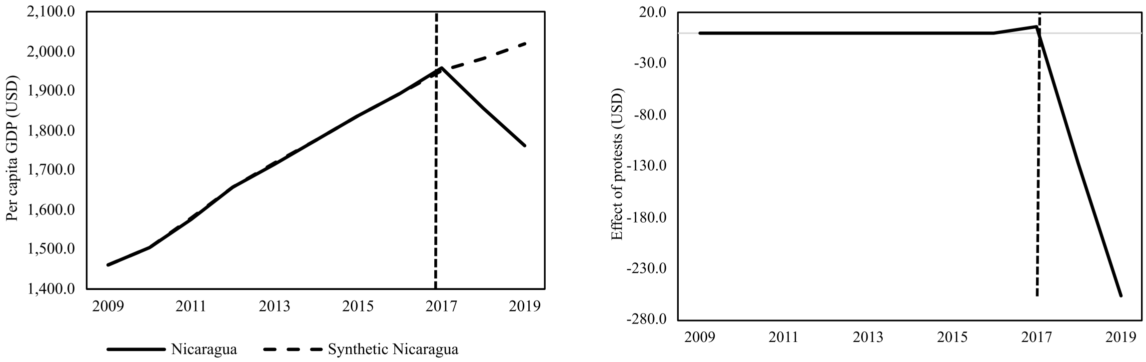
[11] Johansen's cointegration test indicates that there is no presence of cointegration in any of the variables included in the system. Residuals arising from the relationship between the variables of the system without a degree of transformation are not stationary, therefore, the SVAR model can be estimated. Otherwise, so-called Vector Error Correlation Model (VECM), should be estimated, as posited by Restrepo (2020).

[12] It should be noted that this kind of estimates for SVAR models whether in differences or logarithmic differences is common in the related literature (e.g., Blanchard & Perotti 2002, Garry & Rivas 2017, Restrepo 2020).

Figure 2: Causal effect of protests

(*2010 US Dollars*)

(a) Panel A (b) Panel B



Notes: The solid line in Panel A shows the observed per capita GDP in real terms for Nicaragua during the period 2009-2019, and the dotted line represents a simulated series of GDP using a sample of countries that have a similar per capita GDP compared to Nicaragua. Panel B shows the difference between real and simulated series, which represents the causal effect of social protests on per capita GDP in real terms. The vertical line indicates the year before the occurrence of social protests. Source: Own elaboration.

of 0.08 percentage point on output. Nonetheless, this effect is significant solely in a contemporary way, because after the first quarter (up to the eight), the dynamic of output in light of the spending shock is negative, although not significant (similar to what is found by Restrepo & Rincón (2006) for the case of Chile). This finding is in line with the evidence provided by Estevão & Samaké (2013)[13], and Mendieta (2017).

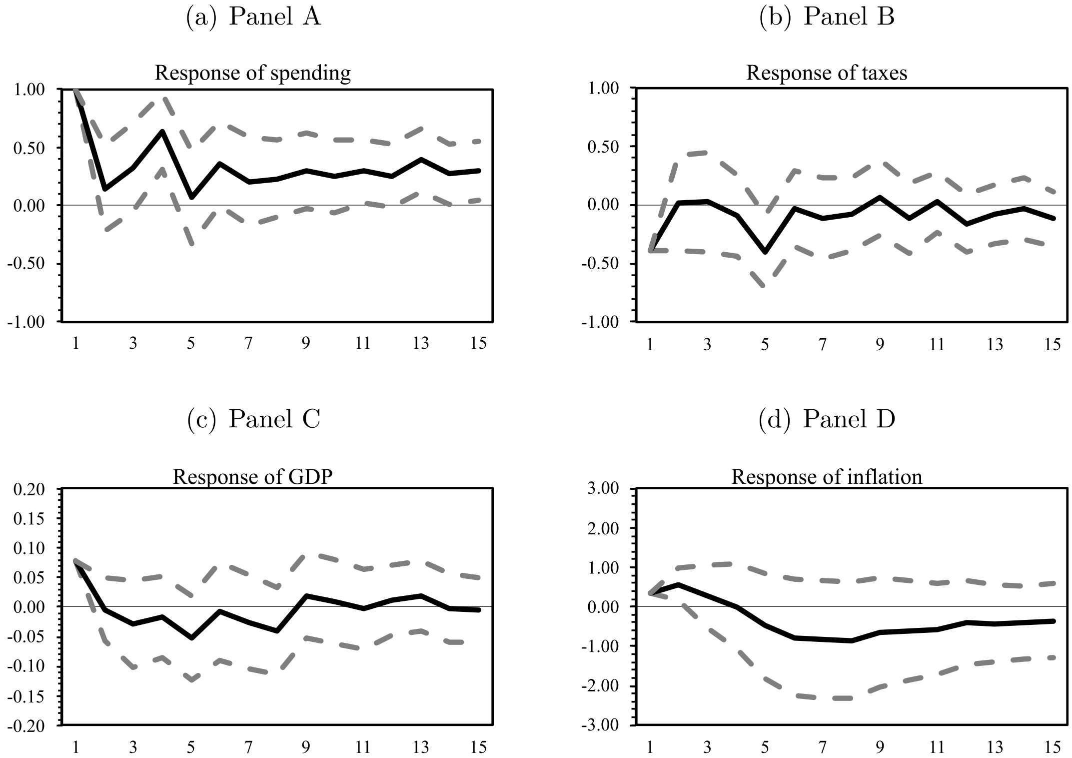
In particular, Mendieta (2017), finds an output dynamic similar to a pure spending shock for the Nicaraguan economy using a Bayesian Autoregressive Vector (BVAR) with monthly data. This researcher argues that the so-called fiscal multiplier behaves like a "U"[14]. Initially, this shock has a positive effect on output for a period of three months. After 24 months, the multiplier turns negative due to the incidence of capital expenditure, while after 36 months the multiplier becomes positive due to the relevance of accumulated current spending (cf. Mendieta 2017, p. 12).

