FISCAL POLICY FROM A STRUCTURAL ECONOMIC DYNAMICS APPROACH WITH GENERAL MACROECONOMIC CONSTRAINT

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Abstract

The aim of this paper is to analyze how fiscal policy can affect per capita economic growth. Therefore, an extension of the model by Araujo and Lima (2007) was made, by considering the public sector taxation and public expenses. Our findings corroborate the fact that positive public savings relieve the external constraint. We demonstrate that sectoral public spending growth rate and sectoral public taxes growth rate can affects economic growth. Still, it shows that the rate of economic growth is sensitive to the sectoral composition of public spending and taxation. Finally, a computer simulation is presented.

Keywords: Structural Change; BOP Constrained Growth; Government Spending; Economic Growth; Multisectoral Models.

JEL Code: E12; F43; O41.

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1. Introduction

Balance-of-payment-constraint growth models, henceforth BOPC, were initially formalized by Thirlwall (1979). One of his aims was to provide an alternative to the dominant theory [see Solow (1956) and Romer (1990)] to understand economic growth in developing countries. Briefly, this was because the theories of the time were unable to explain the growth process in underdeveloped countries, since their assumptions were not supported in countries deprived of mechanisms to improve the labor force.

As can be seen at Blecker and Setterfield (2019), the assumptions used in neoclassical growth models assume that there are no demand restrictions (only occurs in short-term models); the neoclassical production function with constant returns to scale (there is rejection of the use of this type of function in post-Keynesian models) and long-term growth can only be explained through technological progress (exogenous or endogenously explained).

While the mainstream continued to orbit around the concept of Total Factor Productivity (TFP) in order to explain the growth phenomenon, Thirlwall's proposal (which took several elements from the structuralist tradition) was based on other elementary concepts. Essentially, these concepts involve the ratio between the income elasticity of exports and the income elasticity of imports, which provides a parameter of sensitivity to growth in the rest of the world, in order to explain domestic growth.

Thus, regardless of the theoretical perspective (neoclassical or post-Keynesian), we know that long-term growth is supported by productivity growth. It turns out that while in the neoclassical perspective this channel is better explained by the technological and sector-independent progress, the post-Keynesian approach mentioned above shows the composition of sectors for aggregate productivity, as well as the role of sectors in relaxing the main constrain on growth given by the balance of payments balance.

In the line with this notion, in order to achieve higher growth rates, a country should promote an increase in its income elasticity of exports or a reduction in its income elasticity of imports, or both, simultaneously. To this end, in addition to increasing the productivity of production factors [see Kaldor (1961), Baumol (1986) and Solow (1994)], the country should produce and start to export products with greater income elasticity of exports, and stop producing, and start to import, products with lower income elasticity of imports [see Thirlwall (1979) and Araujo and Lima (2007)]. In other words, the country must undergo structural change. In this sense, it is necessary to understand the contribution of each

approach so that economic policies are full of scientific basis, in order to achieve the desired success. In this sense, especially for developing countries a BOPC agenda, which understands the phenomenon of growth from the point of view of structural change can be very useful as it is designed to promote catching-up in poor countries.

Based on just such a structural change approach, this article aims to incorporate the presence of government into the Pasinettian model, with a focus on how the public sector affects economic growth. In this sense, this article seeks to incorporate the work of Araujo and Teixeira (2004a), which extended this model to an open economy, and added new elements into the structural change framework, to make the theory more robust and compatible with reality.

The balance-of-payments-constraint growth approach has contributed to a better understanding of long-term economic experiences in several countries, particularly in underdeveloped ones. According to this theory, a country's economic growth rate cannot be distinct from one which ensures that the balance of payments is stable and equal to zero over time.

This theory, originally proposed by Thirlwall (1979), has been generalized in several ways. Among others, we note the incorporation of capital flows [`], the possibility of external debt [McCombie and Thirlwall (1997) and Moreno-Brid (1998-99)], interest payments [Moreno-Bridd (2003)], sector disaggregation [Araujo and Lima (2007)], commercial disaggregation [Nell (2003)] and, more recently, the conjunction of sector disaggregation and commercial disaggregation [Araujo, Paiva, Santos and Silva (2017)].

In this paper, we start with a multi-sectoral framework for this theory, known in the literature as the Multi-sectoral Thirlwall's Law (MSTL), as derived by Araujo and Lima (2007). Starting with the multi-sectoral Pasinetti model of sectoral changes (1981), these authors demonstrated that the income elasticity of demand for exports and imports should be considered as weighted averages of sectoral elasticity, which is the weight provided various commodities' participation in export and import structures. This result enabled the opening up of a new agenda of empirical research, now focused on demonstrating a better fit, as well as a forecast for the multi-sectoral version in relation to the aggregate one [see Gouvea and Lima (2010) and Romero and McCombie (2016)].

