THE IMPACTS OF ECONOMIC FLOWS, GOVERNMENT TRANSFERS AND TAXES ON THE BRAZILIAN ECONOMY GROWTH

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Abstract: We prepared a simultaneous-equations model solved by vector-error-correction. The findings indicated the relevance of household consumption and private fixed investment in leading the growth of the Brazilian economy. The trade balance proved also to be a valuable asset for economic growth. The transfers to social security showed weak exogeneity in the short run; however, with significant and positive impacts on the economic growth. The transfers to states and municipalities proved to be quite exogenous, in both the short and long run, with negative impacts on the economic growth. The taxes classified into three distinct groups are income taxes and social contributions on net income (TISC), social contributions on payroll (SCP), and taxes on goods and services (TGS). The results showed that TISC was distortionary taxes, in both the short and long run, SCP was distortionary taxes in the short run, and TGS was nondistortionary in the long run.

Keywords: economic growth; household consumption; private investment; tax revenue; government transfers; vector error correction.

JEL Classification: E21 E22 E27 E62 H21 O11 O47

1. Introduction

1.1. The macroeconomic model

In this study, we are going to analyze the impacts on the growth of the Brazilian economy related to household consumption, private investment in fixed capital, trade balance, taxes and income transfers from the federal government to states and municipalities. The macroeconomic growth model included flows in the sectors of household consumption, businesses (firms), governments, and foreign markets (exchange of goods and services with the rest of the world). It was built a vector-error-correction model of simultaneous equations, with the purpose of analyzing the impacts among domestic flows, taxes and transfers, in the Brazilian economy and its interaction with the international market through the trade balance.

The relationship among household consumption, private investment in fixed capital, trade balance, income distribution, taxes and their impacts on growth have long been an important economic research topic; however, in our knowledge, the interactions among these variables have not been analyzed in a simultaneous way. This study explores the impacts imposed on economic growth, in both the short and long run, due to the flow of private investment in fixed capital and consumer spending, the main components in determining the aggregate output and income of a country's economy because they promote the increase in productive capacity and the expansion of economic activity. The study still included the trade balance, a variable that plays a powerful role in determining the available aggregate income of the country, impacting the balance of current account of payment balance, which, if positive, can minimize the effects of saving the economy deficits.

In the analysis, one included the impacts of effective tax revenues and government transfers to populations, states and municipalities in order to determine the influence of these variables on the growth of the Brazilian economy. Nevertheless, despite substantial evidence in the literature that income distribution affects short and long run growth, there is no much empirical research on the Brazilian economy that clearly evinces the impacts of redistributive fiscal spending and taxes on

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growth. In the same way, the impacts of tax burden on the economic growth of the Brazilian economy, in both the short and long run, were not studied.

Thus, considering the variables of household consumption, private investment in fixed capital, trade balance, income distribution and taxes, a model had to be empirically implemented in order to identify the relations of causality and the order of impacts magnitudes from these variables on economic growth. The differential of the model implemented here is essentially as well as simultaneously the integrated analysis of these variables, using a vector-error-correction model.

1.2 Literature review

The present article addresses the empirical relationship among household consumption, private investment on fixed capital, trade balance, income distribution, taxes and their relationship with economic growth for the Brazilian economy. Thus, we formalize the idea of the article by incorporating the rule of these variables into the literature review on economic growth.

Current literature has given little importance to examining the impact of the rule of consumption and fixed capital investment on developing economies growth. Among the studies devoted to analyzing the impacts of private investment (and/or household consumption) on growth, one can highlight the research of Shafik (1992) that modeled private investment in Egypt, using an error correction model, taking into account the oligopolistic structure, supply elasticity of nontraded capital goods and financial repression. The model results indicated, at the macroeconomic level, that private investment depends on markups, domestic financing and interest rates. Feltenstein and Shah (1995), using a dynamic general equilibrium model, analyzed the impacts on private investment in the fixed capital of instruments promoted by the Mexican government, such as tax credits for the industry, tax credits for jobs and reducing corporate taxes. The results indicated that the reduction of corporate tax has proved to be an instrument implemented with greater impact on private investment, increasing demand for capital, especially for new capital. Kwan et al. (1999) empirically investigated the investment-growth relationship in China, using a dynamic model of an equation in order to examine the relationship between economic growth and investment. They found that fixed investment is a key determinant of China's economic growth. The exogeneity test results suggested that exists a robust relationship between fixed capital formation and income growth. Qin et al. (2006) empirically investigated the relationship among GDP growth rates and consumption, government investment in fixed capital formation and inventories, using an error correction model, the VECM. The results indicated that GDP growth rates result in investment. Moreover, they found that government investments cause a strong impact on investment, and the market demand has been the force which drives investment. The authors also argued that government investment amplifies the cycles of investment, creating jobs and increasing consumption. Abdul Karim et al. (2010) empirically analyzed the relationship between economic growth, fixed investment and household consumption for the Malaysian economy, using an approach of a structured model of error correction, the SVECM. The authors found that the effects of household consumption and fixed investment on economic growth were significant only in the short run. The relations issue between investment in infrastructure and productivity (and its consequent impact on economic growth) has been a topic of study. Teles and Mussolini (2011) analyzed the relationship between infrastructure and total factor productivity (TFP), in the four main Latin American economies: Argentina, Brazil, Chile, and Mexico. They used the traditional Johansen methodology (Johansen 1995, 1991) for testing the co-integration between TFP and physical measures of infrastructure stock, such as energy, roads and telephones. The results presented did not support a robust, long-term relationship between infrastructure investment and TFP, in the Latin American countries studied.

Another analysis, in this study, is the trade balance impact on the Brazilian economy´s growth. We simply want to show how trade balance affects and impacts (and how it is impacted) the structure of the Brazilian economy, especially, the flows of private investment, consumption and the GDP growth. However, most of the studies conducted on the behavior of trade balance, found in the literature, have analyzed the relationship between trade balance and macroeconomics variables, as

exchange rate, interest rate and institutional innovations. In this way, we can point out the study by Moenius and Berkowitz (2011) that analyzed the institutions effects on trade volume. The results showed that in countries with low-quality institutions, improvements regarding the protection of property rights and rigor in enforcing contracts reduce the production costs; but, they have little influence on the volume of trade. The results also emphasized that the improvements in institutions increased the diversity of exports. Nevertheless, in countries with more developed institutions, institutional reform primarily influences the transaction costs, leading to increases in trade volume and exports diversity. Freund and Pierola (2012) analyzed the episodes of outbreaks that foster and sustain exports. The results showed that export surges, in developing countries, tend to be preceded by a real depreciation of the exchange rate, leaving it significantly undervalued. In contrast, in developed countries, the role of the exchange rate on export stimuli is less pronounced. The exchange rate depreciation, which stimulates exports to new markets, is leading companies to expand their products. These studies indicate that the effects of trade balance on the economy growth leverage vital information on macroeconomic variables and institutional efficiencies. Therefore, in this study, we will analyze the interactions between trade balance (which captures some macroeconomic effects of the economy) and the Brazilian economy growth, on a path not much explored in quantitative studies about developing economies; that is, the relations of trade balance with consumption, capital investment and GDP.

One is still going to analyze the impacts of effective tax levels on economic growth. Helms (1985), Canto and Web (1987), Mofidi and Stone (1990), Besci (1996), Baldacci et al. (2004), Poulson and Kaplan (2008), Johansson (2008), Arnold (2008), Djankov et al. (2010), Feredea and Dahlby (2012) are some example about studies of tax impacts on economic growth. The main motivation, in studies involving taxation, is the fact that taxes can affect growth through their impacts on factor accumulation and total factor productivity. Taxes may increase the cost of capital and reduce incentives to invest, and also, higher tax rates discourage investment; then economic growth will be adversely affected. As described in Myles (2009), who provides an overview in the literature on growth models, taxation can have both negative effect and positive effect on growth. The negative effect is due to distortions in choosing and disincentive effects. The positive effect arises indirectly through expenditure financed by taxes. For example, public good constitutes a mechanism that provides a positive effect, whereby taxation could boost growth. The relationship between growth and taxation is not monotonous because if the tax rate increases beyond the optimum, it will reduce the growth rate. In practice, the tax rates of economies might be located on one side of the optimum.

Some of the empirical researches conducted in studies try to explain different patterns of economic growth across the countries. In some works of the empirical literature, researchers used aggregate average and effective tax rates as measures of the tax burden. Many studies discovered a negative correlation between taxation and growth by using these measures. Among them, Miller and Russek (1997), Kneller et al. (1999), Bleaney et al. (2001), Padovano and Galli (2002), Holcombe and Lacombe (2004), and Reed (2008) can be cited. Nevertheless, Koester and Kormendi (1989) and Mendoza et al. (1997) did not reveal any significant adverse effect of taxes on the economic growth. Koester and Kormendi (1989) obtained their results from a regression of total tax revenues on GDP, what did not allow indicate any distinctions between the effects of tax instruments about growing. In others researches have been used statutory tax rates as measures of the tax burden. Lee and Gordon (2005) found that the corporate tax rate has a significant negative association with economic growth rate; but, the effect of the top personal income tax rate on growth was insignificant. Katz et al. (1983) also found that the top personal income tax rate has no significant effect on growth. Empirical analysis of OECD (2010) indicates that corporate income taxes have the most adverse effect on per capita GDP growth, followed by personal income and consumption taxes. More recently, Ferede and Dahlby (2012) examined the impact of tax rates of Canadian provincial governments on economic growth. Their empirical estimates suggest that a higher provincial statutory corporate income tax rate is associated with lower private investment and slower economic growth.

Many other studies did not use, in their models, tax explanatory variables, in standard way as specified earlier. Among them, it can be mentioned Kneller et al. (1999), who made predictions with endogenous growth models. Their position is that the structure of taxation and public expenditure affected the steady-state growth rate. They considered that distortionary taxes, like those on income and property, reduce the growth and, non distortionary taxes, which include consumption taxes, do not reduce growth. Arnold (2008) examines the relationship between tax structures and economic growth by entering indicators of the tax structure into a set of panel growth regressions, for twenty-one OECD countries. The results suggest that income taxes associate with lower economic growth, and taxes on consumption and property positively relate with growth. The corporate income tax is the most negative effect on GDP per capita. Gemmell et al. (2011) used an empirical analysis that treats heterogeneous short run dynamics explicitly within a long run model. Results suggest that the long run growth effects of fiscal policy are consistent with the results derived from short run models. The short-term effects persist and evolve quickly to a long-run trend.

The thinking is that taxes are needed; however, they can distort private decisions, generate losses and distort economic growth. Higher taxes mean not only distortion, but also higher levels of public expenditure. On the one hand, they will promote economic growth and, on the other hand, they may also disappear in the process of misuse and corruption. According to Arnold (2008), tax systems can be more or less distorted for two reasons: because they extract resources from private agents (level of taxes), or because they raise a certain amount of revenue in a more or less distorted manner (tax structure). In this study, we will analyze the impacts of effective tax levels on economic growth. Thus, the main question emphasized in a recent research is whether tax cuts can enable an economy to enjoy dynamic growth.

In most countries, there is a distribution of government structures at multi levels; therefore, one of the key issues in the public economy is how to establish rules for tax expenditures (government transfers) between the central government and the subnational governments, at lower levels. Oates (1972) views the federal structures like agencies that determine the balance on provisions of public goods, for both the central government and local governments. According to the author, the provision of public goods by the central government produces inefficiencies of benefits between local governments, creating inefficiencies in public goods decentralization, which can be corrected through transfers from the central government to sub-national governments in order to help local needs. Besley and Kohath (2003) also consider the allocation of public goods as an inefficient operation among regional provinces; essentially, for those at the lowest level of centralization, with unequal distributions of expenditures of public goods across jurisdictions. Accordingly, in the presence of these types of externalities (decentralization of public goods provision in an economy), the transfer of resources plays a crucial role in the development of subregional economies.

The government transfers are expenditures belonging to a financial structure of federal systems of governments, which usually involve transfers from higher levels of the government to lower levels. A federal system of government is a government structure with, at least, two levels. Theoretical discussions on transfers can be found in Oates (1972), Boadway and Flatters (1982), Hines and Thaler (1995). Goodspeed (2002) emphasized the growing importance of local and provincial governments that serve as providers of public services and the importance of these services to the overall performance of the national economy, which requires a careful review of how decentralized governments have allocated public resources. These aspects have encouraged studies about transfer systems, and they have become one of the most prestigious areas of research in federalism, these days.

Buettner (2009) structured a panel data of German municipalities in order to investigate the dynamic fiscal policy adjustment using a vector-error-correction model that explicitly takes into account the intertemporal budget constraint. The results confirm that a substantial part of fiscal adjustment to revenue shocks takes place by offsetting changes on intergovernmental transfers. Rodden (2000) sketched a dynamic panel model of an equation in order to study the impacts of federal transfers to subnational governments and, consequently, the process of equalization. The

results of the model showed that there is a weak correlation between unemployment and spending on subnational governments. However, they indicated positive impacts of GDP per capita on the spending of subnational governments, in both long run and short run shocks. Based on these results, the author concludes that there is no equalization process.

In this subsection, we have conducted a literature review by involving the variables introduced in the econometric study of this research, structured with the aim of analyzing the performance of the Brazilian economy. We seek to highlight some aspects of the variables behavior: consumption, fixed capital investment, trade balance, government transfers and taxes; and verify how they affect economic growth. The knowledge underlined here is going to be used like arguments for structuring the model, in the next subsection.

1.3 Structured model

We intend to construct a framework that establishes a link between taxation and government spending, like transfers and their impacts on household consumption flows and private investment in fixed capital, consequently, with both the gross domestic product and economic growth.

The first point to engage is the idea that taxes are required necessary, but they distort private decisions, generate losses and limit economic growth. Higher taxes mean not only distortion, but also higher levels of public expenditure. On the one hand, they will promote economic growth and, on the other hand, they will disappear in the process of misuse and corruption. According to Arnold (2008), tax systems can be more or less distorted for two reasons: because they extract resources from private agents (level of taxes), or because they acquire a certain amount of revenue in a more or less biased form (the tax structure).

The link between tax structures, tax rates and economic growth is characterized by inelasticity of gross domestic product with respect to certain taxes, which are more harmful to economic growth than others. Therefore, the study reported here aims at detecting patterns of taxes in their respective data and their impact on growth. Thereby, the next question is going to be: If taxes are needed, then, what is the relationship between these taxes and other variables that interact in the process of economic growth?

The answer to the previous topic involves the analysis of two aspects. The first, since government spending may be conducted through transfers and administrative expenses, then, should be understood how these transfers interact in the process of economic growth. The second is with respect to econometrics because if there is the need to build a relationship between taxation, spending and classical factors of economic growth, it will remain only one way out, which is designing a dynamic model of simultaneous equations. Moreover, most of the panel models try to model behaviors that are intrinsic to a homogeneous set of economies, which mostly have specific individual characteristics with regard to the aspects of taxation and public spending. Arnold (2008) emphasizes that the OECD economies have heterogeneities, with varying degrees of flexibility and points the lack of synchronization of business cycles, in OECD countries. Duval et al. (2007) documented significant differences between the OECD countries in relation to their ability to maintain production close to its potential as results of shocks, suggesting that, it should not be expected the setting processes of all countries ought to follow the same path of balance, in the production. In this way, it is need to structure a model that captures the behavior of all important elements, which interact in the economic growth, thus establishing the orders of magnitude and correct signs of causal relationships between variables included in model.

Considering the arguments just cited, it was designed a dynamic model of simultaneous equations to analyze the Brazilian economy behavior, with reference to the interactions among effective tax revenues and public expenditures per capita by the transfer. The model also enables analyzing the main factors that interact on the aggregate-demand side, per capita consumption, on the aggregate-supply side, private investment per capita and the international trade balance per capita. This model allows for better benchmarking of reality while enabling a more accurate assessment on economic policies and their propagation channels in macroeconomic decisions. The solution of the model was through the use of the vector-error-correction model (VECM) (Hendry

and Juselius, 2001; Johansen, 1995, 1991). It is a database used for its solution on a yearly basis, from 1970 to 2010.

The model here prepared is original in its design because it started from the equation of balance between aggregate demand and aggregate supply, involving some key variables for economic growth, integrated endogenously by simultaneous equations solutions. This scheme is noteworthy as it permits an understanding of the magnitude orders of the impacts and their directions, in the interrelations among all variables. Furthermore, the model is unique because it is directed to the analysis of the Brazilian economy since this study has not been yet performed. Finally, the model is original because it involves a dynamic formulation of simultaneous equations and uses the technique of vector error correction (VECM), which allows identifying the long-run adjustments and impacts of innovation shocks, in the short run.

It follows the rest of the article´s organization. Section 2 outlines the Brazilian tax structure in order to highlight its distinctive features and allow the reader to understand the grouping of tax revenues used as variables, in the econometric model of the study. Section 3 shows the formulation of macroeconomic basis for the model, and the characterization of economy dynamics. Section 4 discusses the formulation of the econometric model, illustrating its main theoretical background. Section 5 describes data source and their characteristics. Section 6 is discusses the model´s robustness. Section 7 illustrates the results, the analysis of the quantitative results and analysis of model variables elasticity. Section 8 outlines final considerations about the model and its results.

2. Taxation in Brazil

The first reform taxation in Brazil began with the implementation of Value Added Tax (VAT), at the time of the fiscal reform, in 1965. However, the Constitution of 1988 introduced the current Brazilian taxation system, which establishes that the union, the states, the federal district and the municipalities may collect taxes. The administrative-political autonomy confers, to each level of government, the possibility of instituting taxes and fees, due to its surveillance power or the use of public services and upgrade charges, on account of public works. In relation to social contributions, most of them might only be established by the Federal Government. Also, the Constitution allows the union introduces compulsory loans under special conditions defined in it, establish taxes and social contributions for intervention in the economic order.

2.1 Federal Tax and Social Contribution

At the federal level, all business activities are subject to the impositions of tax, social security, or labor nature, due to the federal tax system is exceedingly complex. The federal taxes, which are more important to the upstream industry, may be cumulative and/or non cumulative[2] (the tax credit may be utilized as payment). They are levied on revenues/sales that are social contributions on gross revenues, federal tax on industrialized goods and retirement fund. Therefore, the focus will be on the main federal taxes and social contributions.

The federal tax on industrialized products (IPI), a value-added tax (VAT), is paid by manufacturers on behalf of their customers, being the rates based on the code of Harmonized Tariff Schedule (HTS). The federal VAT IPI is not imposed on any merchandise, but only on some taxable events related to industrialized products. Except for this fact and its non state character, the general mechanism of this tax is similar to that described in the ICMS (interstate and inter-municipal tax on circulation of goods and services).

The contribution to the National Social Security Institute (INSS) also comprises the federal taxes. The gross remuneration (salary and fringe benefits) serves to calculate the employer's contribution. The employee's contribution (between 8% and 11%) is subject to a low tax limit based on a specific progressive table, and should be withheld monthly by the employer.