It should be noted, however, that with regards to disaggregated effect of a spending shock including both current spending and capital spending, there is still a lack of consensus in the literature for the case of Nicaragua. Garry & Rivas (2017, p. 32), find that the so-called multiplier effect of current spending in the long term has a slight positive effect on output, but does not offset the negative effect generated by capital spending. However, Estevão & Samaké (2013, p. 16), argue that capital spending is the factor that promotes economic activity, while current spending has a significant negative effect on output in the short and long term, thus leaving the discussion open and requiring further

[13]These scholars find a multiplier of public spending of 0.10 for the case of Nicaragua.

[14]This author refers to the causal effect of public spending on output.

Figure 3: Spending shock – Recursive approach



Notes: The solid line represents the response of variables in the system to a pure spending shock. The dotted line represents a 95% analytical asymptotic confidence interval (±2 standard errors). Each panel shows the cumulative response of variables to a pure spending shock. Excluding Panel D (which responds to a shock of one standard deviation), the vertical axis in each panel represents the percentage points of change of variables before a 1 percent shock in public spending, while the horizontal axis indicates the number of quarters. Source: Own elaboration.

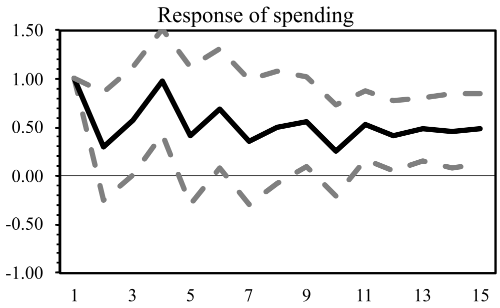
investigation.

On the other hand, the impulse of government spending seems to create slight inflationary pressures in the short term (up to the fourth quarter), which is consistent with the findings by Clements et al. (2004) and Ravnik & Žilić (2011), who argue that an increase in public spending should cause greater dynamism in economic activity, which may be associated with upward pressure on domestic prices, at least in the short term, up to the point where the economy absorbs the shock.

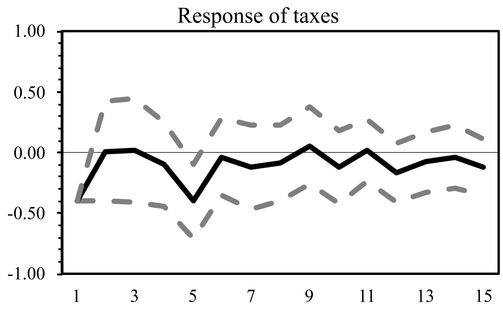
The multiplier effect of public spending under the recursive approach is 0.08, which is the causal effect of a pure spending shock of 1 percent of increase on output. When considering that during the study period (2006Q1-2020Q1), there is an expenditure ratio and an average output of 15.6 percent (see Table A1 in Appendix), the causal effect of increasing 1 Cordoba in public spending on output is obtained. With such results, an increase of 1 Cordoba in public spending would produce an increase of 0.49 Cordoba on

Figure 4: Spending shock – Blanchard & Perotti approach

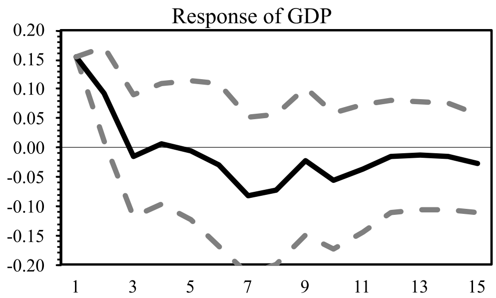
(a) Panel A



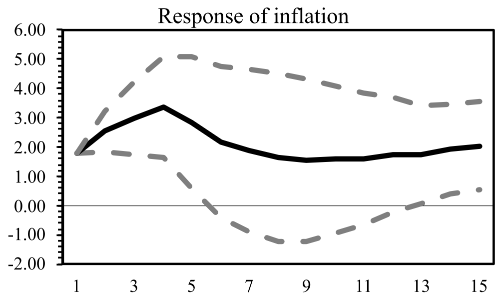
(b) Panel B



(c) Panel C



(d) Panel D



Notes: The solid line represents the response of variables in the system to a pure spending shock. The dotted line represents a 95% analytical asymptotic confidence interval (± 2 standard errors). Each panel shows the cumulative response of variables to a pure spending shock. Excluding Panel D (which responds to a shock of one standard deviation), the vertical axis in each panel represents the percentage points of change of variables before a 1 percent shock in public spending, while the horizontal axis indicates the number of quarters. Source: Own elaboration.

output in the same quarter[15]. After the first quarter, however, it is not possible to assert with certainty what the dynamics of output would be, because this research cannot reject the hypothesis that, in the following quarters, the impact of the increase in spending is zero.