2. An extended version of the Pasinetti model of structural change

As presented by Araujo and Teixeira (2004b), structural economic dynamics is a useful framework for analyzing the uneven development in a North-South set up. In their paper, the authors extended Pasinetti's analysis to an open economy, enabling a study of the effects of international economic relations on the dynamic pattern of production, technological progress and the evolution of preferences.

As Araujo and Lima (2007) demonstrate, structural change was not properly incorporated into demand-oriented theories of economic growth. According to these authors, the exception is the Pasinettian structural dynamics approach, *"[…] whose main implication is that changes in the structure of production lead to changes in the growth rate, so that intercountry differences in the structure of production implies intercountry differences in the growth rate*" (Araujo and Lima, 2007, p. 17). However, authors did not include the government in their analysis, and their interesting results may be enhanced by taking government presence into account.

In this paper, we employ a version of that model which includes the presence of government without capital goods in order to conduct a general macroeconomic constraint growth analysis, as stated in Araujo and Lima (2007, p. 7):

> in a multi-sector economy in which productivity and demand vary over time at particular rates in each one of the sectors of two countries: let A denote the advanced country and U the underdeveloped one. Both countries are assumed to produce n−1 consumption goods: one in each vertically integrated sector but with different patterns of production and consumption. From the point of view of country U the physical and monetary flows of commodities can be summarized by three conditions, namely, the condition for full national income, the condition for disposition of national income and the general macroeconomic equilibrium, along with the solution for the system of physical and monetary quantities.

In order to describe the mathematical notation, it is important to express the physical and monetary flow systems to achieve the full national income coefficient condition and the disposition of national income both with the presence of government. We will follow the procedure as stated by Araujo and Teixeira (2004b), where X_i, represents the domestic physical quantity produced of consumption good i; X_n, represents the total amount of work used domestically which the size of the workforce is equal to the size of the population, and the n-th sector is the household sector.

The family sector in country A is denoted by $X_{\hat{n}}$, while in country *U* is denoted by X_n, and the size of population in each country is related to the other through the coefficient of proportionality ξ. The *per capita* demand for consumption goods is separated into two parts

which are the "domestic demand coefficient" and the "foreign demand coefficient". In this article we consider a division in the domestic demand coefficient in two pieces which are the domestic consumption coefficient for i-th good, a_{in}, and the public consumption coefficient for i-th good, g_{in}. The foreign demand for i-th is denoted by $a_{i\hat{n}}$. The production coefficients are denoted by a_{ni}. We shall now define X_i for all n-1 sectors. Following Pasinetti (1981, 1993) and Araujo and Teixeira (2004b), we can describe the production of the i-th sector as:

$$\begin{cases} X_i - (a_{in} + \xi a_{i\hat{n}} + g_{in})X_n = 0 \quad \forall i = 1, \ldots, n-1 \\ X_n - \sum_{i=1}^{n-1} a_{ni} X_i = 0 \end{cases} \tag{1}$$

Therefore, the physical quantity of each tradable good domestically produced will be determined by the sum of the demands in both countries plus the government demand. It is sufficient for this homogeneous and linear system to admit a non-trivial solution is that the coefficient matrix is singular. Adopting a procedure like Araujo and Lima (2007), the full employment condition, considering the presence of government, may be stated as:

$$\sum_{i=1}^{n-1} (a_{in} + \xi a_{i\hat{n}} + g_{in}) a_{ni} = 1 \tag{2}$$

where a_{in} denotes the domestic demand coefficient for commodity i produced domestically, $a_{i\hat{n}}$ stands for the foreign demand coefficients of the final commodity i, and g_{in} denotes the domestic government demand coefficient for commodity i (which can be understood as subsidies).