[2] In certain circumstances, the tax to be paid by a corporate may be deducted on the tax credit system (mechanism). The tax credit is not refundable, but it can be accumulated for tax purposes, and the tax is going to be deducted accordingly. The principle of noncumulative tax is applicable to value-added taxes on sales and services (ICMS), excise tax (IPI), and also applicable to social contribution taxes.

Another kind of federal taxes levy on financial transactions (IOF). This is a regulatory tax that might be used by the federal government, as auxiliary instruments, in conducting monetary policies. IOF rates vary according to the financial operations (e.g. outstanding loan balances and insurance contracts). Triggering events for the tax on financial operations (IOF) are credit, exchange, and insurance transactions, as well as operations involving securities.

The corporate income tax (CIT) constitutes the federal taxes on profits and net income. Profits, income and capital gains earned worldwide are subject to the Brazilian corporate income taxes. No distinction is made as to the origin of the capital (whether they are foreign or domestic investors). The tax on branches of foreign companies is in the same way than standalone subsidiaries.

The residents in Brazil, either Brazilians or foreigners, are subject to individual income tax (PIT). On a monthly basis, the Brazilian companies should withhold the personal income tax from the compensation paid to employees. This is in accordance with the progressive tax rate, as a function of the monthly income that can vary from 7.5% to 27.5%.

The contribution to the National Social Security Institute (INSS) is the most salient example of social insurance, in Brazil. Treated like a tax, in this study because it is a social contribution that specifically aimed at covering retirements, pensions and health insurance. Thus, its purpose has been already earlier committed, removing any possibility of the federal government to define one's application, and reset the tax rate.

In the constitutional reform of 1988, the concept of security became wider and composed by three components: (i) social security, which intends to pay retirements, pensions and health insurance; (ii) health (political actions on medical health nutrition and health education); and (iii) social welfare to meet the needs (compensatory programs or redistributions).

The Brazilian Social Security system provides that benefits should be universal, without maintaining any close correlation with the ability to pay off different members of the society. A set of integrated policies and actions characterizes it in the areas of health and welfare, with the aim of protecting citizens against social risks base (Araujo, 2005). Thereby, it is possible to assume the existence of non contributory benefits, in these three areas. The non contributory benefits should be funded through taxes or social contributions, by general funds of the state.

Among social contributions, the highlights are the Guarantee Fund to the Service Time (FGTS), the Program of Social Contribution (PIS), the Heritage Training Program for Public Servants (PASEP) and the Social Investment Fund (FINSOCIAL).

FGTS sets up reserves for unified accounts of individual workers, with funds from monthly payments on the part of companies, equivalent to the 8% of employees salaries. It is also worth mentioning that the FGTS resources are to be largely allocated toward funding action in the areas of housing, urban development and sanitation.

The creation of the PIS/PASEP aimed at ensuring the worker the right to participate in life and business development. In practice, it represents a mechanism of compulsory savings formation to finance the industrialization process. The PIS design predicted the formation of a holding fund, a workers' private property and comprising monthly deposits of enterprises. In the PASEP, the contributions to the fund were the responsibility of the public administration. Since 1974, the administration and implementation of the PIS/PASEP came to be applied in a unified manner, by the BNDES (currently, National Bank for Development). The institution of the PIS/PASEP has promoted the concentration and centralization of resources for medium and long terms, for investment projects aimed at deepening the process of industrialization, in Brazil (Araujo, 2005). After the constitution of 1988, PIS/PASEP contributions turned into a collective accounting fund. At least, 40% of funds raised should be earmarked for BNDES in order to finance economic development programs; the remaining portion is used to fund the program of unemployment insurance and salary bonus..

In 1982, the creation of FINSOCIAL aimed at supporting investments in social activity, health, housing, education and support for the small farmers. This fund consisted of contributions collected from companies, and mainly based on gross revenue. The similarity of FINSOCIAL with PIS/PASEP was evident with regard to the tax base (Araujo, 2005). The universe of taxpayers is

virtually the same and the main base of the two contributions was the revenue of companies. The BNDES, National Bank for Development took over the administration of FINSOCIAL. In 1992, the government replaced the FINSOCIAL, creating the Contribution for the Financing of Social Security (COFINS). Both the tax rate and the tax base of the COFINS underwent changes. In the evolution process, although the implementation of changes in the tax base of the COFINS, the principal changes occurred in the tax rate. Currently, the tax rate is 7.6% in the cumulative regime and 3% in the non cumulative one.

The creation of the Social Contribution on Net Income (CSLL) happened in 1989. Unlike other social contributions, the establishment of the CSLL was on the bases of corporate profits as a generator factor that similarly contributes to the Corporate Income Tax (CIT). The tax rate of the CSLL has suffered successive changes, and currently, the same rules for calculating the Corporate Income Tax (CIT) charge the CSLL.

A complementary law established the provisional tax on financial transactions (IPMF), in 1993, and it focused on the charges levied on accounts held by financial institutions. The IPMF changed to CPMF (provisional contribution to financial transactions); it underwent various processes of renewal because it was a temporary social contribution. The Senate rejected the proposed extension of the contribution on December 13, 2007. Unlike IPMF, the CPMF was a contribution that intended to fund specific public health, welfare, funds for combating and eradicating poverty.

2.2 Tax Competence of States and Federal Districts

In this study, although it is dealing with federal taxation impacts on the real gross domestic product growth, it is included the state sale tax (ICMS) because it has a strong impact on the corporate total-taxation, causing the inhibiting growth of the economy. The ICMS revenue fully belongs to the states, with 25% mandatory transfer to the municipalities. However, in the model, it is considered as federal tax revenue with full transfer to the state. The states and the federal district are empowered by the Constitution to institute and collect, among others, the value-added tax (ICMS) on the interstate and inter-municipal circulation of goods and services, including communication, even if such operations and services are originated abroad. The ICMS is the most important state tax. The ICMS tax is a non-cumulative tax and is levied on intra and interstate operations that involve the circulation of goods and in the inter-state and inter-municipal transportation and communication services. Since it is a value-added tax, taxpayers are allowed to offset the ICMS paid in acquired goods and services against the ICMS due on subsequent taxable transactions (e.g., sale of goods and services subject to ICMS tax). The balance between credits and debts will be the amount owed to the state government.

Brazilian municipalities are empowered to collect, among others, Service Tax (ISS). The ISS is charged on the rendering of the services listed in a federal law, specifically excluding telecommunication and transport services. It is also imposed on imported services and engineering.

2.3. Intergovernmental Transfers

The Brazilian Constitution defines a system of unconditional transfers between the union, states and municipalities, which can be either direct or through the creation of special funds (indirect). Regardless of their type, transfers always occur from higher to lower levels of government, that is, from the union to the states and from the union to the municipalities or from the states to their respective municipalities (Tax Study 08, 2002).

Direct transfers, as constitutionally defined, are the following: (i) States and municipalities are entitled to keep the total collection of income tax (CIT and PIT) withheld at the source on income payments, with payments made in autarchies or foundations maintained in the respective municipalities; (ii) Municipalities are entitled to 50% tax collection on rural property (ITR[3]) levied on real estate within their respective territories; (iii) Municipalities are entitled to 50% tax collection

[3] The tax on rural property (ITR) is a Brazilian federal tax, with exclusive jurisdiction of the union tax as established in the Federal Constitution. The triggering event of the Rural Land Tax occurs when the domain possession of the property is outside the urban perimeter.

on motor vehicles (IPVA[4]) registered in their territories; (iv) Municipalities are entitled to 25% tax collection on goods circulation, transportation and communication services (ICMS) (3/4, at least, proportionally to the value added through operations carried out in their territories and up to 1/4 as provided in the State Law); (v) States and municipalities of origin receive a transfer of 30% and 70% respectively, of the collection of IOF–Gold[5] (as a financial asset).

The following funds carry out indirect transfers: (i) export compensation fund (FPEx) consisting of 10% of the total IPI collection. It is distributed proportionally to the amount of industrialized products exports. The individual state participation is limited to 20% of the total fund receipts; (ii) Federal district and states participation fund (FPE) consists of 21.5% of the total IPI and income tax (CIT plus PIT) collection. It is distributed in direct proportion to state population and size, and in inverse proportion to per capita income; (iii) Municipalities participation fund (FPM) consists of 22.5% of the total IPI and income tax (CIT and PIT) collection. It is distributed proportionally to the population of each unit. Overall, 10% of the fund is set aside for the municipalities of the capital cities; (iv) Regional funds consist of 3% of the total IPI and income tax (CIT and PIT) collection. This revenue is directed to developmental programs in the North, Center-West, and Northeast regions.

In addition to the constitutional transfers of direct and indirect taxes (as described earlier), the Brazilian government still has the burden of obligations. Among others, the discretionary transfers (results of agreements), voluntary transfers, resulting as agreements with state governments, and transfers for the financing of decentralized provision of public services, especially education, health with the National Health Service (SUS[6]), the zero hunger program and transfer to supplement Social Security revenue (deficit), among others.

So, we grouped the transfers to states and municipalities, called $TTSM_t$, including the participation amount of states and municipalities in the federal taxes and also in the development funds (as described in this section earlier), constitutionally established; the total amount of the VAT ICMS (as argued in the Section 2.2, it constitutes a tax burden, charged to the states); the total amount of tax on services, ISS (also a burden tax, charged to the municipalities); the subsidies granted by the federal government to private and state corporates, as reasonable compensations for the state shares; and the transfers, as results of agreements and voluntary, to finance the decentralized provision of public services, especially in education, social programs, to supplement the social revenue (such as family allowance, zero hunger, and others) and the health services (such as SUS, unified health system), under the responsibility of states and municipalities. Therefore, this study will consider transfers to states and municipalities, in aggregate, regardless of purpose, in order to ascertain the impact of these transfers on the economic growth of the global economy of the country.

One will also include, as aggregate, the payments to the federal security system termed as $TTSS_t$, related to social security contributions with their own revenues according to Subsection 2.1, and the additional contributions from the government, in order to supplement the resources to retirements, pensions, transfers to social security, attend social programs and health, directly dependent on the federal government, specially the SUS program (unified health system) and also to supplement the social revenue (family allowance, zero hunger, and others).

[4] The Property Tax Vehicle (IPVA) is a Brazilian tax of state competence, i.e., only the states and federal district have the power to institute it.

[5] Tax on gold transactions with financial assets or negotiable instruments, such as operations deswap foreign exchange rate is 1% (exclusive jurisdiction of the union tax).

[6] The Federal Constitution of 1988 consolidated a unified health system (SUS) and the basic principles of universal access and decentralization, in the implementation. When implementing the SUS, one may understand that the strengthening of decentralized management (especially at the municipal level) could be the key to ensuring health access for the population. To make decentralization a reality, the federal government organized a regular system of resources transfer to subnational governments. To get an idea of the importance of the system, according to the Ministry, in 2004, 98% of Brazilian municipalities were already responsible either for the primary health care or the entire health system (Araujo, 2005).

3. Macroeconomic background

In this section, we intend to demonstrate the interaction between internal and external balances, using the complete circular-flow model, with all four macroeconomic sectors (household, business, government and foreign) and all three macroeconomic markets (product, resource and financial), and the interactions with the rest of the world. The interaction with the rest of the world includes only the trade flows, which consists of exports-imports of goods and services (kulkarni and Dolan, 2007).

The classical equilibrium model between the Gross Domestic Product (GDP), Y_t, and the aggregate expenditure, AE_t, in an open economy, can be written as

$$Y_t = AE_t = C_t + I_t + G_t + TB_t \quad (1),$$

where C_t is the household consumption; I_t is the gross capital formation (capital formation includes fixed capital, inventories and valuables). From now, we call I_t only as fixed investment; G_t is the government expenditure[7]; $TB_t = X_t - IM_t$ is the international trade balance, where X_t are exports and IM_t are imports; and the subscript *t* indicates the actual values of the variables.

The flow of government revenue FGR_t is matched to the flow of government expenditure, FGE_t, so that $FGR_t = FGE_t$. Otherwise, the government generates a surplus (or deficit) in the budget. In the case of a surplus$(FGR_t - FGE_t) > 0$, it can either accumulate savings if investment is lower than saving, or lend funds to the private sector. In the case of a growing deficit occurs the opposite: the government spends more than it collects; then, it borrows from the private sector and/or Central Bank, capturing financing in the foreign market.

The needs for borrowing by the government are accounted in the Brazilian finance as Government Finance Needs (GFN_t), which is a nominal result defined as

$$G_t = (RT_t - TR_t - SUB_t) - PDI_t + GFN_t - GI_t \quad (2),$$

where G_t is the government expenditure; PDI_t is the amount of public debt interest paid by the government; GI_t is the government investment; TR_t is the tax revenue and RT_t is the government revenue transferred for states, municipalities and its social programs, and SUB_t is the subsidies offered by the government to the private sector and state corporate. The nominal results of GI_t is the investment budget, which is called *Financing Needs of States Companies*. In another way, we can consider the government savings, GS_t, defined as $GS_t = GI_t - GFN_t$. It can be observed that the existence of deficit does not mean that saving is negative, but may only indicate that although positive, saving is less than government investment value ($GS_t < GI_t$).

In Eq.) (2), the government partly used the net tax revenue to meet its commitments to public debts, interest commitments, repayments, as well as maintaining the government´s operating expenses. Then, one can analyze the taxes impact on the economy performance, taking an overview of each revenue with significant impacts, when it is detailing the main lump-sums of mandatory transfers and social coverage transfers of the government as established by constitutional laws.

The tax burden on the Brazilian economy, as explained in Section 2, will be bounded in our study as (i) TGS_t, the total tax on goods and services, which impacts on the gross revenue of the corporations. It includes the VAT IPI (excise tax), the VAT ICMS (sales tax on goods and services), the ISS (service tax), and the social contribution on the gross revenue of corporates (as PIS/PASEP, FINSOCIAL/COFINS, and CPMF); (ii) SCP_T, which is the social contribution to payroll (social security and FGTS); and (ii) $TISC_t$, the total income tax (personal income tax plus the corporate income tax) added to the CSLL (social contribution to net income corporates).

Note that we add to the variable TGS_t, the ICMS, value-added tax sales, as union revenue, even being a tax of states responsibility, and we also include the service tax, ISS, under municipalities responsibility, as federal revenue. This happens because one of the aims of the study is to

[7] The Government for purposes of National Accounts is the Central Government plus States and Municipalities.

investigate the tax burden impact, on the Brazilian corporations. Thus, we aggregated the variable TGS_t, pertaining to all taxes and social contributions that burden the businesses.

In the same manner than the tax burden, we rank the federal government transfers as it follows: (i) $TTSM_t$, the total transfers to states and municipalities, (ii) $TTSS_t$, the total transfers to the INSS and social securities. The characteristics of these two variables are at the end of Section 2.3.

It should be noted that we classified in the same variable, most of the taxes with common characteristics and similar transfers in order to reduce the number of variables to be included in the econometric dynamic model (VECM - vector error correction). A large variables number significantly restricts the freedom degree of the equation system because of the inclusion of lagged variables that require a large database (the database is from 1970 to 2010, and it is not sufficiently large for a broader study).

The Brazilian tax system is complex as explained in Section 2. It passed through several changes in tax bases and tax rates between 1970 and 2010, which is the period that comprises the sample. Each tax, within the Brazilian system, has a Harmonized Tariff Schedule (HTS) for a comprehensive listing of products. Since it is difficult to find the corresponding tax rates for each tax, we use, in Eq. (2), the aggregate revenue for each tax, as follows:

$$G_t = TGS_t + SCP_T + TISC_t - TTSM_t - TTSS_t + GFN_t - PDI_t - GI_t \quad (3)$$

We use the macroeconomic background outlined by Eqs. (1) and (3) for building a system of simultaneous equations to apply the data sample in the vector-error-correction model. The internal market balance Equation (1) is going to make the basic model, with the following modifications: substituting the Equation (3), aggregating the terms $GS_t = GI_t - GFN_t$ (in the equilibrium, $GS_t \approx 0$), as follows:

$$Y_t = C_t + I_t + TB_t + TGS_t + SCP_T + TISC_t - TTEM_t - TTSS_t - PDI_t - GS_t \quad (4)$$

4. Methodology Framework

In order to investigate the dynamic relationship among key aggregates of the economy flows, this study used the structural vector-error-correction model (VECM). The most general model of structural VECM can be written as Lütkepohl and Krätzig (2004):

$$\Gamma_0 \Delta y_t = \mu + \alpha[\beta' \ \eta'] \begin{bmatrix} y_{t-1} \\ D_{t-1}^{co} \end{bmatrix} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \sum_{i=0}^{q} H_j x_{t-j} + D_t + \epsilon_t \quad (5),$$

where $\Gamma_0 = I_k$ (I_k is the identity matrix or order k). y_t is a $k \times 1$ vector of observable endogenous variables. x_t is a $m \times 1$ vector of observable exogenous variables or unmodeled variables. Γ_i (with $i = 1,2, \dots, p$) is a $k \times k$ matrix of coefficients, Ξ_j (with $j = 1,2, \dots, q$) is also a $m \times m$ matrix of coefficients. D_{t-1}^{co} contains all deterministic terms included in the co-integration relations, and D_t contains all remaining deterministic variables. Deterministic variables may be constant, linear trends, seasonal dummy variables, as well as other user-specified dummy variables. The vector of disturbances ϵ_t is a $k \times 1$ vector of unobservable zero mean white noise (with a positive definite covariance matrix $E(\epsilon_t \epsilon_t') = \sum_\epsilon$), called *innovations*, that may be contemporaneously correlated. They do not correlate with their own lagged values and, thus, do not correlate with all the right-hand-side variables, either.

As Engle and Granger (1987) stated, Granger's representation theorem asserts that if the coefficient matrix has reduced rank, $r < k$, the parameter matrices α and β have dimensions $k \times r$, with rank *r*, such as βy_t is integrated of zero order, I(0). The parameters α and β specify the long-run part of the model, with β containing the co-integrating relations and α representing the loading coefficients (the speed of adjustment parameter). The η' is a $r \times n$ matrix, with *n* corresponding to the dimension of D_{t-1}^{co}.

The vector-error-correction model (VECM) is for using with non stationary time series that are considered cointegrated. The specification of VEC models contains the co-integration relations; thereby, it assumes that the economy converges to the long run relationships. On the other hand, it

also allows the short-run adjustment dynamics, from impacts of random disturbances on the system of variables, denominated innovations.

The vector of exogenous-variables x_t characterizes the generation process of a variable that affects the endogenous observable variables, and whose effects can be determined outside the system of interest. Accordingly, the distinction between exogenous and endogenous variables in a model is subtle and is a subject of a long debate in the literature. Ultimately, exogenous observable variables (instruments) are typically derived from natural or random experiments (Angrist and Krueger 2001). The exogeneity of one variable is going to be characterized if it is uncorrelated with the error term of an econometric model. However, since one expect that all variables, in this study, present direct effects on the model endogenous variables, then, it was only used the endogenous variables in the model structure.