Cumulatively, based on the definition of integral multiplier by Ramey & Zubairy (2018)[16], under the recursive approach, it is found that a maximum multiplier effect occurs in the first quarter (0.08 of magnitude), which is positive until the fourth quarter (0.01 of magnitude). In terms of Cordoba by Cordoba, in the first quarter, a maximum of 0.49 Cordoba of increase on output is reached in light of the increase of 1 Cordoba in spending, while in the fourth quarter the multiplier is reduced to 0.09 Cordoba.

[15] This result is obtained by multiplying the inverse of the ratio of spending to GDP, with the standardized response of GDP before an increase of 1 percent in public spending. This is the standard measure of multipliers in the related literature.

[16] According to this scholar, the accumulated or integral multiplier is defined by $m_g = \sum_{t=1}^{n} yresponse_t / \sum_{t=1}^{n} gresponse_t$. To obtain the multiplier in terms of Cordoba by Cordoba, this is multiplied by the inverse ratio of the share of spending over output.

Results of a pure spending shock using Blanchard & Perotti (2002) approach, are not so different if compared with results shown in Figure (3) above. In Panel C of Figure (4), it is noted that the dynamic of output in response to the increase of 1 percent in public spending is qualitatively the same. As in Figure (3), the output response is significant (with a confidence interval of 95 percent) in the first quarter, as well as in the second quarter after the shock. Although the output response in light of a spending shock is similar in both identification strategies, the magnitude of the spending multiplier effect under the Blanchard-Perotti approach (0.16), is meaningfully higher if compared with that found under the Recursive Approach (0.08), indicating that an increase of 1 percent in spending generates 0.16 percentage points of increase in output. Cumulatively, the multiplier effect under this identification strategy is 0.19, which is reached in the second quarter after the shock.

5.3 Tax Shock

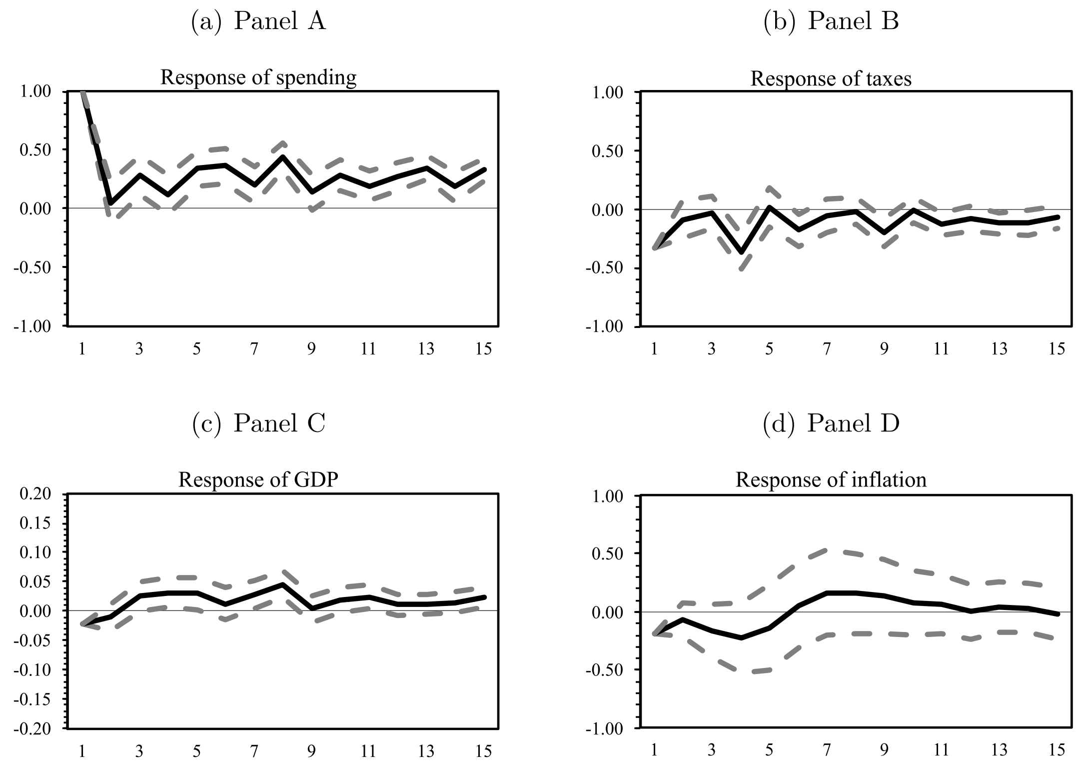
Using the recursive approach, Figure (5) shows the response of variables in the system before a pure shock of 1 percent in taxes. In Panel C it is observed that the response of output to the increase in taxes has a negative and significant effect on this variable (with a confidence level of 95 percent), in a contemporary way, which lasts until the second quarter[17]. Most notably, an increase of 1% in taxes leads to a reduction of 0.02 percentage points on output in a contemporary way. Cumulatively, the output's response to a tax shock is 0.03 percentage points and reaches its minimum in the second quarter. In terms of unit changes, an increase of one Cordoba in taxes is associated with a reduction of 0.14 Cordoba on output in the first quarter, and 0.21 Cordoba in the second quarter cumulatively[18]. After the third quarter, the output's response to the tax shock is positive, which seems to indicate that in the medium and long terms tax shocks do not have distorting effects on economic activity. It should be noted, however, that this effect (although small) is statistically significant. Nonetheless, this result should be interpreted with caution since it tends to be particularly sensitive to changes in the specification of the model (this issue is further discussed in the next section).