Equation (2) is like that presented by Araujo and Lima (2007), with the difference that we consider an open economy with government, while their work is about an open economy without government. From the perspective of the resources, we need to consider the domestic consumption coefficient for i-th good, a_{in}, and the public tax coefficient for i-th good, h_{in}. Therefore, the condition for full expenditure of national income with government presence is given by:

$$\sum_{i=1}^{n-1} (a_{in} + a_{\hat{t}n} + h_{in}) a_{ni} = 1 \tag{3}$$

With p_i being the price of commodity i in country U, and w^U the (uniform) wage rate, the set of solutions for prices can be expressed as:

$$p_i = a_{ni}w^U + (h_i - g_i)a_{ni} \quad (4)$$

Equation (4) shows that, although embedded labor relations continue to regulate the relative prices of goods within each country's borders, the government, through taxes and duties, can influence the final price of the good. If sectoral government intervention is positive, it means that this sector is being net taxed and, as a result, its price will increase, making it less internationally competitive. Otherwise, it means that this sector is receiving net subsidies and, as a result, its price will decrease, making it more competitive internationally. Therefore, fiscal policy can make a sector internationally competitive, as well as make a sector incompetent for international trade.

In the equilibrium between the full expenditure of national income (eq. 2) and the full employment condition (eq. 3), we have:

$$\sum_{i=1}^{n-1}(a_{in} + \xi a_{in} + g_{in})a_{ni} = \sum_{i=1}^{n-1}(a_{in} + a_{in} + h_{in})a_{ni} \quad (5)$$

In fact, equation (5) is the first important result of this extended Pasinettian model. This disaggregated equilibrium condition demonstrates that commercial balance might finances the public deficit, and vice versa. This means that negative foreign savings imply public account surplus.

Therefore, public sector may weaken external constraint. In one hand, if the government were to incur a deficit, there would be positive external savings to satisfy the general condition of macroeconomic equilibrium and, therefore, the country should import more than it exports. On the other hand, if there is a government surplus, then domestic exports are likely to exceed imports.

3. Macroeconomic constraint growth analysis in a Pasinettian framework

Let us consider that foreign demand for commodity *i* is given by a standard export function, such as the one adopted by Thirlwall (1979). This condition can be summarized as follows:

$$x_{i\hat{n}} = \begin{cases} \left(\frac{p_i}{ep_{\hat{t}}}\right)^{\eta_i} Y_A^{\beta_i} & \text{if } p_i < ep_{\hat{t}} \\ 0 & \text{if } p_i \geq ep_{\hat{t}} \end{cases} \quad (6)$$

where $x_{i\hat{n}}$ is foreign demand for commodity *i*, η_i is the price elasticity of demand for the export of commodity *i*, with $\eta_i < 0$, while β_i is the income elasticity of demand for exports and is the national income of country *A*.

Dividing both sides of (6) by the population of country *A*, given by $X_{\hat{n}}$, we obtain the per capita coefficient for foreign demand of commodity *i*, that is:

$$a_{i\hat{n}} = \begin{cases} \left(\frac{p_i}{ep_i}\right)^{\eta_i} y_A^{\beta_i} X_{\hat{n}}^{\beta_i - 1} & \text{if } ap_i < ep_{\hat{t}} \\ 0 & \text{if } p_i \geq ep_{\hat{t}} \end{cases} \quad (7)$$

Suppose that $p_i > ep_{\hat{t}}$ and consider that the import demand coefficients are given by a standard import demand function, which have the following functional form:

$$x_{\hat{t}n} = \begin{cases} \left(\frac{ep_{\hat{t}}}{p_i}\right)^{\psi_i} Y_U^{\varphi_i} & \text{if } p_i > ep_{\hat{t}} \\ 0 & \text{if } p_i \leq ep_{\hat{t}} \end{cases} \quad (8)$$

where ψ_i is the price elasticity of demand for imports of commodity *i*, with $\psi_i > 0$, φ_i is the income elasticity of demand for imports and Y_U is the real income of country *U*.

Dividing both sides of (8) by the population of country *U*, we obtain the per capita import coefficient for commodity *i*:

$$a_{\hat{t}n} = \begin{cases} \left(\frac{ep_i^A}{p_i^U}\right)^{\psi_i} y_U^{\varphi_i} X_n^{\varphi_i - 1} & \text{if } p_i > ep_{\hat{t}} \\ 0 & \text{if } p_i \leq ep_{\hat{t}} \end{cases} \quad (9)$$

Let us consider that government sectoral expenditure can be described by the following equation:

$$G_{in} = \begin{cases} G_U^{\kappa_i} & \text{if } p_i > ep_{\hat{t}} \\ 0 & \text{if } p_i \leq ep_{\hat{t}} \end{cases} \quad (10)$$

where κ_i is the elasticity of government expenditure, that is, if the government increases the aggregate subsidy by 1%, by what percentage does the subsidy increase in sector i and G_U is the aggregate government spending.