A vector-error-correction model is representing cointegrated variables. Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series might be stationary, following a common long run path or equilibrium. If such stationary linear combinations exist, the non-stationary time series are going to be cointegrated. To determine whether a group of non-stationary series might be considered cointegrated or not, it is necessary to apply the cointegration test. In this study, the cointegration tests are applied through the methodology developed by Johansen (1995, 1991), which is a powerful test that uses the maximum likelihood estimation, maximum eigenvalues and trace statistics. The cointegration test is going to be discussed in Section 6.1.

In order to test for cointegration or fit cointegrating VECM, it is necessary to specify how many lags are going to be included. The number of lagged differences of endogenous variables, p, may be chosen with the help of model selection criteria. In this study, the VARSOC routine selected them. It is a routine implemented in the software STATA 11, building on the work of Tsay (1984), Paulsen (1984) and Nielsen (2001). Minimizing one of the usual information criteria made possible to choose the optimal lag order. The optimal lag test results are going to be discussed in Section 6.1.

Various restrictions can be imposed on the parameter matrices, especially in the matrix β of the cointegration coefficients in order to satisfy economic laws or identity relationships of economics. In particular, it is necessary to impose restrictions to ensure an identified model form that can be estimated. Equation (5) is a structural form that could only be estimated if identifying restrictions are to be imposed. Constraints might be imposed on the α and β matrix of coefficients, on deterministic terms, D_{t-1}^{co}, included in the cointegration via η matrix or on deterministic variables of the VAR model, D_t.

The imposition of constraints for the β matrix is going to be discussed, in detail, in Section 6.1. However, in the models built in this study, there was no any constraint on the α matrix because it is not required, and the tests with models demonstrated that the use of deterministic terms (in both D_{t-1}^{co} and D_t) are not necessary either.

5. Dataset and characteristics of samples

The main sources of dataset are the Institute of Applied Economic Researches (IPEA), a public foundation linked to the Federal Secretariat for Strategic Affairs of the Presidency of Brazil, the National Treasury that is responsible for the federal accounting system of Brazil, and the Brazilian Institute of Geography and Statistics (IBGE) also linked to the Brazilian Government.

The authors prepared data, for the most part, obtaining information from multiple sources with the aim of designing the longest time series possible, from 1970 to 2010, in order to increase the model freedom degrees. This is because only from the 1980s onward, the most of macroeconomic series of the Brazilian economy started to be structured.

We used variables specified in US$ at constant prices of 2010. We preferred building a model with real variables, with the aim of purging the harmful effects of significant variations on the exchange rates and inflationary astronomical variations suffered by the Brazilian economy during the period of analysis, due to economic instabilities in some periods, as a function of global economic crisis and mainly because of instabilities of the Brazilian economy.

It should also be emphasized the use of per capita time series (except for the tax variables: TGS_t, SCP_t, and $TISC_t$) in order to eliminate the spurious effects of deterministic growth, mainly due to the evolution of the Brazilian population growth, which rose from 90 million, in 1970, to 190 million, in 2010. Nevertheless, tax variables were normalized by the Gross National Disposal Income, $GNDI_t$, with the purpose of obtaining effective tax revenue evolutions. One could assume that, with this procedure, it is possible to capture the taxation impacts on the Gross Domestic Product growth, in a similar manner that it would be obtained, specifically, through changes in the tax rates. Subsections 2.1 and 2.2 show that to obtain the evolution of tax rates, in the Brazilian economy, is a daunting task in view of the amount of taxes and the number of existing Harmonized Tariff Schedule, for both products and business segments.

The macroeconomic structure, summarized in Section 3, allowed to establish a simultaneous equations model. Through this macroeconomic analysis, one observed that economic growth depends on several variables that interact in the internal environment of an economy, as well as its interaction with the rest of the world´s economy. In view of this idea, the structure of the study is the analysis of a dynamic model that involves the variables described in Table 1, which provides a description of the variables used in the empirical research and their definitions.

Table 1: Definitions of variables.

VARIABLE	DESCRIPTION
GDP_t	Per capita Gross domestic product, at constant prices of 2010, in US$.
$CONS_t$	Per capita consumption, at constant prices of 2010, in US$.
I_t	Per capita gross capital formation (fixed capital plus inventory), at constant prices of 2010, in US$.
TGS_t	Effective tax on goods and services per capita, at constant prices of 2010, in US$.
SCP_t	Effective social contribution on Payroll, at constant prices of 2010, in US$.
$TISC_t$	Effective tax income plus social contribution on net income, at constant prices of 2010, in US$.
$TTSM_t$	Per capita total transfer to states and municipalities, at constant prices of 2010, in US$.
$TTSS_t$	Per capita total transfers to the INSS and social securities, at constant prices of 2010, in US$.
TB_t	Per capita trade Balance, at constant prices of 2010, in US$.

6. Empirical model specification

With the perspective that the variables to be used in the VECM are not zero-order integrated, I(0), one should note the order of variables integration to take the assumption of multivariate normality, and derive the structure of error-correction models. The assumptions of multivariate normality and time constant covariance are potential problems, as derivations of the VAR with error correction rely heavily on multivariate normality, and statistical inference is only valid to the extent that the underlying model assumptions are correct (Hendry and Juselius, 2001). Like this, in the next few subsections, the procedures of models empirical analysis implementation are going to be discussed.

6.1 Cointegration analyses

A VECM built in the form of Eq. (5), with the identities present in the corresponding equation, namely: GDP_t, I_t, $CONS_t$, TB_t, TBS_t, SCP_t, $TISC_t$, $TTSM_t$ and $TTSS_t$ (Table 1 defined these variables. As planned earlier, this model aims at analyzing the dynamic behavior of the internal structure of the Brazilian economy, and also, the inter-impacts among variables of the specified set to model. One can neglect the variables GS_t (Government Saving) and PDI_t (amount of public debit interest paid by the government) present in Eq. (4), with the objective of increasing the model´s freedom degree, since they can be treated as non-observable peripheral variables, with relatively smaller importance than the others included in the model.

The cointegration of variables needs to be carefully examined because we need to identify how many cointegrating relationships (and, therefore, stochastic trends) are going to be specified in each model. A detailed procedure needs to be followed. The first logical step is to inquire whether the variables are cointegrated, what becomes possible in the linear transformations among them, inducing the stationary. Thus, we have tested whether the variables are integrated in first order, I(1), and we had also checked whether they are integrated; i.e., of order zero, I(0). The results of the unit root tests using the Augmented Dickey−Fuller test, for both the level and the first difference,

showed that all variables are I(1), in the level, and I(0), in the first differences, at 5% of the significance level. Moreover, the cointegration analysis could be designed to find linear combinations of variables to remove unit roots.

The cointegration relations determine I(0) relations that exist between variables, which are individually non stationary. Such relations act as attractors toward which convergence occurs whenever there are departures from there (Granger, 1986). One should specify how many lags must be included in the VECM before testing the cointegration. With help of the *VARSOC* routine was possible to choose the number of lagged differences of endogenous variables, p, implemented in the *STATA 11* software (see Stata Time Series Reference Manual Release 11, page 435). In this study, the selection based on the criterion Akaike Information (AIC) and Hannan−Quinn Information (HQIC) indicated two lags.

The cointegration tests used the Stata package *VECRANK* (see Stata Time Series Reference Manual Release 11, page 505) for determining r, the number of cointegrating equations, in a VEC model. These cointegration tests utilized the methodology developed by Johansen (1995, 1991). It is a powerful test that uses the maximum likelihood estimation, maximum eigenvalues, trace statistics, and also, a method that chooses the rank r, minimizing the information criteria. The results of cointegration tests indicated that the best number of cointegration equations was three.

Finally, to complete the requirements of the model, it is essential to identify restrictions. In general, such identification can be achieved by imposing an appropriate normalization (care is necessary to ensure that the normalized coefficient is non zero). On the other hand, restrictions can be also made following some economic hypotheses and imposing them on the equilibrium relationships between observable variables (Johansen 2005, 2004). This procedure is quite convenient and a very popular way of thinking about such relationships along with the concept of cointegration. The economic theory usually serves to find the meaningful equilibrium relationships. In this case, one remarked that the identities in Equation (4) maintain relationships; however, it is not possible to imagine the weights of each identity on the right side of Eq. (4), when it reaches the equilibrium. Considering this feature of the problem (and the pretests carried out), it was possible to assess the normalization of the matrix of cointegration vectors as follows:

$$\begin{pmatrix} A_r \\ \beta_2 \end{pmatrix} \quad (6),$$

where β_2 is a $(k-r)\times r$ matrix of unrestricted elements and A_r is a $r \times r$ (in this case, the cointegration rank r = 3 and k = 9) matrix as

$$A_r = \begin{pmatrix} 1 & * & * \\ * & 1 & * \\ * & * & 1 \end{pmatrix} \quad \text{or} \quad A_r = I_r = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \quad (7 \text{ and } 8),$$

where β_2 is a $(k-r)\times r$ identity matrix, and $*$ is unrestricted elements estimated by the convergence of the likelihood procedure. The two conditions (7) and (8) work in the same way; the condition (7) better satisfies the white-noise condition for the residual disturbances of the cointegration equations.

6.2 Robustness of the estimates

The development of VAR/VEC models was an attempt to characterize the behavior of a joint time series, involving a set of variables, without making the restrictive assumptions that would allow the identification of structural dynamic models (Enders, 1995). However, to obtain robust VAR/VEC models, some assumptions should be satisfied (since the residual disturbances ought to be white noise processes[8], in the sense of weak white noise), as the multivariate normality and time-

[8] A time series u_t has a weak white-noise process if $\{u_t\}$ is a sequence of serially uncorrelated ($E(u_iu_j)=0$, with $i\neq j$) random variables with zero mean ($E(u_i)=0$) and finite variance($E(u_iu_i) = \sigma^2$). The strong white-noise process has also the quality of being independent and identically distributed (each random variable has the same probability distribution), which implies no autocorrelation. In particular, if u_t can be normally distributed with mean zero and standard deviation σ, the series name is Gaussian white noise (Diebold, 2007).

constant covariance, facing a simulation with the truncation of lags. Then, for testing assumptions and enhancing the empirical application success (valid inference), a linear model in the parameters as outlined in Equation (5), demands normally distributed errors, ϵ_t, and independents (e.g., $\mathrm{E}(\epsilon_t \epsilon_{t+j}) \approx 0$, with $j = 1, 2, \ldots$).

Studies according to Hendry and Juselius (2001) have demonstrated that statistical inference is sensitive to the validity of some assumptions, such as serially correlated residuals, residual skewness, kurtosis excess and residual heteroscedasticity. In addition, as described by Hendry and Juselius (2001), the VAR/VEC models with autocorrelated residuals would characterize agents that did not use all data information as efficiently as possible, unlike the white-noise innovation, which is not explicable by the past of the process. Hence, checking the white-noise requirement of the residuals and normality tests (a measure of asymmetry and excess kurtosis), is possible to confirm that one derived an estimator under the assumption of multivariate normality. In the same way, in the co-integration vector, disturbances in the equations should be white noise, but differently of the residual disturbances of the VAR model, they may be correlated with each other (Enders. 1995, p. 368).

Consequently, to ensure that the disturbances in both the VAR model and the cointegration are white noise, one applied Bartlett's periodogram-based test for white noise. Bartlett's test is the null hypothesis that data come from a white-noise process of uncorrelated random variables having constant mean and variance (for details of this test, see Bartlett, 1955, 92–94 or Newton, 1996). One applied, to ensure the normality of the residuals, Jarque–Bera statistic, which computes a series of statistics against the null hypothesis that the disturbances, in a VEC model, are normally distributed (for more detail see Stata time series reference manual release 11, p. 497). The results for the residual disturbances analysis on the VAR model and cointegration equation showed that all residual disturbances, on the VAR model and cointegration equations, were white-noise processes and normally distributed at 5% significance level.

We have also checked whether the VAR model estimated is stationary. The dynamic stability of the process can be investigated by calculating the eigenvalues of the companion matrix of a VEC model with k endogenous variables and r cointegrating equations. It has *k-r* unit eigenvalues (Lütkepohl and Krätzig, 2005 and Hamilton, 1994). If the process is stable, the modules of the remaining eigenvalues will be strictly less than one. If all the eigenvalues are less than or equal to one, the process will be non stationary, and if at least any eigenvalue is higher than one, the process will be explosive. In this last case, the model needs to be reformulated (Hendry and Juselius, 2001).

We have used the package of software *VECSTABLE* of the *STATA 11* (Stata time series reference manual release 11, p. 509) to check whether we have correctly specified the number of co-integrating equations. The eigenvalues estimated in the companion matrix showed that some of the remaining eigenvalues (those different from one) appears close to the unit circle. The stability check does not indicate that our model is incorrectly specified. Thus, we note that the system is stable (no explosive eigenvalues) and suggests the presence of stochastic trends, as there are some near-unit eigenvalues. In this case, the series seems non-stationary and possibly co-integrated. However, it is important to emphasize that there is no general distribution theory that allows one to determine whether an estimated root is too close to one for all the cases that commonly arise in practice.

It seems to have ensured that all assumptions allow the success of the empirical applications. Therefore, we claim that the empirical model built in this study is capable of accounting for all the systematic information in the data in a satisfactory manner.

7. Results analyses

Before beginning the result analyses, we write Eq. (5) as applied in this study, which assumes the following form:

$$\Gamma_0 \Delta y_t = \mu + \alpha \beta' y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \epsilon_t \quad (9),$$

where in Equation (9), $p = 3$, $k = 9$, $\Gamma_0 = I_k$, Γ_i (with $i = 1, 2$) is a k×k matrix of coefficients and the k×1 transposed vector of observable endogenous variables $y_t' = [\mathrm{GDP_t\ I_t\ CONS_t\ TB_t\ TBS_t\ SCP_t\ TISC_t\ \ TTSM_t\ TTSS_t}]$. The unmodeled variables neglected were treated as non-observable peripheral variables, with relatively smaller importance than the others included in the model, which were absorbed by the disturbances ϵ_t is a $k \times 1$ vector, as random innovations.

The model analyzes the dynamic behavior of the internal structure of the Brazilian economy and inter-impacts among observable endogenous variables in the long and short run, and also the direct and indirect impacts of the innovation disturbances. Thus, the parameters of interest are (i) in the adjustment coefficients that characterize the performance of the model; (ii) in the parameters of the co-integrating equations, which allow to evince the long-run interactions, among the macroeconomic endogenous variables; (iii) the short-run coefficients, which permit to highlight the short-run impacts among the variables and in the long-run impacts; and (iv) the standard impulse response function that allows useful interpretations about innovation disturbances.

7.1 Model Results

Therefore, to fully analyze the results of the estimated VEC model, we introduced tables A.1, A.2, and A.3, in Appendix A. Table A.1 reports the estimates of the parameters in the co-integrating equations, along with their standard errors; t statistics; and the confidence intervals of 5% significance levels. Recalling the adjusted model is a model of three equations, with the lag in the co-integration equations. In the header of Table A.2, one observes among other statistics, the coefficients of determination for each equation of the VAR model. It is noted in this table that the adjustments are quite satisfactory, ranging from 0.6 to 0.95. The results shown in Table A.2 indicate the short-run impacts in each equation of the VAR model, with standard errors in the first parenthesis below the coefficients and the t-statistic in the second parenthesis also below the coefficients. The asterisks introduced as superscript in front of the estimated coefficients represent $*$ 10% significance level, a $**$ 5% significance level, and a $***$ 1% significance level.

The results in Table A.1 (Appendix A) indicate strong support for co-integrating equations, as almost all coefficients of the three equations are significant with a level less than 1% (except the coefficients of the variables $\mathrm{TGS_{t-1}}$ equation two and $\mathrm{TB_{t-1}}$, equation three). Identification of the parameters in the co-integrating equations was achieved by normalizing to 1 (as explained in Section (6.1)), the coefficients of the variables $\mathrm{GDP_t}$, $\mathrm{CONS_t}$ and $\mathrm{TTSS_t}$, respectively, for the first, second, and third equations; thus, these fixed parameters do not indicate standard errors, as one can observe in Table A.1. Overall, the output of the co-integration equations shown on the header of Table A.1 indicates that the model fits each equation well, and the overall co-integration model, as can be observed in the p-values of the χ^2 (chi-square) statistics.

The interpretation of the coefficients of co-integration shown in Table A.1 are in the following manner. In Eq. (1), when the deviation $\mathrm{ce1_{t-1}} > 0$, and the adjustment parameters of co-integrating are positive (as the variables $\mathrm{TTSM_{t-1}}$, $\mathrm{GDP_{t-1}}$ and $\mathrm{SCP_{t-1}}$), they are above their equilibrium values, and the adjustment to the equilibrium occurs by diminishing their levels. The other variables in Eq. (1) ($\mathrm{TTSS_{t-1}}$, $\mathrm{TISC_{t-1}}$, $\mathrm{TB_{t-1}}$, $\mathrm{CONS_{t-1}}$, $\mathrm{I_{t-1}}$ and $\mathrm{TGS_t}$) are below their equilibrium values, as their coefficients are negative; then, the adjustment to the equilibrium occurs by augmenting their levels. In Eq. (2), the coefficients of the variables $\mathrm{TTSM_{t-1}}$, $\mathrm{SCP_{t-1}}$, $\mathrm{TB_t}$ and $\mathrm{CONS_{t-1}}$ are positive, and the coefficients of the other variables ($\mathrm{TTSS_{t-1}}$, $\mathrm{GDP_{t-1}}$, $\mathrm{TISC_{t-1}}$, $\mathrm{I_{t-1}}$ and $\mathrm{TGS_{t-1}}$) are negative. Finally, in Eq. (3), the coefficients of the variables $\mathrm{TTSS_{t-1}}$, $\mathrm{GDP_{t-1}}$, $\mathrm{TISC_{t-1}}$, $\mathrm{I_{t-1}}$ and $\mathrm{TGS_{t-1}}$ are positive, and the coefficients of the other variables ($\mathrm{TTSM_{t-1}}$, $\mathrm{SCP_{t-1}}$, $\mathrm{CONS_{t-1}}$ and $\mathrm{TB_{t-1}}$) are negative. As a general rule, when the long-run equilibrium suffers a positive deviation, the positive coefficients of the co-integration equations have to diminish their levels to adjust to the equilibrium in the long run, and the negative coefficients have to augment their levels to adjust to the equilibrium, also in the long run.

Through the coefficients of co-integration, when the co-integrating equations receive positive exogenous disturbances, we can identify which variables are above or below the long-run equilibrium level and the intensity of the deviations, but we cannot identify the speed with which each term will be adjusted.

In the VEC model, estimations are computed in the matrix of co-integration parameters β ($k \times r$ matrix, where k is the number of variables and r is the rank of cointegration), and also α (also, $k \times r$ matrix), a matrix with the weight of each co-integrating vector that enters in the k equations of the VAR model. In a sense, the α matrix has important implications for the dynamics of the system. It can be viewed that α is a matrix of the adjustment speed of adjustment parameters of the long-run equilibrium, when the co-integrating equations receive exogenous disturbances.