Associated with this, the response of inflation to a tax shock is negative until the fifth quarter under the so-called recursive identification approach (see Figure 5 here above), and its response is particularly marked under the identification approach by Blanchard & Perotti (2002). These results are in line with some other previous studies carried out by Caldara & Kamps (2008). Since a tax shock supposes a slowdown in economic activity in the short term, under both identification approaches, it is reasonable to believe this

[17] Qualitatively, the response of output before the tax shock is very similar to results found by Restrepo & Rincón (2006) using data from Chile.

[18] According to Ramey & Zubairy (2018), the accumulated or integral multiplier is defined by $m_\tau = \sum_{t=1}^{n} yresponse_t / \sum_{t=1}^{n} \tau response_t$.

Figure 5: Tax shock – Recursive approach

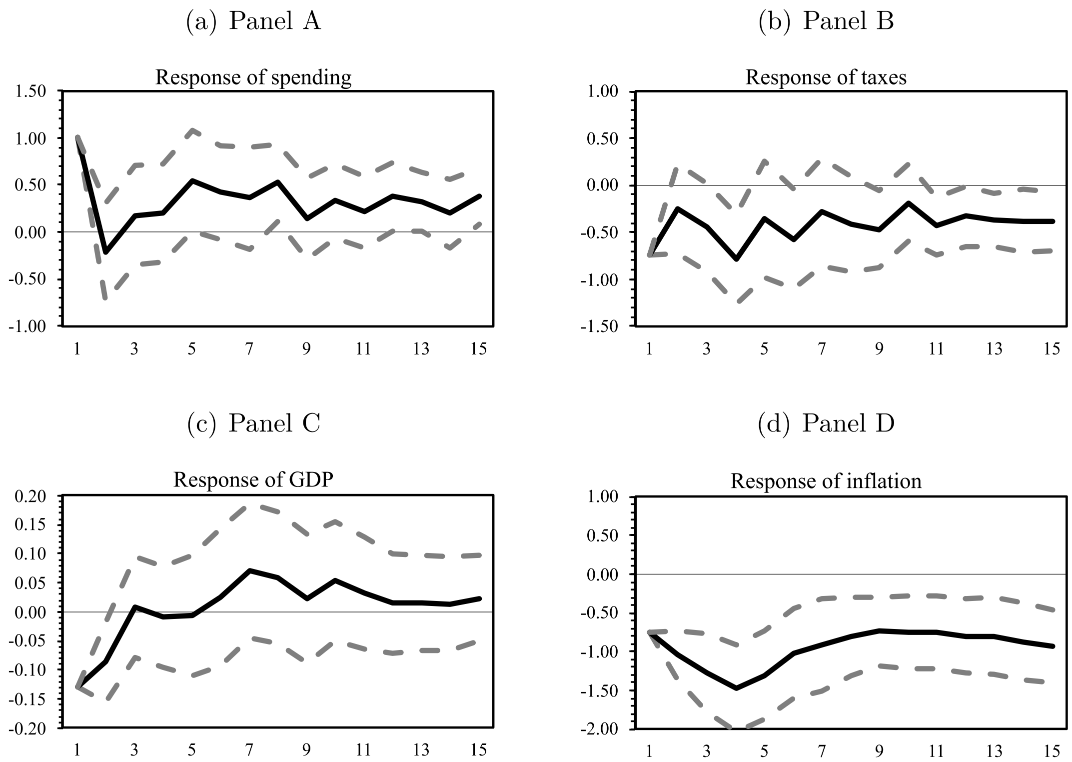


Notes: The solid line represents the response of variables in the system to a pure tax revenue shock. The dotted line represents a 95% analytical asymptotic confidence interval (±2 standard errors). Each panel shows the cumulative response of variables to a pure tax revenue shock. Excluding Panel D (which responds to a shock of one standard deviation), the vertical axis in each panel represents the percentage points of change of variables before a 1 percent shock in tax revenues, while the horizontal axis indicates the number of quarters. Source: Own elaboration

can be associated with a reduction in upward pressure on prices. This is particularly the case because of potential negative demand shocks that consumers would face, as a result of reduction in available income resulting from the increase in taxes.

Figure (6) shows the response of variables in the system under the approach of Blanchard & Perotti (2002). Regarding the response dynamics of output before the tax shock, results are not substantially different if compared with those presented in Figure (5), however, it should be noted that the magnitude of the effect is different. As can be seen in Figure (6), the contemporary response of output to a pure fiscal shock of 1 percent, i.e., the multiplier effect, is -0.13 percentage points. This response of output is negative until the fifth quarter when the multiplier effect reaches -0.01. After the fifth quarter there is a positive (but not significant) response of output to a tax shock, similar to what is found under the Recursive Approach (see Panel C of Figure 5 above).