Basically, the government has the function of spending in sectors that are not yet competitive, and which have a high-income elasticity of exports. This means that the sectoral income elasticity of government spending will be directly proportional to the sectoral income elasticity of exports.

Dividing both sides of (10) by the population of country *U*, we obtain the per capita government expenditure coefficient for commodity *i*:

$$g_{in} = \begin{cases} g_U^{\kappa_i} X_n^{\kappa_i - 1} & \text{if } p_i > ep_{\hat{t}} \\ 0 & \text{if } p_i \leq ep_{\hat{t}} \end{cases} \tag{11}$$

We now define the sectoral tax that will finance government expenditure, which can be described by the equation:

$$H_{in} = \begin{cases} 0 & \text{if } p_i > ep_{\hat{t}} \\ H_U^{\tau_i} & \text{if } p_i \leq ep_{\hat{t}} \end{cases} \tag{12}$$

where τ_i is the elasticity of tax, that is, if the government increases the aggregate tax by 1%, by what percentage does the tax increase in sector i.

Equation (12) shows that, to finance the sectors that are not yet competitive, but which have high income elasticity of exports, the government imposes non-negative taxes on sectors that are competitive. Similar to public expenditure, taxation focuses on competitive sectors, but those which have lower income elasticity of exports, that is, the income elasticity of taxes is inversely proportional to the income elasticity of exports. The government equations for decision (10) and (12) express the government logic in this model: the government draws resources from the competitive sectors of lower income elasticity of exports and passes this on to the non-competitive sectors of greater income elasticity of exports.

Dividing both sides of (12) by the population of country *U*, we obtain the per capita government tax coefficient for commodity *i*:

$$h_{in} = \begin{cases} 0 & \text{if } p_i > ep_{\hat{t}} \\ h_U^{\tau_i} X_n^{\tau_i - 1} & \text{if } p_i \leq ep_{\hat{t}} \end{cases} \tag{13}$$

We can take the natural logarithms on both sides of equations (7), (9), (11) and (13) and differentiate these with respect to time. Considering the long-term, by adopting the following notation $\frac{\dot{y}_U}{y_U} = \sigma_y^U$, $\frac{\dot{p}_i}{p_i} = \sigma_i^U$, $\frac{\dot{p}_{\dot{t}}}{p_{\dot{t}}} = \sigma_i^A$, $\frac{\dot{e}}{e} = \varepsilon$, $\frac{\dot{y}_A}{y_A} = \sigma_y^A$, $\frac{\dot{X}_{\dot{n}}}{X_{\dot{n}}} = \frac{\dot{X}_n}{X_n} = 0$, $\sigma_i^U - \sigma_i^A - \varepsilon = 0$, this procedure yields the following equations:

$$\dot{a}_{i\dot{n}} = a_{i\dot{n}}\beta_i\sigma_y^A \tag{14}$$

$$\dot{a}_{\dot{t}n} = a_{\dot{t}n}\varphi_i\sigma_y^U \tag{15}$$

$$\dot{g}_{in} = g_{in}\kappa_i\sigma_g^U \tag{16}$$

$$\dot{h}_{in} = h_{in}\tau_i\sigma_h^U \tag{17}$$

Considering the equilibrium condition given by equation (5), for this equilibrium to be maintained, its rate of change must be equal to zero. Formally:

$$\sum_{i=1}^{n-1}\left[(\xi\dot{a}_{i\dot{n}} - \dot{a}_{\dot{t}n}) + (\dot{g}_{in} - \dot{h}_{in})\right]a_{ni} + \sum_{i=1}^{n-1}\left[(\xi a_{i\dot{n}} - a_{\dot{t}n}) + (g_{ni} - h_{ni})\right]\dot{a}_{ni} = 0 \tag{18}$$

Following Araujo and Lima (2007), let us consider that there is no sectoral technical progress, $\dot{a}_{ni} = 0 \quad \forall i = 1, \ldots, n-1$, and replacing (14), (15), (16) and (17) into (18), after some algebraic manipulation, we obtain:

$$\sigma_y^U = \frac{\sum_{i=1}^{n-1}\xi a_{ni}a_{i\dot{n}}\beta_i}{\sum_{i=1}^{n-1}a_{ni}a_{\dot{t}n}\varphi_i}\sigma_y^A + \frac{\sum_{i=1}^{n-1}g_{in}\kappa_i}{\sum_{i=1}^{n-1}a_{ni}a_{\dot{t}n}\varphi_i}\sigma_g^U - \frac{\sum_{i=1}^{n-1}h_{in}\tau_i}{\sum_{i=1}^{n-1}a_{ni}a_{\dot{t}n}\varphi_i}\sigma_h^U \tag{19}$$

Equation (19) demonstrates the domestic per capita economic growth improves with the growth rate of per capita income of country *A*, σ_y^A, and with per capita government spending growth, σ_g^U, and dumps with tax burden growth, σ_h^U. An implication of equation (19), therefore, is that changes to the composition of government taxes and expenditure have an impact on the production structure. It is therefore very important for the process of economic growth. This result is related to which found by Araujo and Lima (2007). We can get the result they got on the balance-of-payments-constraint growth rate doing for all sectors.