The estimated coefficients of α and β implies that when disequilibria occur in the co-integration equations, the product $\alpha \times \beta'$ characterizes the long-run adjustments of the variables, which adjust toward the new equilibrium. At the same time, all the variables of all equations of co-integration are also adjusting their long-run levels. The velocities of adjustment depend on how large the module of the α coefficients are, and the directions of adjustment depend on the signs of α and β. Thus, we should consider the average evolutions in the long run of adjustments by means of the matrix coefficients $\Pi = \alpha\beta'$. The estimation of these coefficients is shown in Table A.3, in Appendix A. Therefore, we should interpret the matrix Π, as a weighted average (where the weight is α) of long-run adjustment of a respective variable of the co-integration equations, corresponding to an equation of the VAR model.

The results shown in Table A.3 indicate the weighted average of long-run adjustment in each equation of the VAR model, with standard errors in the first parenthesis below the coefficient and the t-statistic in the second parenthesis below. The asterisks introduced as superscript in front of the estimated coefficients represent a $*$ 10% significance level, a $**$ 5% significance level, and a $***$ 1% significance level.

Before commencing the analysis of the results, we will introduce in Section 7.2 the concepts and estimates of the impulse response functions, by which we characterize the evolution of exogenous short-run impacts.

7.2 Impulse Response Function (IRF)

IRFs describes how the stochastic innovations on one variable affect another variable after a given number of periods (Stock and Watson, 2001). Thus, the IRF is used to investigate how the effect of a surprise shock on one macroeconomic variable of the Brazilian economy affects the other economic variables applied in the VECM model. The results of IRF estimations highlight the direction and intensity of impacts of the orthogonalized shocks, for which we present the causal interpretation. In our study, the evolution of a shock is identified by the joint equation of the shock, where the shock mirrors the residual covariance structure, as orthogonalized impulse responses, OIRFS, as explained in Lütkepohl and Krätzig (2005, page 55–63). The reaction is measured for every variable a certain time, after one unit of the impulse variable shocking the system.

In a co-integrating VAR, some of the eigenvalues of the model are one, whereas the remaining others have module strictly less than 1. This implies that some of the variables in the model do not evolve to zero, as a VAR stable, when time continues till infinity, implying that some of the OIRFs are not going to be zero as $t \to \infty$. The fact that the OIRFs die out for stationary VARs, but not for co-integrating VARs, is one of the differences between the two models. When the OIRF from the innovation in one variable to another dies out as time goes on, the innovation to the first variable has a transitory effect on the second variable; the shocks are said to be transitory. In contrast, when the effect does not taper off, shocks are said to be permanent and generate a stochastic trend.

The graphs in Figs. 1 to 6, presented in the text next, show the evolution of orthogonalized IRFs, considering a unit of shock from each variable in the time zero and then, how they involve for twenty steps (years). Hence, we measure the time profile of the effect of shocks at a given point in time on the future expected values of variables in a dynamic system.

7.3 Result analyses of the per capita variables: GDP, CONS, I, and TB

In this subsection, we consider the results of the dynamic behavior of per capita Gross Domestic Product, GDP_t, the per capita consumption $CONS_t$, the per capita fixed investment, I_t, and the per capita trade balance, TB_t. We note that these variables present significant impacts on the growth of the economy and, especially, the variables GDP_t, $CONS_t$, and I_t behave as completely endogenous, and have been impacted by almost all variables of the model, in both the long run and short run. The TB_t variable is weakly exogenous in the short run, however, significantly impacting the other variables of the model in the long run, being an important element in the process of economic growth. Therefore, we analyze this set of variables in sequence.

7.3.1 Interactions among GDP, consumption, fixed investment, and trade balance

First, we consider the results of the equations of GDP[9], consumption, fixed investment, and trade balance, restricting in this section the analyses to the dynamic behavior interactions among the respective variables.

Observing Table A.3, which describes the behavior in the long run, we find that the per capita of Gross Domestic Product (GDP), at a 5% significance level, negatively adjusts its trend, diminishing its equilibrium level, in terms of positive impacts on the lagged output in itself. On the other hand, the GDP positively adjusts its equilibrium trend in the long run, at a 5% significance level, in terms of the positive impacts on the lagged per capita consumption (CONS), on per capita fixed investment (I), and on per capita of trade balance (TB). The analysis of the behavior of these adjustment factors in the long run should be jointly made with the factors of impact on gross domestic product in the short run.

We remark based on Table A.2 that in the short run, at a 5% significance level, the GDP is positively adjusted, due to positive changes in the first and second lags of per capita trade balance, TB, in the first and second lags of per capita consumption, CONS, in the first and second lags of itself (GDP), and in the first lag of per capita fixed investment, I.

It is observed from the results just cited that the economic growth (the product per capita) of the Brazilian economy is being impacted through various channels. Therefore, identification of the relationship adjustment of long-run and short-run impacts allows us to interpret the decompositions of GDP into permanent and transitory components, and also to make explicit the interactions among variables that drive growth. Here, we assume the traditional assumption that both permanent and transitory components originate in exogenous permanent shocks.

Our empirical results revealed in the Brazilian economy that per capita fixed investment, per capita consumption, and per capita trade balance support growth, because they influenced positive adjustments in the long run of per capita GDP, establishing a permanent effect on increasing the product. In the short run, as one can observe in the right graphs of Fig. 1 next, the per capita consumption and per capita trade balance also significantly impact the increase in the per capita gross domestic product and, with less intensity, the per capita fixed investment also positively impacts the product. We still remark in the right graphs of Fig. 1 that an increase in per capita GDP causes in the short run an increase in itself. This is a right way, as in the dynamics of the economy, an increase in the gross domestic product generates the future expectations of consumption that affect the investments, and may put the economy in the way of growth.

The OIRFs shown in Fig. 1 outline the evolution of the result of a unit of innovation shock in step one, along the future time steps (in study twenty). The situation observed in the right graphs of Fig. 1, for impulses on CONS, I, TB, and GDP, with responses on GDP, the innovation shock lasts and evolves to a trend (constant level). We can interpret these behaviors as the permanent effects of stochastic trends, in a way that the random shocks drive the economy toward growth in the long run.

[9] From now, we will use the abbreviations of variables without the subscript t, which indicates time series.

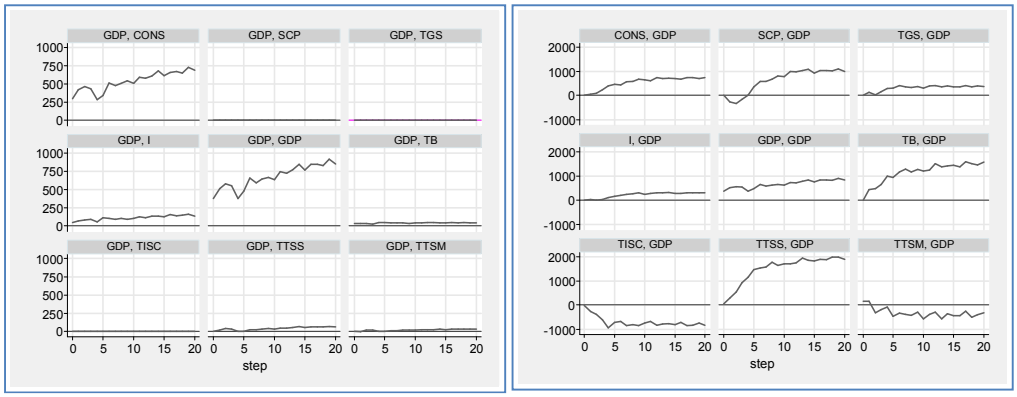

Figure 1: Ortogonalized Impulse Response Functions, OIRFs, related to the Gross Domestic Product, GDP (the first variable is the impulse, and the second variable is the response).

With regard to the long-run equilibrium, it can be remarked that the adjustment sign of GDP is expected to lead to long-run growth, when considering the impacts on the variables CONS, TB, and I. Positive changes in all these variables cause, in the long run, positive adjustment in the gross domestic product. In the same way, it is also observed that, in the short run, the gross domestic product, the consumption, the trade balance, and the fixed investments impact the product with correct signs. Positive impacts on these variables cause positive variations in the product. However, in the long run, positive impacts on the GDP cause negative adjustment on the equilibrium trend of the GDP. This makes us understand that the increasing trend of GDP cannot be characterized as sustained growth; or, in another way, an increase in GDP (in itself) cannot generate the future expectations of consumption that affect the investments, and may put the economy in the way of growth.

To understand the relationship between an increase in GDP and growth, we need to discuss a few of the conventional aggregate supply and aggregate demand models, *AD/AS*. Economic growth means an increase in real per capita GDP. Economic growth is caused by an increase in aggregate demand and/or an increase in aggregate supply (productive capacity). The *AD/AS* model is used to illustrate the Keynesian model of the business cycle. Movements of the two curves (*AD* and *AS*) can be used to predict the effects that various exogenous events will have on two variables: real GDP and the price level (Dutt and Skott,1996; Dutt and Skott, 2005 and Palley, 1997).

The *AD* curve is defined by the *IS-LM* equilibrium income at different potential price levels. The *AD/AS* curve shows the combinations of the price level and the level of the output at which the goods and assets markets are simultaneously in equilibrium. A reduction in price level leads to an increase in the equilibrium and spending. The slope of the *AD* curve reflects the extent to which the real balances change the equilibrium level of spending on assets and goods. An increase in real balances leads to a larger level of income and spending, the larger the value of the multiplier and the smaller the income response of money demand (Dutt and Skott, 2005).

The aggregate supply curve may reflect either labor market disequilibrium or labor market equilibrium. In either case, it shows how much output is supplied by firms at various potential price levels. The aggregate supply curve (*AS* curve) describes for each given price level the quantity of output the firms are willing to supply.

The aggregate supply curve, for the case of excess supply in the labor market, is called the *short-run aggregate supply curve*. It is a function of a vector of exogenous variables that can affect the position of the labor demand curve, changing either the capital stock or the current state of technological knowledge. The *long-run aggregate supply curve* refers to a time frame in which wages are free to adjust in order to equilibrate the labor market and in which price anticipations are accurate, with them being endogenous. At the full-employment level of production, the long-run aggregate supply curve is vertical. In this long-run aggregate supply curve, the vector of exogenous

variables also includes factors affecting the position of the labor supply curve, as in the labor market equilibrium, the location of labor supply affects the labor market outcome (Dutt and Skott,1996 and Palley, 1997). Classical economists argue that an increase in *AD* will only increase real GDP in the short run, and that in the long run, the *AS* curve is inelastic; therefore, higher *AD* only causes inflation. Classical economists emphasize the role of supply-side policies in increasing economic growth. This question is disputed by Keynesians, who believe that in the long run, the *AS* can be elastic, for example, in a recession.

Economic changes in the short run in production can be distinguished from economic growth in the long run. Variations in economic growth in the short run, termed by the Keynesian current as a *business cycle*, consisted of booms and busts in production that occur over a period, months, or years. The ups and downs in a business cycle are attributed to a number of causes, including, among others, the overexpansion and contraction of credit and international economic crisis. In contrast, the topic of economic growth is concerned with the long-run trend in production due to basic causes such as industrialization. Once it has resumed, the business cycle moves up and down, creating fluctuations in the long-run trend in economic growth.

The shift in the aggregate demand curve to the right or left should be caused by exogenous events. Therefore, the aggregate demand shifts to the right, emanating from the *IS* curve, as a function of the following exogenous impacts (Dutt and Skott, 2005): (i) increase in consumer spending; (ii) increase in investment spending on physical capital; (iii) increase in intended inventory investment; (iv) increase in government spending on goods and services; (v) increase in transfer payments from the government to the people; (vi) decrease in taxes levied; and (viii) increase in the exports and decrease in imports. Aggregate demand shifts emanating from the *LM*, as a function of the following exogenous impacts: (i) increase in the nominal money supply and (ii) decrease in the demand for money (in liquidity preference).

Analyzing the time series of the Brazilian economy, it is obvious that the GDP has been growing in the short run, due increasing in the consumption, increasing in the fixed investment (as compensation to the growth in consumption), increasing in government spending, and growth in trade balance. This characterizes income growth in the short run, which fluctuates and is not a sustained growth.

Consumption in the Brazilian economy has increased due to the sharp reduction in interest rates, which are still considered high. Its gradual decline has caused the expansion of domestic credit to finance consumption, especially for durable goods. A marked improvement in income for the population has also occurred, both due to increasing the integration of stranded workers in the labor market, due to heating of the economy, and due to the inclusion of the low-income population in consumption, as a function of the facilities of credits and the programs of income distribution implemented by the Brazilian governments in the last two decades. The wages increased and became higher. A higher real wage increases disposable income and the expending of consumers and also increases the government spending. In addition, the expansion of household consumption has caused an increase in gross fixed capital formation, which plays an important role in production in both the short and long run. The expansion of household consumption has also caused, in the short run, the expansion of GDP per capita, which, in its turn, causes the increase in consumption and fixed investments, as can be seen in the left graph of Figure 1. It is observed from this figure of OIRFs that, in the short run, exogenous innovation impulses in per capita GDP cause the development of stochastic trends on consumption per capita, on GDP per capita, and on the gross fixed capital formation per capita (numerically, these results can be seen in Table A.2).

However, for a growth in GDP that is characterized as sustained economic growth in the long run, it is also necessary that the economy grows on the side of aggregate supply. In the short run, some exogenous events would shift the *AS* curve to the right, causing the drop of the price level and increasing real GDP (Dutt and Skott, 2005). They are (i) a decrease in the wage rate; (ii) an increase in the physical capital stock; and (iii) technological progress (improvements in the knowledge of how to transform capital and labor into output). In addition, the following exogenous events can

shift the long-run *AS* curve to the right: (i) an increase in population, (ii) an increase in the physical capital stock, and (iii) technological progress.

Considering these aspects mentioned earlier, we find that the Brazilian economy also showed increases in several exogenous factors in the aggregate supply curve. It has had significantly increased in capital, especially foreign investments in new factories and investments in infrastructure, such as roads, telephones, and electricity generation and distribution. These types of investments made the inclusion of new products on the market, encouraging consumption and implementing technological progress. This investment in the supply curve occurred mainly after the 1990s, first due to privatization programs and later due to heating of the Brazilian consumer market. The Brazilian agribusiness sector also evolved intensively, due to the use of new technologies and improvements in knowledge and learning. The agribusiness today has a strong impact on Brazilian exports.

The aspects listed earlier, which impact *AD* and *AS* curves, may justify the positive signs found for the adjustments of GDP, in both the long and short run, as a function of the consumption, gross capital formation, trade balance, and the positive signs of the impact of GDP on GDP, in the short run. However, we found that, in the long run, the adjustment signal of GDP on GDP is negative. This characterizes that GDP is not in a situation of long-run growth, although it is growing in the short term and developing a stochastic trend, as observed in the right graphs of Fig. 1. So, the question becomes: How do we explain this behavior?

We found that the Brazilian economy has had a major impact on the aggregate demand curve; however, with regard to the aggregate supply curve, the Brazilian economy as a whole is deficient with regard to technological progress. Brazil has not devoted the necessary efforts toward improving the learning level of the educational system, which prevents the proper training of youth and their insertion in the labor market of advanced technologies. The quality of education with knowledge is an important asset that contributes to the generation of economic growth, which allows attracting companies of high technologies, according to an adequately prepared workforce. We believe that this is one of the factors which prevent a long-run sustained growth in the Brazilian economy and this is the reason for the adjustment coefficient of GDP on GDP being negative in the long run, as found in the study specified earlier.

Resuming, we supported that the household consumption, the fixed investment, and the trade balance were the main factors that caused the dynamics in short-run growth of the Brazilian economy. To make this conclusion clear, we analyze the interplay among per capita GDP, per capita consumption, per capita fixed investments, and per capita trade balance, considering the results of the equations of CONS, I, and TB.

Observing Table A.3, which describes the behavior in the short run, at a 5% significance level, the CONS increases due to positive impacts in the first and second lags of GDP, in the first and second lags of TB, in the first and second lags of itself, CONS, and in the first lag of I. It can be remarked that in the short run, the impacts on CONS are in the same direction (and with slightly different intensities) and in the same order of magnitude as the corresponding variables cause in the short run on the GDP (compare the right graphs in Figs. 1 and 2).

We also observe in Table A.3 (long-run behavior) that CONS, at a 5% significance level, positively adjusts its equilibrium level, in terms of positive impacts on itself (on lagged CONS), I, and TB. We can also observe in Table A.3 that in the long run, at a 5% significance level, the CONS fits into its equilibrium trend, reducing its level, due to positive changes in GDP. In the long run, the association between consumption and gross domestic product also stands out clearly; if we closely observe these two variables, they, practically, suffer the same impacts and in the same directions, with a few exceptions.

Our empirical results revealed for the Brazilian economy that per capita consumption is one leader variable that absolves the exogenous effects of the economy, impacting both demand side and supply side. The consumption transmits this exogenous effect to itself, to the gross capital formation (fixed investment), to the gross domestic product, and to the total transfers to social

security (as can be seen in the left graphs in the Fig. 2). Consumption is leading and driving the process of economic growth.

Then, from the results described, we support in this study that the per capita consumption is a leader variable that channels the exogenous impacts for per capita GDP, both on the aggregate-demand side (according to the *AD* curve, consumption in the *AD* side cause short-run impacts on per capita GDP) and on the aggregate-supply side (according to the *AS* curve, per capita fixed investment cause long-run impacts on per capita consumption and, consequently, on per capita GDP).

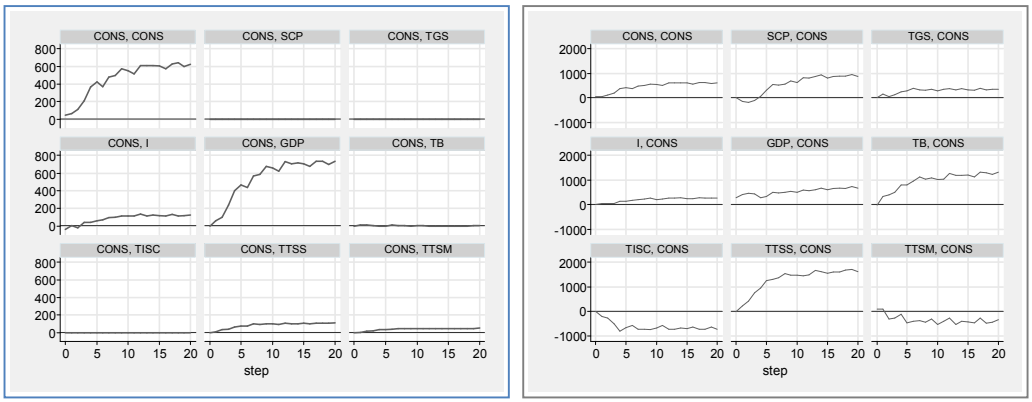

Figure 2: Ortogonalized Impulse Response Functions, OIRFs, related to the Consumption, CONS (the first variable is the impulse and the second variable is the response).