Figure 6: Tax shock – Blanchard & Perotti approach



Notes: The solid line represents the response of variables in the system to a pure tax revenue shock. The dotted line represents a 95% analytical asymptotic confidence interval (±2 standard errors). Each panel shows the cumulative response of variables to a pure tax revenue shock. Excluding Panel D (which responds to a shock of one standard deviation), the vertical axis in each panel represents the percentage points of change of variables before a 1 percent shock in tax revenues, while the horizontal axis indicates the number of quarters. Source: Own elaboration

5.4 Sensitivity of Results

Results presented in the previous section are particularly noteworthy. The theoretical discussion regarding fiscal multipliers indicates that shocks of public spending normally entail a positive and sustained effect on output (cf. Blanchard & Perotti 2002, Boiciuc 2015, Caldara & Kamps 2008, Restrepo 2020), which is in line with so-called New Keynesian economic theory. However, findings in this research suggest that in the case of Nicaragua, public spending affects output significantly only in the short term. This claim, however, could be influenced by the event of April 2018, which prompted an important structural break in the series (see Panel A in Figure 2)[19]. To verify the magnitude of the so-called multiplier effect prior to 2018 protests, estimates are carried out using a data window that comprises 2006Q1-2018Q1, which is presented in Figure (A1), (A2), (A3) and (A4) in Appendix. In these figures, it is observed that results for the case where an spending shock is considered, do not vary qualitatively with respect to the findings

[19]This is the case, despite the estimates being controlled with dichotomous variables for that period.

presented in Figures (3) and (4). Furthermore, quantitatively the results are very similar.

Under the recursive approach, the contemporary effect of a spending shock is similar to what is found in the initial estimates, reaching 0.07. Coming to the Blanchard-Perotti approach, the value of so-called multiplier effect is 0.18. As far as the effect of a tax shock is concerned, results are somewhat dispersed. If considering the recursive identification approach, the contemporary multiplier effect is 0.02, while under the Blanchard-Perotti approach it is -0.47, considerably lower than initial estimates. This entails a significant degree of sensitivity to changes in the system specifications, which constrains the scope of conclusions regarding the potential effect of tax shocks on the Nicaraguan economy[20].

5.5 Discussion

As noted in the outset of this paper, until April 2018, the economic performance of Nicaragua demonstrated impressive dynamism with respect to other Central American countries. However, there is no robust evidence that government spending has been decisive in this process (cf. Mendieta 2017, p. 12). With respect to spending shock, evidence suggests that this could promote economic activity in the short term, but there is no clear information about the causal effect, a finding outlined in other studies, (e.g., Mendieta 2017). The small effect of this shock suggests that expenditure policies should be adopted with caution to guarantee a fiscal balance when attempting to boost economic activity, considering the monetary policy arrangements underway[21]. Therefore, focused spending measures, efficiently implemented, should be a priority when trying to boost growth, improve macroeconomic stability and achieve sustainable social results (cf. Garry & Rivas 2017, Shahid et al. 2010, Ravnik & Žilić 2011, p. 26). This research does not offer specific policy recommendations regarding current spending or capital spending decisions. Further research on this subject still is needed since there is a lack of consensus in the current theoretical discussion concerning the effect of such expenditure modes on output (e.g., Mendieta 2017, Garry & Rivas 2017, Estevão & Samaké 2013).

The evidence arising from this study suggests that the causal effect on output of policies increasing the tax burden still is not clear under the identification strategies used in this research, since results are sensitive to different specifications. An alternative way to estimate the causal effect of such policies would be the use of so-called event study identification strategy, after the period in which fiscal shocks occurs. This could lead to a more consistent result regarding the actual effect of tax shocks on output.

[20]It should be noted that estimates regarding tax shocks under the Blanchard-Perotti approach are identical to that carried out by Blanchard & Perotti (2002) in their research. Results of replications in this study are shown in Figure (A5) in Appendix. This may occur because of using a short data window and seasonal persistence in the series.

[21]Under the New Keynesian perspective, fiscal policy (either by means of increasing public spending or reducing taxes), is fundamental to boost economic activity, in a fixed exchange rate regime, similar to the case of Nicaragua.

Based on the foregoing, it seems reasonable to think that, although it is necessary to implement contractionary fiscal policy (i.e., increase in tax burden) to sustain both economic and social policies underway, in the Nicaraguan context, i.e., social, and institutional fragility, such a policy is not sufficient because the success of such a policy relies upon internal and external factors related to structural and institutional fundamentals. This can obviously constrain the effect of fiscal policy on the ground, since economic agents living in contexts of uncertainty normally respond atypically, thus affecting the effectiveness of fiscal policies as indicated by Vegh & Vuletin (2014). Viewed this way, data and theory suggest that it will be challenging to recover the path of growth in the short or medium term, mainly due to institutional imbalances (cf. Lavigne 2006, p. 3).

6 Conclusions

There is no doubt that one of the most important challenges for the economic performance of Nicaragua in the years to come deals with preserving macroeconomic and financial stability (cf. BCN 2018a, p. 44). More importantly, addressing fiscal imbalances in the medium term and undertaking structural reforms is inevitable to safeguard sustainability. The empirical evidence in this research reveals that achieving fiscal goals and maintaining good fiscal policy most often relies on institutional premises that provides a "level playing field" to quote Acemoglu & Robinson (2012), in which economic actors can work and invest in major productive activities needed to boost economic growth in the medium and long term, as posited by Lavigne (2006, p. 3); Persson (2002, p. 883) and Poterba (1994, p. 799), to name but a few.