We also remark in Table A.3 that in the long run, at a 5% significance level, I is positively adjusting its equilibrium trend, in terms of positive impacts on CONS and TB, and I adjusts negatively its equilibrium trend, due to positive changes in GDP. In the short run, as can be seen in Table A.2, at a 5% significance level, the I decreases as a function of positive impacts in the first and second lags on TB, in the first and second lags of CONS, and in the first and second lags of itself, I; and it increases due to positive changes in GDP.

Investment in fixed capital is considered a major component in determining the GDP, employment, and gross domestic income of a country's economy, because it promotes an increase in productive capacity and the expansion of economic activity. In the Brazilian economy, the per capita fixed investments were priority performed by the private sector. Understanding the pace and pattern of investment in fixed capital becomes possible while understanding some features of economic activity. A few empirical studies have sought to identify the determinants of private investment in Brazil. Studies by Melo and Rodrigues (1998) and Ribeiro and Teixeira (2001) are frequently cited in the literature. The results of these studies show, inter alia, the importance of positive effects of the aggregate household consumption on investment. The study by Luporini and Alves (2010) empirically analyzed the determinants of private investment in Brazil. The results obtained suggest that increases in both aggregate income and economic activity have stimulated private investment in the Brazilian economy. They have observed lags between the decision making and the implementation of private investment, suggesting the hypothesis of the irreversibility of investment.

We observe in the description just provided that in the long run, consumption and fixed investment are being adjusted in the same direction, positively, due to positive impacts on the variables CONS and TB, and negatively, due to positive impacts on the variable GDP. Consumption and fixed investment are also impacted in the same direction in the short run, positively, due to positive impacts on the variable GDP, and they are impacted in a counter direction by CONS, TB, and I, being positively impacted in per capita consumption and negatively in per capita fixed investment.

In a similar way to the per capita consumption, our empirical results for the Brazilian economy have revealed that per capita fixed investment is also one leader variable that absolves exogenous

effects of the economy, impacting both the aggregate-demand side (as can be seen in the right graphs in Fig. 3, where the positive impact on I develops a positive trend in CONS and in GDP) and the aggregate-supply side (positive impacts of the long run on GDP). Thus, the investments are leading and also driving the process of economic growth.

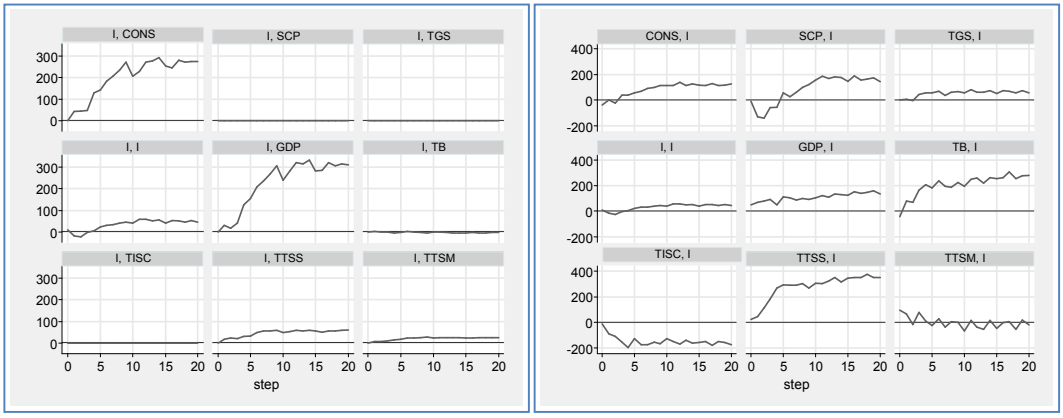

Figure 3: Ortogonalized Impulse Response Functions, OIRFs, related to the per capita gross fixed capital formation (investment), I (the first variable is the impulse, and the second variable is the response).

Our empirical results have shown that adjustment on per capita GDP, as a function of per capita GDP, is negative in the long run, but positive in the short run, which evolved to a stochastic trend of growth. In the same way, the adjustment on per capita consumption as a function of per capita GDP is negative in the long run and positive in the short run, evolving to a stochastic trend of growth. It should also be emphasized that positive variations in per capita GDP do not adjust per capita fixed investment in the long run, but the fixed investment is positively adjusted in the short run, as a function of innovation shocks on per capita GDP, which also evolved to a positive stochastic trend.

These similar behaviors of per capita consumption and per capita GDP in the short and long run, and the fact that the per capita GDP does not impact fixed investment in the long run, further reinforce the conclusion drawn earlier that the Brazilian economy is not on a path of sustained economic growth. In the sustained economic growth, the economy becomes expansionary as a function of its own growth, causing positive impacts on consumption and in fixed investment in the short and long run. In sustained economic growth, it systematically leads to investments in infrastructure and in new technologies on the aggregate-supply side, which enhance the consumption, thus increasing the gross domestic product and closing the circle of growth. Hence, we affirm that the Brazilian economy is simply on a stochastic trajectory of growth, sustained by the exogenous effect, essentially, on the aggregated-demand side.

As observed for the Brazilian economy, the per capita investment positively adjusted its level of long-run equilibrium, in terms of positive impacts on per capita consumption, and negatively adjusted, due to the positive impact of consumption innovations in the short run. The interplay between positive adjustments on per capita fixed investment in the long run and negative adjustment on per capita fixed investment in the short run are the factors responsible for the immediate (after three steps) reversing of short-run impacts to positive ones in the long run, developing a long-run stochastic trend, as can be seen in the right graphs in Fig. 3. Resuming, we note here that the per capita consumption is driving per capita fixed investment in the long run, on the aggregate-demand side and thus driving the increase in the GDP, making the economy expansionary.

The per capita fixed investment positively adjusts its level of long-run equilibrium, in terms of positive impacts on per capita trade balance, but in the short run, the per capita fixed investment is negatively adjusted, due to the positive impact of innovations on per capita trade balance, however, evolving to a positive stochastic trend. Again, this occurs due to the interplay between positive

adjustments on per capita investment in the long run and negative ones in the short-run, which causes the reversal immediately in the first step, from the short-run impact to being positive in the long run, developing a stochastic trend, as can be seen in the right graphs in Fig. 3. Thus, the long-run adjustment of the per capita fixed investment as a function of the per capita trade balance prevails, as expected. Therefore, positive values in the trade balance are capital inflows, which can turn into investments, depending on future expectations of the entrepreneurs. The consolidation of these investments over time takes place in a lag between the decision making and implementation of private investment.

Per capita fixed investment does not cause long-run investment on itself, however, causing negative impacts on itself, in the short-run investment, which reverts to a positive trend in the long run, after the fourth period, as can be seen in the right graphs in Fig. 3. We can associate this reversal with the reversal of per capita consumption impacts on per capita fixed investment (also in positive stochastic trend), which occurred similarly in the fourth year, as can be observed in the right graphs in Fig. 3. We see here the interaction between these two important exogenous effects that impact aggregate demand curves and aggregate supply.

We remark in Table A.3 that TB negatively adjusts in the long run, at a 5% significance level, with the lagged effective tax on goods and services, TGS, and with the lagged per capita total transfers to social security, TTSS. These relations between TB, TGS, and TTSS will be explained later. What needs to be emphasized is that TB was not impacted by the GDP, consumption, fixed investment, and also by itself. These facts also reinforce the conclusion drawn that the Brazilian economy is not on a path of sustained economic growth. There is no relationship between the performance of the economy in the domestic market and the performance of the external economy (i.e., there is no impact of fixed investments or of the GDP on the trade balance).

In Table A.2, in Appendix A, we remark that TB is presented in the short run as weak exogeneity, as it is not influenced in the short run, at a 5% significance level (or even 10% level of significance), by any of the variables, but current changes in TB affect, in the short run, other variables in the system equations, as can be seen in the graphs in Fig. 4, given next. The hypothesis that a variable is influencing the short-run development of the other variables of the system, but is not influenced by them, is called the *hypothesis of no levels feedback*, or *short-run weak exogeneity* (Hendry and Jucelius, 2001). Short-run weak exogeneity does not imply long-run weak-exogeneity, as will be explained later. Hence, we remark that the variable TB adjusts the short-run evolution solely as a function of the impact of random shocks of innovation, by the stochastic errors of the equation of TB.

With regard to the insignificance of short-run impacts on TB per capita, this shows how this variable is exogenous. The exogenous character of the TB variable is understandable, as its performance depends on several factors, among which are the planning of foreign trade, trade agreements, and supranational organizations that manage and promote international trade.

Ricardo (1817) introduced the comparative-advantage analysis (see also Adam Smith, 1776 and *Absolute and comparative advantage* in International Encyclopedia of the Social Sciences). In this work, the importance of specialization as a source of increased output and for obtaining competitive prices was emphasized. He treated international trade as a particular instance of specialization to export a part of the production. The cost of production is usually measured in terms of labor time, effort, and the technological level employed in the production. This measurement of the efficiency of production may result from differences in climate, worker training, or skill, in the amount of available tools and equipment, or due to numerous other reasons. The incentive to export and import can be explained in price terms, which will be affected by these changing flows of goods. Thus, loss of comparative advantage in many goods and exchange rate may significantly affect trade balance. So, it is not difficult to understand the issue of exogeneity in the short run with regard to the international trade of the Brazilian economy, as international trade depends not only on the performance of the economy, but also on the positioning of this economy in terms of the efficiency of international economies. This justifies the exogeneity of international trade, a fact that is capitated by the model developed here.

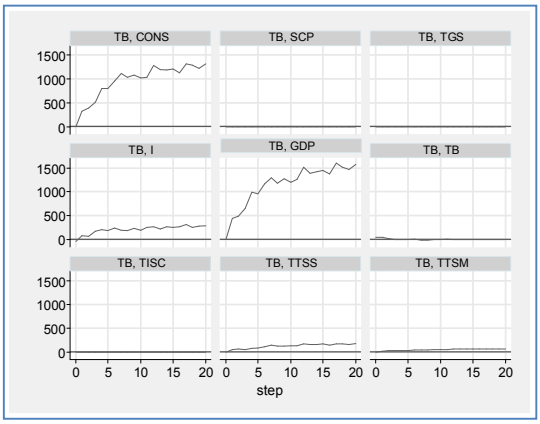

Figure 4: Ortogonalized Impulse Response Functions, OIRFs, related to per capita trade balance, TB (the first variable is the impulse, and the second variable is the response).

Current changes in the variable TB affect other variables in the system equations, as can be seen in Table A.3 for long-run adjustment and in Table A.2 for short-run adjustment. In the long run, TB positively impacts the GDP, TTSS, TISC, CONS, I, and TBS. In the short run, TB positively impacts the GDP in the first and second lag, the SCP in the second lag, the CONS in the first and second lag, and negatively, the I in the first and second lag. This behavior can be seen in the graphs in Fig. 4.

It is observed that the variable TB sets up a dynamic in the Brazilian economy, because this variable, in the long run, is an important element for the establishment of economic growth (i.e., if TB remains positive, because it can be either positive or negative). In the long run, it causes a positive impact on GDP, on I, and on CONS, the main variables that result in growth of the economy. In addition, TB generates taxes and transfers, positively impacting TISC (income tax and social contribution on net income) and TGS, tax on goods and services, and it also positively impacts on TTSS, through increases in revenues.

7.4 Results analyses of per capita variables: TTSM and TTSS

We can observe in Table A.3 that no variable causes long-run adjustment in the variable TTSM, because all coefficients of the nine variables included in the model are insignificant, at a 5% significance level, even at 10%. However, we can also observe that, at a 5% significance level, the variable TTSM negatively influences the development of SCP in the long run and positively influences I, also in the long run. The hypothesis that a variable is influencing the long-run development of the other variables of the system, but is not influenced by them, is called the *hypothesis of no levels feedback*, or *long-run weak exogeneity* (Hendry and Jucelius, 2001).

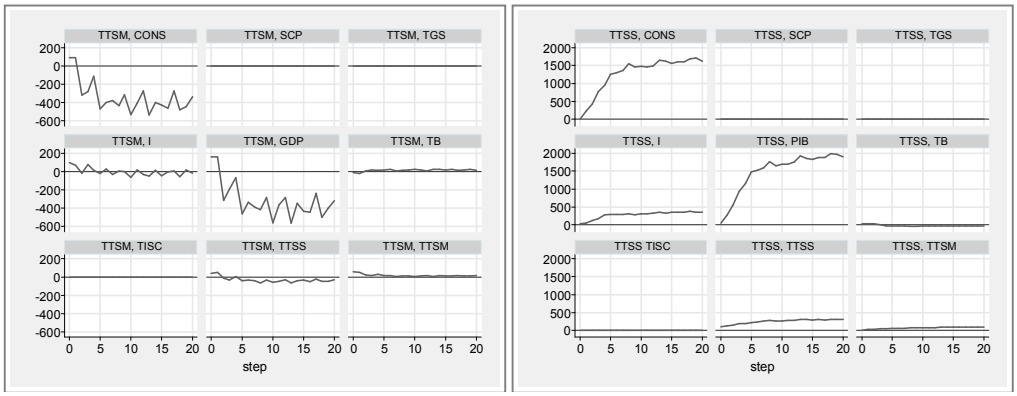

Figure 5: Ortogonalized Impulse Response Functions, OIRFs, related to the TTSM, the total transfers to states and municipalities, and TTSS, the total transfers to social security (the first variable is the impulse, and the second variable is the response).

TTSM is also not influenced in the short run, at a 5% significance level, by any of the variables, as can be seen in Table A.2, which is influenced only by the two-lagged TISC variable, at a 10% significance level. Thus, we can say that the variable TTSM adjusts the trajectory of evolution solely as a function of the impact of random shocks of innovation, by the stochastic errors of the equation of TTSM. However, positive current changes in this variable affect, in the short run, other variables in the system equations, as can be seen in Table A.2. In the short run, TTSM negatively impacts the GDP, positively impacts the SCP, negatively impacts the CONS, and negatively impacts the I, as can be seen on the left side of Fig. 5. Thus, the TTSM is also presented in the short run as weak exogeneity, as it is not influenced in the short run, but current changes in this variable affects, in the short run, other variables in the system equations.

In order to analyze the behavior of the TTSM, first we emphasize that the tax on goods and services, TGS, the principal donor to transfers to states and municipalities (TTSM), includes (i) the value-added Tax ICMS, a sale tax on goods and services; (ii) the federal tax on industrialized products (IPI), a value-added tax (VAT), is paid by manufacturers on behalf of their customers; (iii) personal and corporate income tax; (iv) the ISS burden tax, charged to the municipalities, is ruled by the Constitution; (v) the social contributions that the tax bases are gross corporate revenue, such as CPMF, FINSOCIAL/COFINS, PIS/PASEP, and other kinds of social contributions; and (vi) federal taxes levied on financial transactions (*IOF*).

The total transfers to states and municipalities, TTSM, include the participation amount of states and municipalities in the federal taxes and also in the development funds, constitutionally established, the total amount of the VAT ICMS (a tax burden charged to the states), and the total amount of tax on services, ISS (a burden tax charged to the municipalities). The TTSM also includes the subsidies granted by the federal government to private and state corporates as compensations for the state shares and the transfers, as results of agreements and voluntary, to finance the decentralized provision of public services, especially in education, social programs, to supplement the social revenue and the health services, under the responsibility of states and municipalities.

In particular, for the value-added tax ICMS, the states and the federal district are empowered by the Constitution to institute and collect taxes. The ICMS is the most important tax levied in the country. The states have considerable autonomy to set their VAT rates and bases. Thus, due to this freedom of the states, they establish a horizontal tax competition and react strongly to changes in their neighbors, which provide an exogeneity to ICMS. In addition, the ISS burden tax, charged to the municipalities, is ruled by the Constitution; however, it also has a margin to establish a horizontal competitive taxation with the neighboring municipalities, considering that the rates may vary between 2% and 5%. This characteristic of the ISS makes it an exogenous tax. Therefore, these revenues that partially sustain the TTSM provide them with exogenous features, with the behavior of random chocks, which do not clearly characterize the origins of the impact of explanations, coming from some specific variables.

Voluntary agreements are subsidies granted by the federal government to private and state corporates. The transfers to finance the decentralized provision of public services in education and social programs to supplement the social revenue and health services are also voluntary agreements. The voluntary agreements depend on the policies implemented by the governments in power, which are also characterized as exogenous behavior. Hence, we remark that most of the transfers included in TTSM come from sources possessing exogenous features, therefore being presented as exogenous random shocks, a fact that is captured by the model, as described earlier.

TTSM positively impacts I in the long run and negatively impacts it, in the short run, as observed in GDP, CONS, and I. The global impact of TTSM on I is characterized by the interplay between the positive impact in the long run (that is also manifested in the short run) and the negative impact in the short run. Both these impacts with almost the same magnitude vanish and die immediately (in the first two steps), without making any long-run effectiveness, as shown in the graphics in the right of Fig. 3. This shows that the total transfers to states and municipalities restrict

the GDP growth on the demand side, restricting the consumption, without virtually any important impact on investment.

In order to analyze the behavior of the impacts of TTSM on CONS, I, and GDP, as already emphasized, we consider the fact that the tax on goods and services, TGS, is the principal donor to the transfers to states and municipalities. The large part of the TGS is transferred to the states and municipalities, supporting the administrative machine and the expenditure of the states and municipalities. As emphasized, these transfers to the states and municipalities, via TTSM, are, in its principal part, resources from the VAT ICMS and a part less significantly, from the VAT IPI and personal income and corporate income taxes, as required by the law, which also support a portion to compose the fund of the development of states and municipalities. These resources are transferred to the states and municipalities; a large part is meant to sustain the administrative machine of the states and municipalities in the three powers: executive, judiciary, and legislative. Until a short time ago, at the beginning of the 2000s, governments of states and municipalities and state and municipal legislatures were not assuming any responsibility for their administration, opening avenues for corruption. This situation began to change with the fiscal responsibility law[10] imposed on states and municipalities, beginning in the 2000s.

We believe that the misuse of public administration resources in states and municipalities is the main exogenous factor, as the transfers to states and municipalities have had negative impacts on per capita consumption, per capita fixed investment, and per capita GDP, thereby developing a negative stochastic trend on both consumption and GDP in the long run, and also a negligible negative stochastic trend on fixed investment. Positive impacts of TTSM on consumption, fixed investments, and GDP were expected, given that they are simply transfers of appeal which should impact the regional development, in both states and municipalities. In our analysis, we also emphasize that our data are from 1970 to 2010, involving a long period of the misuse of resources in the administrative of sub-governments.

Before looking at the adjustment relationships in TTSS, it should be noted that TTSS includes the transfers to the National Institute of Social Security (INSS), in order to guarantee retirements, pensions, and health insurances, with collections suitable for this purpose, and the transfers to the social and health programs, which are directly dependent on the federal government, especially the program SUS (unified health system) and the revenue to supplement the social programs (family allowance, zero hunger, and others). Transfers to TTSS are established largely from levies on payroll, including SCP, the effective social contribution to social security, and by complementation of government transfers, whose resources come from the effective tax on goods and services, TGS, as social contributions, such as FINSOCIAL/COFINS, CSSL, PIS/PASEP, and other kinds of social contributions.

In the long-run adjustment, TTSS, the per capita total transfers to social security, is influenced at a 5% significance level, as can be seen in Table A.3, positively adjusting its equilibrium level, by positives changes in the variables, in GDP, CONS, TB, and I. First, we note that the growth of TTSS transfers can be done by increases in tax rates or change in tax bases, but this can be captured by the model only as innovation shocks. Second, the revenues of social contributions can also increase by changes in exogenous variables that positively affect the aggregate-demand side and aggregate-supply side of the AD/AS curves, as a consequence, positively impacting the gross domestic product, GDP. As analyzed earlier, CONS, TB, and I are the principal exogenous variable of the AD and AS equations, positively impacting the aggregate-demand and aggregate-supply sides, which cause significant positive changes in the GDP. As we will also analyze later, the taxes

[10] The Fiscal Responsibility Law (Supplementary Law 101), issued on May 4, 2000, marks the introduction of a legal requirement in the management of public finances buoyed by the responsibility of managers of all public authorities, public bodies, and entities of the federation, representing progress in managing financial resources that taxpayers collect from public coffers. The responsibility for fiscal management requires a planned action and transparency, which prevent the risks and correct deviations that may affect the balance of public accounts, using mechanisms aimed at achieving the target results in the realization of revenue and expenditure execution, according to limits and conditions for the resignation of revenue and increased expenses.

SCP and TGS (the principal feed resource of TTSS) impact the growth of their revenues, as a function of the increase in the GDP. Thus, it is natural to expect that these variables (discussed earlier) positively impact the TTSS, in the long run, indicating the correct direction of impacts in TTSS.

As also noted in Table A.2, in Appendix A, TTSS is presented in the short run as weak exogeneity, as it is not influenced in the short run, at a 5% significance level, by any of the variables, with only wellness being influenced by the lagged one of the variable SCP, at 9.8% significance; thus, it cannot reject the hypothesis $H_0: \alpha\beta' = 0$. Hence, we remark that the variable TTSS adjusts the short-run evolution solely as a function of the impact of random shocks of innovation, by the stochastic errors of the equation of TTSS. However, current changes in the variable TTSS affect other variables in the system equations, in both the short and long run, as can be seen in Tables A.2 and A.3, and on the right side of Fig. 5, described earlier.

Positive current changes in TTSS, in the long run, positively affect the CONS, I and SCP, and negatively, the TISC and TB. Positive current changes in TTSS positively impact, in the short run, in the first lag, the CONS and GDP, and in the second lag, SCP.

The positive adjustments on consumption, in both the long run and short run, on fixed investment in the long run and on GDP in the short run, due to positive adjustments on total transfers to social security, confirm that TTSS is a true system of income distribution, establishing strong positive impacts on consumption, on investments, and on GDP, developing positive trends, as can be seen in the right graphs of Fig. 5, leading to continued growth. Thus, we conjecture that the TTSS are simply payments which are transferred to feed the governmental programs that benefit the population, which do not constitute a part of government expenditure, but distributions of tax revenue on the economy, and cause positive stochastic trends on growth of the economy, as captured by our model.

We still remarked that positive changes in the lagged TTSS causes, in the long run, a diminishing level with regard to TB. As already emphasized, TTSS is a true system of income distribution, establishing positive impacts on consumption and on investments, leading to continued growth of GDP; thus, TTSS heats the consumption and the investment, then increases imports, and, consequently, reduces the effectiveness of the trade balance.

It was emphasized earlier that positive changes in TTSS positively affect, in the long run, the SCP and negatively, the TISC, and also positive changes in TTSS positively impact, in the short run, the SCP. It was also emphasized that the positive impacts on the variable TTSM positively adjust the SCP in the short run and negatively adjust in the long run. In the next section, we will analyze the relations of these impacts.

7.5 Results analyses of effective variables: TISC, SCP, and TGS

We remark in Table A.3 that the equation SCP, the first difference of the effective social contribution on payroll, is positively adjusted in the long run, at a 5% significance level, with positive changes in GDP (per capita gross domestic product), with positive impacts on TTSS, and with positive impacts on itself (social contribution on payroll). The equation SCP is negatively adjusted in the long run, at a 5% significance level, with positive changes in TTSM.

We observe in Table A.2 that in the short run, the effective SCP increases, at a 5% significance level, as a function of positive impacts in the second lag of TTSS, due to positive variations in the first and second lags of TTSM, and due to positive changes in the second lag of TB. In the short run, the effective SCP decreases as a function of positive impacts in the first and second lags on GDP.

The GDP per capita positively impacts the SCP, in the long run, and negatively impacts it in the short term. As can be observed in the left graphs of Fig. 6, in the short run (two steps), the GDP per capita negatively impacts the SCP, reverts to the positive, and evolves into a long-run stochastic trend. We again note the interplay between long-run and short-run impacts, and the sum of them evolves into a long-term positive trend, which is in the right direction. It is natural to expect that tax revenue grows with national disposable income, or gross domestic product.

Likewise, we observed that the TB positively impacts the SCP, in the short run. The trade balance is an exogenous factor that impacts the aggregate demand side by imports, increasing the level of consumption of goods and services and generating taxes; and also, the trade balance impact on the aggregate-supply side by exports, creating new jobs in trade as well as in production. Therefore, we see that through positive impacts on the trade balance, positive impacts occur in the aggregate wage bill of the economy and, consequently, on the revenue of SCP, which is a tax that is essentially based on the payroll.

The TTSS causes a positive impact on SCP, in both the short and long run. Hence, an association is observed between these two impacts that causes the development of a positive stochastic trend in the long run. To understand this behavior, it is necessary to also recall that the TTSS constitutes a program of income distribution due to payments related to retirements, pensions, and social assistance programs of the government. Thus, these transfers are also a program of the devolution of income, placing it in different regional poles, therefore being an impact factor of regional economic growth, which increases the household consumption and creates jobs, thus positively impacting the economy's aggregate wages, and, indirectly, the revenue of SCP.

We have also noted that TTSM negatively impacts SCP in the long run and positively in the short run. The association between these two impacts, in the long and short run, generates a positive stochastic trend of the long-run, as shown in the left graphs of Fig. 6. As explained earlier, these transfers are also transfers of tax revenue to the regional poles of states and municipalities, as a large part to supply salaries for workers of the public sectors. Despite the historic misuse of these resources in the states and municipalities, they also play a role in income distribution, with wage impacts in various regions of the country. Thus, TTSM should also positively impact the revenues of the tax bases of SCP, as identified by the model.

Finally, we see that in the long run, social contributions to payroll, SCP, positively impact themselves. We observe that the impact of SCP on itself constitutes a stochastic trend, as shown in the left graphs of Fig. 6. It is natural that a tax impacts itself. We can imagine that growth in the revenue of a tax may somehow have a positive impact on itself due to the improvement in the process of supervision and/or growth of the tax base, which is tied to a procedure of tax accounting. Therefore, we cannot dismiss the fact that taxes positively impact themselves.

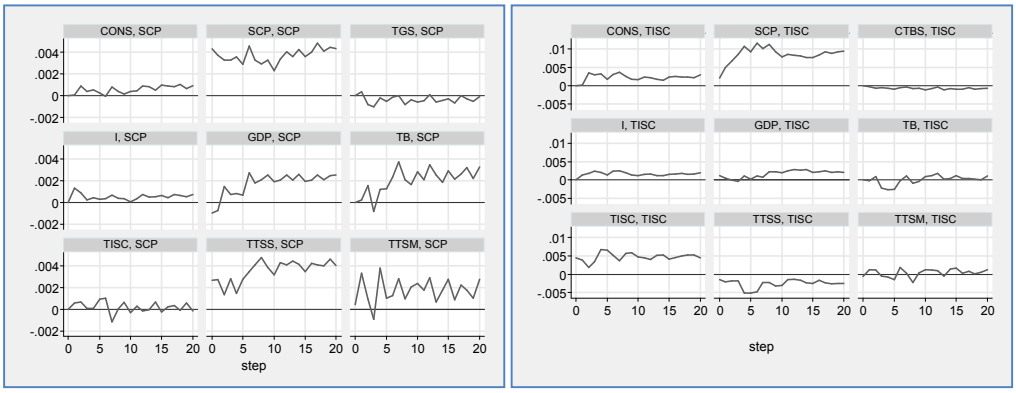

Figure 6: Ortogonalized Impulse Response Functions, OIRFs, related to the *SCP*, social contribution to payroll, and TISC, income tax and social contribution to net profit (the first variable is the impulse, and the second variable is the response).

We remark in Table A.3 that the variable TISC (Tax Income and Social Contribution on Net Income) is positively adjusted in the long run, at a 5% significance level, with positive changes in the following lagged variables: itself (TISC), CONS, I, TB, and GDP; and negatively adjusted in the long run, at a 5% significance level, with positive changes in TTSS. We also observe in Table A.2 that in the short run, at a 5% significance level, the effective TISC increases as a function of positive impacts in the first lag of TGS, and also increases due to positive impacts in the second lag on itself (TISC).

We observed that, in the long run, main variables of growth of the Brazilian economy (GDP, CONS, I, and TB) positively impact the tax TISC. The arguments that prevail here were already presented with regard to the analysis of the equation of social contributions to payroll, where growth on GDP, CONS, I, and TB generate new jobs, which increases the aggregate wage bill and net profits of businesses, increasing revenues for income tax and net profits, TISC. Therefore, the model implemented here captures the correct direction of the impacts of these variables on TISC.

We see also that, in the short run, social contributions to payroll, SCP, positively impact TISC (Tax Income and Social Contribution on Net Income). We observe that the impact of SCP on TISC constitutes a positive stochastic trend, as shown in the right graphs of Fig. 6. Taxes with similar tax bases may impact each other, as SCP on TISC. The tax base of the social contribution to payroll coincides, partly, with the tax base imposed on income and net income, given that a significant part of the latter is also taxed with base on wage income. Thus, in this situation, the model can identify the exogenous changes in the revenue of the tax base, which are similar in these two kinds of aggregate taxes.

We also observed that growth in income tax and social contribution to net income, TISC, positively impact TISC, in both the long and short run, developing a positive stochastic trend, as shown in the right graphs of Fig. 6. As already emphasized earlier, this causality relation can be due to the improvement in the process of supervision and/or growth of the revenue of the tax base, which are tied to a procedure of tax accounting that allows for maintaining this effect.

The total transfers to social security per capita, TTSS, cause a negative impact on income tax and social contribution, TISC, in the long run, as can be seen in the development of a negative stochastic trend, in the right graphs of Fig. 6. Due to the characteristics of the distribution of income of TTSS transfers, we should expect positive results, as already argued earlier, because these transfers are distributions of income in regional and municipal poles. However, we should emphasize that these transfers are mainly due to the low-income population, who practically do not contribute to the taxation of income taxes, as they are included in the revenue range of free tax charge. Thus, despite the TTSS increasing household consumption, creating jobs and regional income, they do not positively affect the revenue of the TISC; on the contrary, they negatively affect it.

We remark in Table A.3, at a 5% significance level, that the variable TGS (effective tax on goods and services) is positively adjusted, in the long run, with positive impacts on the following lagged variables: itself (TGS), CONS, I, TB, and GDP. The same arguments that have already been extensively presented prevail here, where growth with regard to GDP, CONS, I, and TB positively impact the aggregate-demand side and aggregate-supply side, intensifying the marketing of products and services and, therefore, increasing the TGS revenue, because the tax base of the TGS includes sales taxes and tax on gross income, factors that intensify with consumption, fixed investments, trade balance, and gross domestic product. Thus, the model captures the correct direction of the impacts of these variables on TGS. We also observed that TGS positively impacts itself (TGS), in the long run. As already emphasized, this is because the improvement in the process of supervision and/or growth of the revenue of its tax bases is tied to a procedure of tax accounting that allows for maintaining this effect.

We remark in Table A.2 that TGS is present in the short run as weak exogeneity, as it is not influenced in the short run, at a 5% significance level (or even a 10% significance level), by any of the model variables; but current changes in this variable affect, in the short run, other variables in the system equations, as will be described later. Thus, the variable TGS adjusts its trajectory of evolution as a function solely of the impact of random shocks of innovation, by the stochastic errors, on the equation of TGS. As emphasized earlier in Section 7.4, a large part of the revenue of TGS has exogenous features, along with the behavior of random shocks, which do not clearly characterize some of the origins of impact explanations, and also do not characterize the variables from which the causalities are derived.

We now consider the results of the dynamic impacts of tax variables on GDP, CONS, I, and TB. First, we remark in Table A.3 that the variable TB is negatively adjusted in the long run, at a

5% significance level, with a positive impact on the effective tax on goods and services, TGS. This is a correct sign of impact (increasing in TGS causes negative changes in TB), as the effective tax on goods and services impacts the gross revenue of the corporations, as emphasized earlier. It includes the VAT IPI (excise tax), the VAT ICMS (sales tax on goods and services), the ISS (service tax), and the social contribution to the gross revenue of corporates (as PIS/PASEP, FINSOCIAL/COFINS, and CPMF). Thus, the negative impact of the TGS on TB, in the long run, provides evidence that the tax burden, charged by the tax on goods and services, is a constraint to the external performance of the Brazilian economy, making the Brazilian export products less competitive.

We also observe in Table A.3 that the GDP, CONS, and I, at a 5% significance level, are negatively adjusted in the long run, in terms of positive impacts on the lagged TISC, and they are positively adjusted in the long run, in terms of positive impacts on TGS and SCP.

Table 2: Relationship among impulses in tax variables (TISC, SCP, and TGS) and the response variables GDP, CONS, and I.

Impulse Variable / Response Variable	Long run			Short run		
	TISC	**SCP**	**TGS**	**TISC**	**SCP**	**TGS**
GDP	Negative	Positive	Positive	Negative	Negative	Negative
CONS	Negative	Positive	Positive	Negative	Negative	Negative
I	Negative	Positive	Positive	Negative	Negative	Negative

We remark in Table A.2 that in the short run, at a 5% significance level, the GDP decreases as a function of positive impacts in the first lag of TGS, in the first lag of SCP, and in the second lag of TISC. The CONS also decreases in the short run, due to positive changes in the first lag of SCP, due to positive changes in the second lag of TGS, and due to positive changes in the second lag of TISC. The I is negatively adjusted in the short run, due to positive changes in the first lag of SCP, in the first and second lag of TGS, and in the first and second lags of TISC.

We observe in the description just provided that in the long run, GDP, consumption, and fixed investment are being adjusted in the same direction, positively, due to positive impacts on the variables SCP, and TGS and, negatively, due to positive impacts on the variable TISC. GDP, consumption, and fixed investment are also impacted in the same direction, in the short run, negatively, due to positive impacts on the variables SCP, TGS, and TISC. These results are resumed in Table 2.

With regard to income taxes and social contribution to net income, TISC, we remark in Table 2 that in the long run, positive adjustments in the trend of the TISC causes negative adjustments in the trend of GDP, consumption, and fixed investment. We also observe in Table 2 that in the short run, positive shocks of exogenous innovation on TISC variables also cause negative impacts on GDP, consumption, and fixed investment, developing negative stochastic trends, as can be observed in the right graphs of Figs. 1, 2, and 3, respectively, for GDP, consumption, and fixed investment. Thus, we conclude that an increase in TISC serves as a constraint to the expansion of the economy in the short and long run, restricting the consumption and the fixed investments, consequently, inhibiting the GDP growth.

To understand some aspects of the results presented in the earlier paragraph, we emphasize that taxes first restrict consumption and investment, then the GDP. The TISC is personal and corporate income tax and social contribution of corporates on net profit that restricts personal and corporate income and, hence, personal consumption and corporate investments. More precisely, the TISC is restraining consumption on the demand side and investments on the supply side, what justifies, in the short and long run, the negatives adjustments of GDP, due to positive impacts on the TISC.

With regard to tax on goods and services, TGS, we remark in Table 2 that in the long run, positive adjustments in the trend of the TGS cause positive adjustments in the trends of GDP, consumption, and fixed investment. In the short run, we also observe in Table 2 that positive shocks of exogenous innovation on TGS variable negatively adjust the GDP, consumption, and fixed

investment; however, some steps after the positive impulse on TGS, the response on GDP, consumption, and fixed investment variables developed positive stochastic trends, as can be observed in the right graphs of Fig. 1, 2, and 3. It is observed here that the interaction between exogenous shocks innovation on TGS in the short run also enables the adjustments on GDP, consumption, and fixed investment in the long run.

As an example, we can suppose that interest rates fall and the credit for financing domestic consumption increases as a function of liquidity in the international economy. This availability of funding heats consumption on the demand. The industry also assumes, as a function of the liquidity of the international economy, long-run financing at low cost to its investments and launching new products in the market, with new technologies, stimulating demand. In summary, consumption is intensified on both the aggregate-supply side and the aggregate-demand side. This has, as a result, impacted the growth of GDP and also on the taxes, TGS, as the most part of these taxes are VAT taxes that, as such, increase with consumption. In this example, the exogenous effect that positively impacts GDP growth also impacts TGS, and the results may be a positive impact of TGS on GDP growth in the long run.

It is difficult to understand how tax can cause growth in the long-run. However, for example, in the Brazilian economy, with regard to the social contributions of PIS/PASEP, a component of the TGS, at least 40% of this social contribution is administered by the National Bank of Development (BNDES), which finances technological development in industries and industrial facilities in the country. This characteristic of the PIS/PASEP social contribution as funder of the Brazilian industry by TGS constitutes the exogenous factor that may positively impact, in the long run, the GDP, consumption, and fixed investment and may contribute to the development of a positive stochastic trend, in the long run.

With regard to the social contribution to payroll (SCP), as can be seen in Table 2, in the long run, it causes positive adjustments to GDP, consumption, and fixed investment; and it also causes negative impacts, in the short run, on GDP, consumption, and fixed investment. Thus, we can observe with this feature the interplay between the SCP adjustments in the short and long run, which add up and cause a reversal from negative impacts in the short run to positive impacts in the long run, developing long-run stochastic trends, as can be seen in the right graphs of Fig. 1, 2, and 3, respectively, for GDP, consumption, and fixed investment. In these figures, we observe that the innovation in the step zero on SCP causes negative impacts on GDP, consumption, and fixed investment, which evolve negatively until the fourth year. However, after the fourth period, the impacts on GDP, consumption, and fixed investment become positive and grow into positive stochastic trends; that is, SCP taxes cause a reduction in GDP, consumption, and fixed investment in the short run and cause growth in GDP in the long run, developing positive stochastic trends for these variables. We verify here that adjustments in the long-run economy also have an impact in the short run.