When estimating a spending shock under the identification approaches used in this research i.e., recursive and Banchard-Perotti, and turning the attention to impulse response functions, it is noted that the dynamics of variables in the model do not differ substantially. Nonetheless, results often lack statistical significance. In both cases, output response is small, suggesting the size of the spending multiplier is small and economic activity does not respond substantially to impulses of this kind. Economic theory suggests that contractive fiscal policy works much better when economic activity in a given country is buoyant, but not the other way around (cf. Ravnik & Žilić 2011). The minor response of output to spending shocks indicates that efficiency should be paramount in expenditure execution (so that fiscal decisions of this kind can influence productivity of production factors), which is decisive in periods of economic downturn when it is evident that the spending multiplier is higher (due to its stabilizing effect), compared to what is found in normal times (cf. De-Castro & Hernández de Cos 2006), which is not the case in this research.

Last, but not least, the output response to a tax shock is significantly negative in the short term. However, in the medium and long term, the negative effect of contractionary tax policies on economic activity tends to soften, and it is found that output responds positively to this kind of shocks. Despite this noteworthy finding and given the sensitivity of results to changes in estimation conditions, this should be taken with caution. Viewed this way, one of the main conclusions from this study is that further research on fiscal policy in Nicaragua should be a priority to provide useful information to policy-makers concerning the potential effects of fiscal policy. Above all, this research agenda should include (in addition to macroeconomic variables normally used e.g., interest rates or private consumption), institutional factors that seem to play an important role in the effectiveness of any policy once it is implemented, as outlined by Vegh & Vuletin (2014) and Lavigne (2006).

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A Appendix

Table A1: Descriptive Statistics

Indicator	Ratio over GDP		Growth rate		
	Expenditure	Taxes	GDP	Expenditure	Taxes
Mean	15.6	15.1	2.9	5.4	4.8
Median	15.5	14.6	3.9	5.9	3.3
Max.	20.6	20.6	8.7	26.7	32.3
Min.	12.3	12.1	-9.2	-20.1	-33.3
St. Deviation	1.7	2.2	4.3	9.5	13.0
Variance	2.9	4.9	18.4	90.9	168.1
N	57.0	57.0	53.0	53.0	53.0

Notes: Descriptive statistics of the main variables of the system. For details see Section 3. Source: Own elaboration.

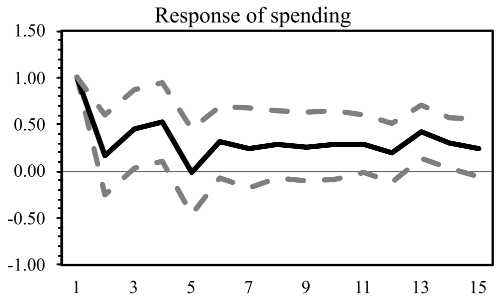
Table A2: Optimal Lags VAR Model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	126.39	NA	0.00	-3.70	-2.49	-3.24
1	165.11	59.22	0.00	-4.59	-2.77*	-3.90
2	192.75	37.95	0.00	-5.05	-2.62	-4.12
3	216.18	28.48	0.00	-5.34	-2.31	-4.18
4	244.70	30.20*	0.00*	-5.83	-2.20	-4.44*
5	260.76	14.48	0.00	-5.83*	-1.59	-4.21

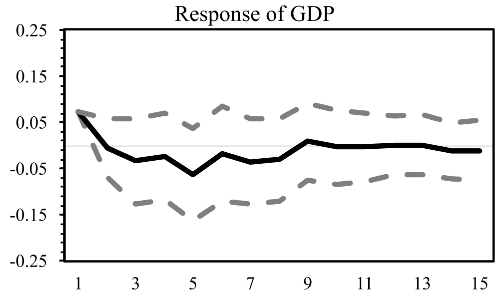
Notes: Estimations from reduced form VAR model. See Section 4 for more details. The (*) Indicates lag order selected by the criterion. LR: sequential modified LR test statistic. FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion. Source: Own elaboration.

Figure A1: Spending shock - Recursive approach

(a) Panel A



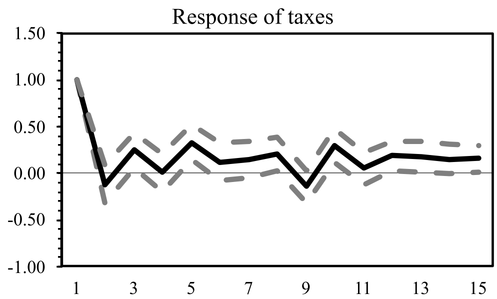
(b) Panel B



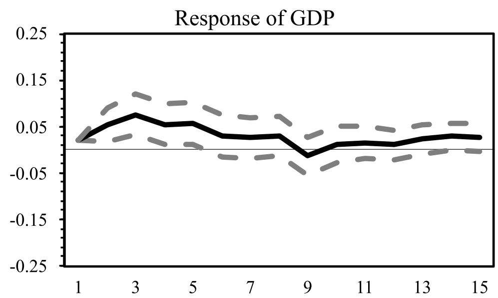
Notes: The solid line represents the response of variables in the system to a pure spending shock. The dotted line represents a 95% analytical asymptotic confidence interval (±2 standard errors). The model includes information for the period 2006:Q1-2018:Q1. Source: Own elaboration.