We return here to the question as to how tax can cause growth in the long run. Once more, we emphasize that social contribution to payroll (SCP) consists of social contributions toward wages and payroll services paid by the employees (the corporate makes the same amount of contribution as the employees), established with the purpose of financing the social security of the National Social Security Institute, INSS, and also corporate contribution to the fund guarantee workers, FGTS. The FGTS component of the SCP, which consists of the corporate contribution to the fund guarantee workers, FGTS, is a fund by which the worker is rescued at the time of the loss of a job. This fund is administered by the Federal Savings Bank, and it is intended to finance housing for low-income population and the basic treatment of sewage for the Brazilian cities, being the big driver of the building construction industry in the country. We believe that the characteristics of income distribution by social security and the financing of the Brazilian industry by SCP constitute the exogenous factor that positively impacts, in the long run, the GDP, consumption, and fixed investment in the Brazilian economy.

We have observed that the Tax Income and Social Contribution to Net Income (TISC) constitute a constraint to the growth of the economy, in the short and long run. However, the Tax on

Goods and Services (TGS) and the Social Contribution on Payroll (SCP) restrict the economic growth in the short run (in the first four years after positive exogenous innovations), but implement the growth in the long run. These features are the behavior outlined by the results of the econometric model structured in this study. We will discuss the impacts of these aspects in the next section.

7.6 Analysis of elasticity of the model variables

In the analysis presented in the previous section, we were concerned only with the direction of the impacts occurring between the variables of the model. Therefore, we will show in this section, in relative terms, the order of magnitude of impacts that occurred among the main variables of the model. All estimates of elasticities presented in this study were calculated from long-run equilibrium equations.

Figure 7 shows the elasticity evolutions in the long run of per capita GDP, per capita consumption, and per capita fixed investment, which are related with the other variables of the model, over the period of analysis. Figure 8 also shows the elasticity evolution in the long run of per capita trade balance, TB, related to the tax on goods and services, TGS, and total transfer to social security, TTSS. Table 3 shows the descriptive statistics of the elasticities of per capita GDP, per capita consumption, and per capita investment, with regard to all the other variables of the model and per capita trade balance related to the tax on goods and services, TGS, and total transfer to social security, TTSS.

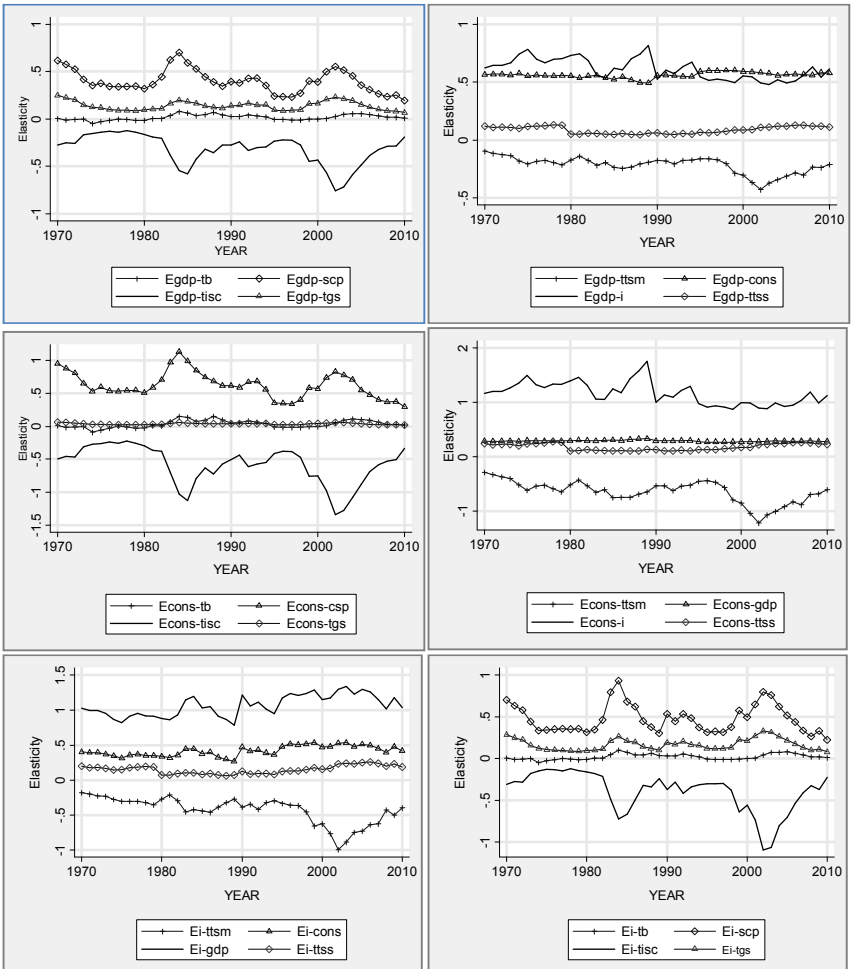

Figure 7: Elasticity in the long run of gross domestic product, GDP, consumption, CONS, and fixed investment, I, related to the other variables.

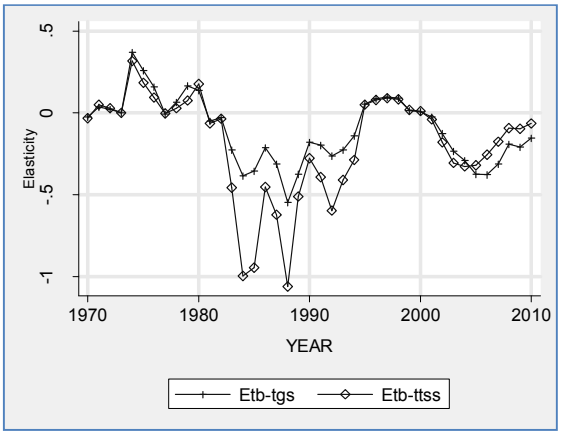

Figure 8: Elasticity in the long run of trade balance, TB, related to the tax on goods and services, TGS, and total transfer to social security, TTSS.

Table 3: Elasticity in the long of gross domestic product, consumption, and trade balance, related to the other variables (Ei-j is the elasticity of the variable i, related to the variable j).

VARIABLE	MEAN	STD. DEV.	MIN	MAX
$E_{gdp-ttsm}$	-0.2165	0.0722	-0.4252	-0.0962
$E_{gdp-ttss}$	0.0883	0.0313	0.0452	0.1343
$E_{gdp-tisc}$	-0.1973	0.1232	-0.5449	-0.0566
$E_{gdp-scp}$	0.3816	0.1197	0.2527	0.6743
$E_{gdp-tgs}$	0.0888	0.0340	0.0447	0.1782
$E_{gdp-cons}$	0.5615	0.0247	0.4928	0.6015
E_{gdp-i}	0.6145	0.0901	0.4795	0.8168
E_{gdp-tb}	0.0361	0.0615	-0.1013	0.1655
$E_{cons-gdp}$	0.2889	0.01324	0.26920	0.32854
$E_{cons-tb}$	0.0334	0.0565	-0.0879	0.1534
$E_{cons-tisc}$	-0.5814	0.2899	-1.3365	-0.2248
$E_{cons-ttsm}$	-0.6454	0.2075	-1.2238	-0.2853
$E_{cons-ttss}$	0.1771	0.0613	0.1027	0.2749
E_{cons-i}	1.1620	0.2116	0.8740	1.7498
$E_{cons-scp}$	0.6238	0.1959	0.2941	1.1321
$E_{cons-tgs}$	0.0369	0.0124	0.0171	0.0654
E_{i-ttsm}	-0.4249	0.1922	-0.9935	-0.1773
E_{i-ttss}	0.1502	0.0588	0.0622	0.2583
E_{i-tisc}	-0.3934	0.2422	-1.0968	-0.1232
E_{i-scp}	0.4737	0.1683	0.2256	0.9282
E_{i-tgs}	0.1678	0.0685	0.0775	0.3304
E_{i-cons}	0.4162	0.1529	0.7830	1.3338
E_{i-gdp}	1.0627	0.1529	0.7830	1.3338
E_{i-tb}	0.0212	0.0343	-0.0452	0.1018
E_{tb-tgs}	-0.1044	0.2019	-0.5479	0.3718
$E_{tb-ttss}$	-0.1888	0.3212	-1.0624	0.3164

It can be observed from the upper right graphics of Fig. 7 that per capita consumption and per capita fixed investment have strong impacts on GDP. As shown by the descriptive statistics of these results in Table 3, a 1% increase in per capita fixed investment causes an average increase of 0.61% in per capita GDP, varying from 0.48% to 0.82%; and an increase of 1% in per capita consumption causes an average increase of 0.56% in GDP, ranging from 0.49% to 0.60%. These results have shown that growth in household consumption and private fixed investment established the dynamics of economic growth, with significant impacts on the growth of the gross domestic product. In the upper right graphics of Fig. 7, the elasticity evolutions of per capita gross domestic product related to the per capita transfers in the long run, TTSM and TTSS, can be observed. According to Table 3, the impact of 1% on per capita TTSM and on per capita TTSS cause, in average, on per capita GDP, respectively, -0.22% (with a minimum of -0.42 and a maximum of -0.10%) and 0.09% (with a minimum of 0.045 and a maximum of 0.13%). These results show that TTSM has a strong negative impact and TTSS has a moderately positive impact on the growth of GDP. We also observe in the upper left graphics of Fig. 7, the elasticity evolutions of per capita gross domestic product related to the effective taxes and per capita trade balance. As observed in Table 3, in the long run, for a 1% increase in the per capita trade balance causes an average increase of 0.04% in per capita GDP, ranging from -0.10% to 0.16%. As also observed in Table 3, in the long run, the effective impact of 1% on TISC, SCP, and TGS cause, in average, on per capita GDP, respectively, -0.19% (with a minimum of -0.56% and a maximum of -0.06%), 0.38% (with a minimum of 0.25% and a maximum of 0.68%), and 0.09% (with a minimum of 0.05% and a maximum of 0.18%). These results demonstrated that the income tax and social contribution to net income have a strong negative impact on the growth of domestic product.

It can be seen in Fig. 7 (and Table 3) that the elasticity evolutions in the long run of per capita consumption, per capita fixed investment, and per capita GDP are related with the other variables in the model, manifested in a similar manner. However, the elasticities of per capita consumption and per capita fixed investment are less inelastic than the corresponding elasticities with regard to the gross domestic product (except that it is made for the elasticities of consumption with regard to TB and TGS, which are the same magnitude order of GDP elasticities). This shows that the dynamic growth stimulus to consumption and fixed investment is less restrictive than the stimulus for the growth of gross domestic product, as for the growth on GDP; a coordinated process on both aggregate-demand side and aggregate-supply side is demanded for growth, as discussed by Diamond (1982).

Finally, in Fig. 8, the evolution of the trade balance elasticities is observed, and as resuming in Table 3, we find that for a 1% increase in taxes on goods and services, the trade balance is negatively impacted, in average, -0.10%; and for a 1% growth in transfers to social security, the trade balance is negatively impacted, in average, -0.19%. The model shows that these two variables are factors that limit the behavior of the trade balance.

Certain aspects related to the results presented earlier deserve to be highlighted. First, the strong restrictive impact of taxes on income and social contribution on net income, in the long run, on gross domestic product, on consumption, and on fixed investment. Obviously, these taxes are a limiting factor to the growth of the Brazilian economy. Second, the strong impact in relative values, of fixed investment on consumption and on gross domestic product, can be seen in Table 3. These facts are important elements that result in the increase in the Brazilian economy. The Brazilian economy has a deficit of private savings and, possibly, is being supplemented by foreign investment, mainly by foreign direct investment and portfolio investment. Third, the small positive impact of trade balance on consumption, on fixed investment, and on gross domestic product. In our opinion, these aspects of high inelasticity of TB are related to the poor performance of the Brazilian trade balance, which is maintained lower, in real terms, than the growth on gross domestic product, due to not having a significant agenda related to exports of products of a high aggregate value, focusing primarily on the exports of commodities and agro-industrial products. In addition, over the past two decades, the Brazilian production has suffered price competitiveness, due to the appreciation in exchange rate. For completeness, the tax burden imposed as sales taxes should be characterized, such as IPI VAT and ICMS VAT inhibit the power of competitiveness of Brazilian

exports, as captured by the model, which according to the results in Table 3, indicate that for a 1% increase in tax on goods and services, the trade balance is negatively impacted with -0.10%.

8. Conclusion

We prepared an original model for the Brazilian economy, from the equation of balance between aggregate demand and aggregate supply, involving some key variables for economic growth, integrated endogenously, by simultaneous equation solutions. The model is a dynamic formulation of simultaneous equations, solved by the vector-error-correction model (VECM), which allowed us to identify the long-run adjustments and the impacts of innovation shocks in the short run. In designing this model, we consider the needs for an integrated accounting of government spending with transfers to sub-national governments and health programs, educational and social assistance, and the tax revenue impacts on the performance of the economy, in view of the particularity of Brazilian public policies.

Among the main results, we mention that the Brazilian economy is not in a situation of sustained long-run growth, as growth of the per capita gross domestic product does not cause sustained growth in itself, although it is growing in the short run and developing a stochastic trend.

These findings also indicated the relevance of household consumption and private fixed investment in leading the growth of the Brazilian economy. They cause growth in *GDP*, in the short and long run. The consumption and fixed investments were shown to be the main drivers of growth in the Brazilian economy. These findings signal that the design of the Brazilian economy, in an appropriate way, however, needs adjustment in its fiscal policy in order to stimulate the *GDP* growth in a sustained way. The trade balance also proved to be an important asset for economic growth. It showed a weak exogeneity in the short run, however, positively impacting consumption, fixed investment, and gross domestic product. It is also found that its performance is being inhibited by the tax burden imposed by sales taxes, such as *IPI VAT* and *ICMS VAT*.

With regard to the transfers, we conclude that these public expenditures affect economic performance, as follows: (i) transfers to social security (*TTSS*) showed a weak exogeneity in the short run, however, with significant positive impacts on per capita consumption, per capita fixed investments, and per capita gross domestic product in the Brazilian economy, in the short and long run. Specifically, we attributed this feature of *TTSS* as an instrument of regional development, due to its characteristic of income distribution in the economy; and (ii) transfers to states and municipalities (*TTSM*) exhibited a totally exogenous characteristic, in both the short and long run, with negative impacts on the per capita *GDP*, consumption, and investment. We associated the inefficiency of these transfers to driving regional economic growth to the misuse of its resources. These findings suggest that the policy makers in Brazil urgently need to establish regulatory laws that curb the excesses and misuse of public resources.

Taxes have been grouped into three distinct groups of taxation: income taxes and social contributions on net income (*TISC*), social contributions on payroll (*SCP*), and taxes on goods and services (*TBS*). Our results have shown that the income tax and social contribution to net profit (*TISC*) may be considered distortionary taxes, which reduce the economic growth in the short and long run, negatively impacting consumption, fixed investment, and gross domestic product. The social contribution to payroll (*SCP*) can also be considered distortionary tax, in the short run, as it also negatively impacts the fixed investment, consumption, and gross domestic product in the short run. However, these kinds of tax were non-distortionary in the long run, showing the positive impacts on economic growth. The tax on goods and services (*TGS*), essentially sale taxes, have shown, in a general way, the impact of non-distortionary taxes on the economic growth, imposing positive effects on fixed investment, consumption, and gross domestic product. Nevertheless, they are negatively impacting the trade balance, which may be considered a factor that diminishes the performance of trade balance in the long run. The results obtained in this study indicate that policy makers should design fiscal and monetary policies that make tax revenues smooth, for example, with indifferent elasticities of the gross national domestic disposal income, with regard to the taxes,

that is, equal to unit-elastic. Thus, the increase in gross national domestic disposal income can totally compensate the burden of tax charge.

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Appendix A: Tables of results

Table A.1: Cointegrating equations.

Coint. Equation	Parms	χ^2			$p > \chi^2$		
$ce1_{t-1}$	8	60231.53			0.0000		
$ce2_{t-1}$	8	25960.76			0.0000		
$ce3_{t-1}$	8	1196.594			0.0000		
Coint. Equation	Variable	Coef	Std. Error	t	$p > \|t\|$	95% Conf. Interval	
$ce1_{t-1}$	$TTSM_{t-1}$	4.976238	0.4604564	10.81	0.000	4.07376	5.878716
	$TTSS_{t-1}$	-1.391423	0.0614878	-22.63	0.000	-1.511937	-1.270909
	GDP_{t-1}	1					
	SCP_{t-1}	34555.08	3489.802	9.90	0.000	27715.2	41394.97
	$TISC_{t-1}$	-27549.67	3789.224	-7.27	0.000	-34976.41	-20122.93
	TB_{t-1}	-1.110261	0.2990088	-3.71	0.000	-1.696308	-0.5242146
	$CONS_{t-1}$	-0.4424212	0.0555381	-7.97	0.000	-0.5512738	-0.3335686
	I_{t-1}	-4.278385	0.2769131	-15.45	0.000	-4.821125	-3.735646
	TGS_{t-1}	-4998.342	1656.001	-3.02	0.003	-8244.045	-1752.639
$ce2_{t-1}$	$TTSM_{t-1}$	7.279375	0.8088884	9.00	0.000	5.693983	8.864768
	$TTSS_{t-1}$	-1.553587	0.1970904	-7.88	0.000	-1.939877	-1.167297
	GDP_{t-1}	-0.2288969	0.0751876	-3.04	0.002	-0.376262	-0.0815319
	SCP_{t-1}	42530.93	4525.21	9.40	0.000	33661.68	51400.18
	$TISC_{t-1}$	-49834.9	5623.858	-8.86	0.000	-60857.46	-38812.34
	TB_{t-1}	1.687891	.3364685	5.02	0.000	1.028425	2.347357
	$CONS_{t-1}$	1					
	I_{t-1}	-4.538114	.4534589	-10.01	0.000	-5.426877	-3.649351
	TGS_{t-1}	-1043.968	1973.256	-0.53	0.597	-4911.48	2823.543
$ce3_{t-1}$	$TTSM_{t-1}$	-2.785547	0.3207749	-8.68	0.000	-3.414255	-2.15684
	$TTSS_{t-1}$	1					
	GDP_{t-1}	0.5038475	0.1887557	2.67	0.008	0.1338932	0.8738018
	SCP_{t-1}	-21212.72	2658.153	-7.98	0.000	-26422.6	-16002.84
	$TISC_{t-1}$	14014.52	2794.859	5.01	0.000	8536.693	19492.34
	TB_{t-1}	-0.1818433	0.3058495	-0.59	0.552	-0.7812973	0.4176107
	$CONS_{t-1}$	-0.8087463	0.1908925	-4.24	0.000	-1.182889	-0.4346039
	I_{t-1}	1.305799	.2810557	4.65	0.000	.7549403	1.856659
	TGS_{t-1}	3823.962	1280.901	2.99	0.003	1313.442	6334.482

Table A.2: Results of the Vector Autoregressive Model (VAR).

Sample:	1970-2010				No. of obs =	41	AIC =	45.20303	
Log likelihood =	-651.8575						HQIC =	48.37688	
Det(Sigma_ml) =	6421.431						SBIC =	54.12356	
	D(TTSM)	**D(CONS)**	**D(GDP)**	**D(SCP)**	**D(TISC)**	**D(TB)**	**D(TTSS)**	**D(I)**	**D(TBS)**
R-SQ	0.5936	0.6850	0.9176	0.6775	0.7603	0.6016	0.9569	0.9305	0.5835
Error Correction	**D(TTSM)**	**D(CONS)**	**D(GDP)**	**D(SCP)**	**D(TISC)**	**D(TB)**	**D(TTSS)**	**D(I)**	**D(TGS)**
	-0.5162639	**-9.05079*** **	**-11.162*** **	**-0.000021**	**-0.00011** **	**0.5195871**	**-1.8098** **	**-2.21618** **	**-0.000192** **
ce1	*(0.4781433)*	*(2.598341)*	*(3.391199)*	*(0.0000428)*	*(0.0000441)*	*(0.543369)*	*(0.892463)*	*(1.043757)*	*(0.0000976)*
	(-1.08)	*(-3.48)*	*(-3.29)*	*(-0.49)*	*(-2.41)*	*(0.96)*	*(-2.03)*	*(-2.12)*	*(-1.97)*
	0.1781095	**4.545068*** **	**5.92292*** **	**- 4.93×10-07**	**0.0000178**	**-0.31055** **	**0.553076** **	**1.72788*** **	**0.0000548***
ce2	*(0.1597324)*	*(.8680226)*	*(1.132891)*	*(0.000014)*	*(0.0000147)*	*(0.160522)*	*(0.298143)*	*(0.348686)*	*(0.0000326)*
	(1.12)	*(5.24)*	*(5.23)*	*(0.03)*	*(1.21)*	*(-1.94)*	*(1.89)*	*(4.96)*	*(1.68)*
	-0.4927586	**-4.631584***	**-5.57015***	**-0.0000139**	**-0.00014*** **	**0.0457675**	**-1.69380** **	**-0.385322**	**-0.000168***
ce3	*(0.4739367)*	*(2.575482)*	*(3.361364)*	*(0.0000424)*	*(0.0000437)*	*(0.538589)*	*(0.884611)*	*(1.034574)*	*(0.0000967)*
	(-1.04)	*(-1.80)*	*(-1.66)*	*(-0.33)*	*(-3.12)*	*(0.08)*	*(-1.91)*	*(-0.37)*	*(-1.74)*
	-0.330273	**-0.997078**	**-1.440205**	**0.0000793** **	**.0000318**	**-0.36004**	**.3136097**	**-1.035764**	**0.0001405**
L1.D(TTSM)	*(0.4602542)*	*(2.501128)*	*(3.264322)*	*(0.0000412)*	*(.0000425)*	*(0.52304)*	*(.859073)*	*(1.004706)*	*(0.0000939)*
	(-0.72)	*(-0.40)*	*(-0.44)*	*(1.92)*	*(0.75)*	*(-0.69)*	*(0.37)*	*-1.03)*	*(1.50)*
	-0.2607947	**-5.83855*** **	**-6.73722** **	**0.00007** **	**0.0000578**	**0.4240415**	**-0.333552**	**-2.1659*** **	**0.0000567**
L2.D(TTSM)	*(0.4015331)*	*(2.182024)*	*(2.847846)*	*(0.0000359)*	*(0.0000371)*	*0(.456308)*	*(0.749469)*	*(0.876522)*	*(0.000082)*
	(-0.65)	*-2.68)*	*(-2.37)*	*(1.95)*	*(1.56)*	*(0.93)*	*(-0.45)*	*(-2.47)*	*(0.69)*
	0.3119754	**2.241862** **	**2.478996** **	**-7.45×10-06**	**-0.0000222**	**-0.011845**	**0.311929**	**0.4320252**	**-0.0000481**
L1.D(TTSS)	*(0.1972842)*	*(1.072088)*	*(1.233325)*	*(0.0000177)*	*(0.0000182)*	*(0.224197)*	*(0.368234)*	*(0.430659)*	*(0.0000403)*
	(1.58)	*(2.09)*	*(2.01)*	*(-0.42)*	*(-1.22)*	*(-0.05)*	*(0.85)*	*(1.00)*	*(-1.20)*
	-0.0156482	**0.0603836**	**-0.2983948**	**0.0000368** **	**-2.1×10-06**	**-0.078838**	**0.0643593**	**-0.264255**	**0.0000324**
L2.D(TTSS)	*(0.1968739)*	*(1.069858)*	*(1.396315)*	*(0.0000176)*	*(0.0000182*	*(0.223730)*	*(0.367469)*	*(0.429763)*	*(0.0000402)*
	(-0.08)	*(0.06)*	*(-0.21)*	*(2.09)*	*(-0.12)*	*(-0.35)*	*(0.18)*	*(-0.61)*	*(0.81)*
	0.1250004	**8.690437** **	**11.78222** **	**-0.000073** **	**0.0000757**	**-1.00108**	**1.187031**	**4.121588** **	**0.0002151**
L1.D(GDP)	*(0.7886725)*	*(4.285829)*	*(5.593607)*	*(.00003715)*	**(0.0000728)**	*(0.896259)*	*(1.472071)*	*(1.721622)*	*(0.000161)*
	(0.16)	*(2.03)*	*(2.11)*	*(-1.97)*	**(1.04)**	*(-1.12)*	*(0.81)*	*(2.39)*	*(1.34)*
	0.0596718	**5.260639** **	**9.325199** **	**-0.000052** **	**-7.68e-06**	**-0.431048**	**0.3512533**	**4.72652*** **	**0.0001475**
L2.D(GDP)	*(0.5563028)*	*(2.639078)*	*(3.94554)*	*(0.0000266)*	*(.0000513)*	*(0.632191)*	*(1.038349)*	*(1.214374)*	*(0.0001136)*
	(0.11)	*(1.96)*	*(2.36)*	*(-1.96)*	*(-0.15)*	*(-0.68)*	*(0.34)*	*(3.89)*	*(1.30)*
	-3520.328	**-78370.3*** **	**-102282*** **	**-0.1623928**	**0.641962** **	**1932.943**	**9646.152***	**-28098*** **	**0.6488151**
L1.D(SCP)	*(2835.598)*	*(15409.3)*	*(20111.29)*	*(0.2538629)*	*(0.2617155)*	*(3222.415)*	*(5024.694)*	*(6189.932)*	*(0.5787976)*
	(-1.24)	*(-5.09)*	*(-5.09)*	*(-0.64)*	*(2.45)*	*(0.60)*	*(1.82)*	*(-4.54)*	*(1.12)*
	-1765.37	**3777.928**	**-2840.629**	**-0.0073437**	**0.3632634**	**3696.949**	**2456.102**	**-8502.594**	**-1.114867**
L2.D(SCP)	*(3388.544)*	*(18414.13)*	*(24033.02)*	*(0.3033666)*	*(0.3127504)*	*(3850.792)*	*(6324.778)*	*(7396.979)*	*(0.6916641)*
	(-0.52)	*(0.21)*	*(-0.12)*	*(-0.02)*	*(1.16)*	*(0.96)*	*(0.39)*	*(-1.15)*	*(-1.61)*
	-418.0065	**-17747.3**	**21447.7**	**-0.0200237**	**0.1233476**	**-2396.451**	**-1619.697**	**-8960.57** **	**-0.1442135**
L1.D(TISC)	*(2208.336)*	*(12000.61)*	*(15662.48)*	*(0.197706)*	*(0.2038215)*	*(2509.586)*	*(4121.899)*	*(4571.659)*	*(0.450762)*
	-0.19)	*(-1.48)*	*(1.37)*	*(-0.10)*	*(0.61)*	*(-0.95)*	*(-0.39)*	*(1.96)*	*(-0.32)*
	3619.074*	**-62458.9*** **	**-70308.3*** **	**0.1297584**	**0.514689*** **	**-3263.256**	**5187.585**	**-13208*** **	**0.3295011**
L2.D(TISC)	*(2062.357)*	*(11207.33)*	*(14627.13)*	*(0.1846369)*	*(0.1903482)*	*(2343.693)*	*(3849.427)*	*(4501.996)*	*(0.420965)*
	(1.75)	*(-5.57)*	*(-4.81)*	*(0.70)*	*(2.70)*	*(-1.39)*	*1.35)*	*(2.93)*	*(0.78)*
	-0.052447	**8.510574** **	**12.26483** **	**0.0000965**	**-0.0000529**	**1.276477**	**-0.481832**	**-5.3473*** **	**-0.0002225**
L1.D(TB)	*(0.901792)*	*(4.342146)*	*(6.163299)*	*(0.0000807)*	*(0.0000832)*	*(1.02481)*	*(1.683211)*	*(1.968555)*	*(-0.000222)*
	(-0.06)	*(1.96)*	*(1.99)*	*(1.20)*	*(-0.64)*	*(1.25)*	*(-0.29)*	*-2.72)*	*(-1.21)*
	0.108618	**9.29119*** **	**14.2227*** **	**0.0000976** **	**0.0000527**	**0.6491553**	**-.2608732**	**-6.3283*** **	**-0.0000641**
L2.D(TB)	*(0.6217622)*	*(3.378799)*	*(4.409806)*	*(0.0000494)*	*(0.0000574)*	*(0.70658)*	*(1.16053)*	*(1.357268)*	*(0.0001269)*
	0.17)	*(2.75)*	*(3.23)*	*(1.96)*	*(0.92)*	*(0.92)*	*(-0.22)*	*(-4.66)*	*(-0.51)*
	-0.1417438	**8.71815** **	**11.8529** **	**0.0000747**	**-0.0000754**	**1.015658**	**-1.157369**	**-4.1943*** **	**-0.0002207**
L1.D(CONS)	*(0.7904327)*	*(4.295394)*	*(5.60609)*	*(0.0000708)*	*(0.000073)*	*(0.898259)*	*(1.475357)*	*(1.725465)*	*(0.0001613)*
	(-0.18)	*(2.03)*	*(2.11)*	*(1.05)*	*(-1.03)*	*(1.13)*	*(-0.78)*	*(-2.43)*	*(-1.37)*
	-0.0247716	**5.45762** **	**9.683177** **	**0.0000563**	**0.0000142**	**0.4045359**	**-0.299285**	**-4.8952*** **	**-0.0001438**
L2.D(CONS)	*(0.5575591)*	*(2.759905)*	*(3.95445)*	*(0.0000499)*	*(0.0000515)*	*(0.633618)*	*(1.040694)*	*(1.217116)*	*(0.0001138)*
	(-0.04)	*(1.98)*	*(2.45)*	*(1.13)*	*(0.28)*	*(0.64)*	*(-0.29)*	*(-4.02)*	*(-1.26)*
	-0.1220497	**8.37323** **	**11.18176** **	**0.000046**	**-0.0000786**	**1.027197**	**-1.380141**	**-3.65002** **	**-0.0002604**
L1.D(I)	*(0.8165197)*	*(4.277157)*	*(5.375811)*	*(0.000073)*	*(0.0000754)*	*(0.927905)*	*(1.524049)*	*(1.782411)*	*(0.0001667)*
	(-0.15)	*(1.96)*	*(2.08)*	*(0.63)*	*(-1.04)*	*(1.11)*	*(-0.91)*	*(-2.05)*	*(-1.56)*
	0.030254	**2.964413**	**6.071327**	**0.0000438**	**-0.000022**	**0.5280655**	**-0.205726**	**-3.5898*** **	**-0.0001709**
L2.D(I)	*(0.5552343)*	*(3.017272)*	*(3.937961)*	*(0.000050)*	*(0.0000512)*	*(0.630976)*	*(1.036355)*	*(1.212041)*	*(0.0001133)*
	(0.05)	*(0.98)*	*(1.54)*	*(0.88)*	*(-0.43)*	*(0.84)*	*(-0.20)*	*(-2.96)*	*(-1.51)*
	1439.187	**6021.335**	**-552.8694**	**0.0147577**	**-0.0336543**	**-241.9816**	**3581.616**	**-6670.04** **	**0.554316***
L1.D(TGS)	*(1328.305)*	*(7218.315)*	*(9420.911)*	*(0.118919)*	*(0.1225977)*	*(1509.505)*	*(2479.305)*	*(2899.606)*	*(0.3041314)*
	(1.08)	*(0.83)*	*(-0.06)*	*(0.12)*	*(-0.27)*	*(-0.16)*	*(1.44)*	*(-2.30)*	*(1.82)*
	-255.4951	**-23594.6*** **	**-36118.1*** **	**-0.0662447**	**0.1934271**	**-34.8393**	**721.2398**	**-13748*** **	**0.1530228**
L2.D(TGS)	*(1577.107)*	*(8570.363)*	*(11185.52)*	*(0.141194)*	*(0.1455613)*	*(1792.247)*	*(2943.698)*	*(3442.725)*	*(0.3219164)*
	(-0.16)	*(-2.75)*	*(-3.23)*	*(-0.47)*	*(1.33)*	*(-0.02)*	*(0.25)*	*(-3.99)*	*(0.48)*

Note: $*\rightarrow$ 10% of significance, $**\rightarrow$ 5% of significance and $***\rightarrow$ 1% of significance; *L1*= delayed a lag; *D* = first difference.

Table A.3: Impact parameters Π=αβ'.

Error Correction	D(TTSM)	D(CONS)	D(GDP)	D(SCP)	D(TISC)	D(TB)	D(TTSS)	D(I)	D(TGS)
	- 0.100077	**0.9478491**	**3.084067**	**-0.0000621****	**-0.0000188**	**0.1974618**	**-0.2619213**	**2.623004*****	**-0.0000917**
L1.TTSM	*(0.290581)*	*(1.579084)*	*(2.060926)*	*(0.000026)*	*(0.0000268)*	*(0.3302205)*	*(0.5423746)*	(0.63432)	*(0.0000593)*
	(0.34)	*(0.60)*	*(1.50)*	*(-2.39)*	*(-0.70)*	*(0.60)*	*(-0.48)*	(4.14)	*(-1.55)*
	-0.0511258	**0.9007412****	**0.759773**	**0.0000145****	**-0.0000163****	**-0.1947252****	**-0.0348174**	**0 .3119155*****	**0.0000148**
L1.TTSS	*(0.0909499)*	*(0.4592427)*	*(0.6450559)*	*(8.21×10^{-06})*	*(8.27×10^{-06})*	*(0 .099335)*	*(0.1697596)*	*(0.080898)*	*(0.0000186)*
	(-0.56)	*(1.96)*	*(1.18)*	*(1.96)*	*(-1.94)*	*(-1.96)*	*(-0.21)*	*(3.86)*	*(0.80)*
	-0.8053078	**-12.42476*****	**-15.3247*****	**0.0000282****	**0.000179*****	**0.6137318**	**2.789845****	**-2.805834****	**0.0002899****
L1.GDP	*(0.7389216)*	*(4.015471)*	*(5.240752)*	*(0.0000140)*	*(0 .0000682)*	*(0.8397214)*	*(1.37921)*	*(1.446319)*	*(0.0001442)*
	(-1.09)	*(-3.09)*	*(-2.92)*	*(2.01)*	*(2.62)*	*(0.73)*	*(2.02)*	*(-1.94)*	*(2.01)*
	188.3715	**21196.49****	**15654.14****	**0.4094219****	**-0.0184758**	**3775.369**	**-3085.778**	**9394.89*****	**-0.7611107***
L1.SCP	*(2076.537)*	*(10759.38)*	*(7866.40)*	*(0.1859064)*	*(.1916569)*	*(2359.808)*	*(3875.894)*	*(3967.464)*	*(0.4238594)*
	(0.09)	*(1.97)*	*(1.99)*	*(2.20)*	*(-0.10)*	*(1.60)*	*(-0.80)*	*(2.37)*	*(-1.80)*
	-1558.945	**-42066.03*****	**-65709.32*****	**0.3589597**	**0.1265394****	**1803.388**	**-1440.14**	**-30453.98*****	**0.2219354**
L1.TISC	*(2015.575)*	*(10953.1)*	*(14295.33)*	*(0.2504486)*	*(0.0.063908)*	*(2290.529)*	*(3762.107)*	*(4399.873)*	*(0.4114159)*
	(-0.77)	*(-3.84)*	*(-4.60)*	*(1.43)*	*(1.98)*	*(0.79)*	*(-0.38)*	*(-6.92)*	*(0.54)*
	0.9634221	**18.56255*****	**23.40339*****	**0.0000267**	**0.0001727****	**-1.109381**	**3.250923****	**5.447093*****	**0.0003368****
L1.TB	*(0.8598202)*	*(4.672462)*	*(6.098216)*	*(0.000077)*	*(0. .0000794)*	*(0.9771123)*	*(1.60487)*	*(1.876933)*	*(0.0001755)*
	(1.12)	*(3.97)*	*(3.84)*	*(0.35)*	*(2.18)*	*(-1.14)*	*(2.03)*	*(2.90)*	*(1.92)*
	0.8050323	**12.29511*****	**15.36627*****	**0.0000211**	**0.0001751*****	**-0.5774447**	**2.72364****	**3.019999****	**0.0002759****
L1.CONS	*(0.7205611)*	*(3.915696)*	*(5.110531)*	*(0.0000645)*	*(0 .0000665)*	*(0.8188563)*	*(1.34494)*	*(1.55674)*	*(0.0001400)*
	(1.12)	*(3.14)*	*(3.01)*	*(0.33)*	*(2.63)*	*(-0.71)*	*(2.03)*	*(1.94)*	*(1.97)*
	0.7570506	**12.04883*****	**13.60489*****	**0.0000695**	**0.0001954*****	**-0.753901**	**3.021456****	**1.137192**	**0.0003561****
L1.I	*(0.8307188)*	*(4.514318)*	*(5.891817)*	*(0.0000744)*	*(0 .0000767)*	*(0.9440411)*	*(1.550551)*	*(1.813407)*	*(0.0001696)*
	(0.91)	*(2.67)*	*(2.31)*	*(0.93)*	*(2.55)*	*(-0.80)*	*(1.95)*	*(0.63)*	*(2.10)*
	510.2327	**22783.05*****	**28310.39*****	**0.0512088**	**0-.0094782**	**-2097.852*****	**1991.712**	**7799.928*****	**0.2627541****
L1.TGS	*(768.5372)*	*(4176.409)*	*(5450.798)*	*(0.0688049)*	*(0 .0709332)*	*(873.377)*	*(1434.488)*	*(1677.668)*	*(0.1320372)*
	(0.66)	*(5.46)*	*(5.19)*	*(0.74)*	*(-0.13)*	*(-2.40)*	*(1.39)*	*(4.65)*	*(1.99)*

Note: $*\rightarrow$ 10% of significance, $**\rightarrow$ 5% of significance and $***\rightarrow$ 1% of significance; *L1* = delayed a lag; *D* = first difference.