Figure A2: Tax shock - Recursive approach

(a) Panel A



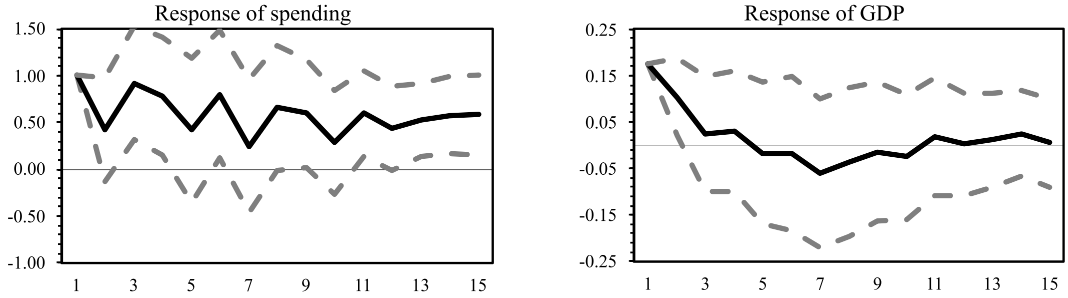
(b) Panel B



Notes: The solid line represents the response of variables in the system to a pure tax shock. The dotted line represents a 95% analytical asymptotic confidence interval (±2 standard errors). The model includes information for the period 2006:Q1-2018:Q1. Source: Own elaboration.

Figure A3: Spending shock – Blanchard & Perotti approach

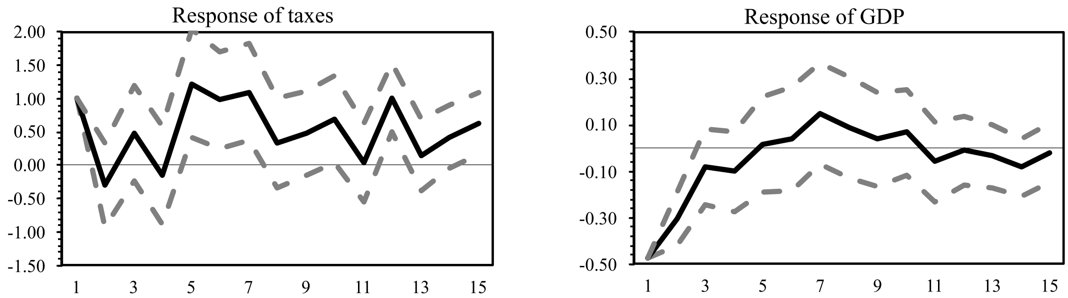
(a) Panel A (b) Panel B



Notes: The solid line represents the response of variables in the system to a pure spending shock. The dotted line represents a 95% analytical asymptotic confidence interval (±2 standard errors). The model includes information for the period 2006:Q1-2018:Q1. Sources: Own elaboration.

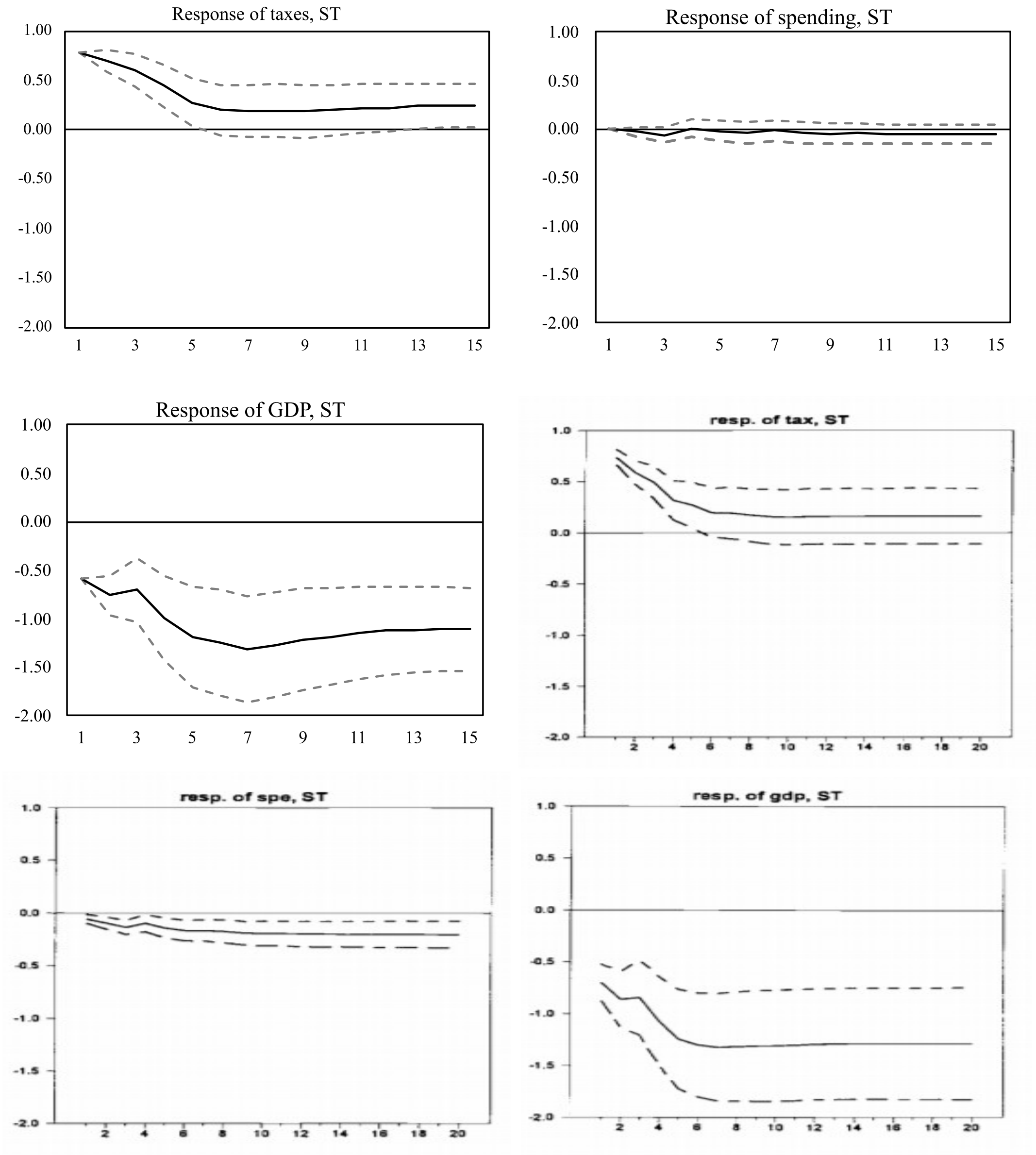
Figure A4: Tax shock – Blanchard & Perotti approach

(a) Panel A (b) Panel B



Notes: The solid line represents the response of variables in the system to a pure tax shock. The dotted line represents a 95% analytical asymptotic confidence interval (±2 standard errors). The model includes information for the period 2006:Q1-2018:Q1. Sources: Own elaboration.

Figure A5: Tax shock replication – Blanchard & Perotti approach



Notes: This replication takes into account the assumption of stochastic trends (ST) in the series, as in Blanchard & Perotti (2002). Differences are attributed to data revisions.Source: Own elaboration, adapted from Blanchard & Perotti (2002).

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A.1 Synthetic Control

Following Abadie & Gardeazabal (2003), Abadie et al. (2010) and Abadie et al. (2015), under the assumption we have $c+1$ indexed countries as $i = 1, 2, 3, \ldots, c+1$ in T periods of time $t = 1, 2, 3, \ldots, T$, wherein only country number 1 ($i = 1$), experiences a 'treatment', for instance, is affected by socio-political protests, then the remaining countries that were not affected by such protests can be used to 'design' a counterfactual with the aim of simulating what would have happened in the absence of such protests. This is the so-called synthetic control in the related literature. We find that there are T_0 periods in which the involved country is not affected by protests, and we have T_1 periods after protests occurs, this implies that $T_0 + T_1 = T$.

The effect of protests in Nicaragua is given by $\alpha_{it} = Y_{it}^E - Y_{it}^N$. Wherein Y_{it}^E is the outcome variable for Nicaragua. In this case, Y_{it}^N is the real per capita GDP estimated by combining the real per capita GDP of all other countries considered in the sample i.e., those countries that were not involved in socio-political protests. Since we assume that $i = 1$ is the country involved in protests, we have to estimate the causal effect based on a factorial model that takes the following form:

$$Y_{it}^N = \delta_t + \gamma_t \mu_i + \theta_t + \varepsilon_{it}$$

wherein Y_{it}^N is the outcome variable of countries that were not involved in socio-political protests. δ_t is a common factor between countries, which is known as common support. θ_t is an unknown vector of time parameters and ε_{it} represents the error term of the model.

In order to 'design' the counterfactual, it is necessary to weigh the information of countries with the objective of obtaining the best simulation of real per capita GDP for Nicaragua, drawn from the GDP of all the other countries. Therefore, we have to consider a vector of $C \times 1$ weighted elements and indexed by $j = 2, 3, \ldots, c+1$. Thus, it is found that $(w_2, w_3, \ldots, w_{c+1}) = W$, wherein w_j represents the weights of any country that is used to create the synthetic control series of real per capita GDP for Nicaragua. It is worth noting that $0 \leq w_j \leq 1$ and $\Sigma_{j=2}^{c+1} w_j = 1$. Therefore, values of the outcome variable are given by $\hat{Y}_{jt} = \Sigma_{j=2}^{c+1} w_j^* Y_{jt}$. With these weights ($w_j^*$), we seek to minimize the Root Mean Squared Prediction Error (RMSPE) defined as: $\sqrt{\frac{1}{T_0}\Sigma_{t=1}^{T_0}(Y_{1t} - \Sigma_{j=2}^{c+1} w_j^* Y_{jt})^2}$, with the aim of obtaining the best simulated series of real per capita GDP for Nicaragua (i.e., Synthetic Nicaragua), to be able to assert that the result obtained after the protests, is a causal effect of this exogenous shock to real per capita GDP.