In the model, the trade policy transmission mechanism occurs through public intervention in the sectors. From the sectoral price equation, which we added in the new

version of the article, it is possible to see that the price is a function of the wage rate, the unit requirement and net taxes.

Therefore, the government can choose the sectors to carry out its tax policy, which involves knowing which sectors will be taxed and to what extent and which will be subsidized and to what extent. The article also advises that the choice should consider the ratio of income elasticities to determine the sectors to be affected by the policy. We prefer to consider that taxation (or subsidy) does not affect the productivity of the sector, but only the final price of the product.

If the government intends to keep its budget balanced over time, $\sigma_g^U = \sigma_h^U = \sigma^U$, then equation (19) can be rewritten as follows:

$$\sigma_y^U = \frac{\sum_{i=1}^{n-1} \xi a_{ni} a_{in} \beta_i}{\sum_{i=1}^{n-1} a_{ni} a_{in} \varphi_i} \sigma_y^A + \frac{\sum_{i=1}^{n-1} (g_{in} \kappa_i - h_{in} \tau_i)}{\sum_{i=1}^{n-1} a_{ni} a_{in} \varphi_i} \sigma^U \quad (20)$$

Equation (20) shows that a government with a balanced budget can stimulate domestic economic growth through fiscal policy. To do so, it suffices that it subsidizes the sectors of greater elasticity of public spending and tax the sectors of lesser elasticity of taxation. Sectors with greater elasticity of public spending are the ones that benefit most from an increase in aggregate public spending (subsidies) and sectors with less elasticity of taxation are the ones that least feel the negative effects of the increase in the aggregate tax burden.

From the standpoint of a policy maker, to evaluate fiscal and tax policies deriving out of this approach, it is necessary to know the income elasticities of taxation and public spending in each sector of the economy. The parameter of the sectorial public expenditure coefficient is directly correlated with the income-elasticity of exports and inversely with the income-elasticity of imports, whereas the sectoral taxation coefficient is negatively correlated with the income-elasticity of exports and inversely with the income-elasticity of exports, both parameters being conditioned by the sector's level of competitiveness.

Look at the following example. Suppose that a sector has high income-elasticity of exports with low income-elasticity of imports but is not competitive (or this sector may trade internationally, but as an import to the underdeveloped country). In this case, it is a strategic sector, but it does not trade internationally and does not contribute to long-term economic growth. According to our model, the government would be called upon to reduce the taxation coefficient of this sector (or to zero it, if applicable) while increasing the coefficient of sectoral expenditure in this sector. Thus, the government would induce an increase in the

supply of the physical quantity of consumption goods in this sector, which, given international demand, would operate at a price lower than the price before economic policies. This policy can last until the sector becomes competitive, that is, induce an increase in the production of consumer goods in this sector until the domestic price of these goods is lower than that practiced in the international market.

Assume an opposite sector to the past example, whose income-elasticity of imports is small compared to the income-elasticity of exports. Also assume that this sector is internationally competitive. Clearly, this is a sector whose elasticity ratio reduces long-term economic growth. According to our model, the government is urged to raise the tax coefficient of this sector while reducing (or zeroing it, if applicable) the public spending coefficient in this sector. So, the government would induce a reduction in the supply of the physical quantity of consumption goods in this sector, which, given international demand would operate at a price higher than the price before economic policies. This policy can last until it makes the sector uncompetitive internationally, specially, induce a reduction in the production of consumer goods in this sector until the domestic price of these goods is higher (or equal) to that practiced in the international market. In this way, what was taxed in this sector will be spent in sectors with a higher elasticity-income ratio of exports and imports, in order to produce the effects described in the first example.

Accordingly, in order to develop a mix of fiscal and tax policies that are advantageous to long-term economic growth, it is necessary to be aware of the income elasticities of public spending and the taxation of each of the sectors. Also, the government needs to separate sectors into two groups, namely, those that are internationally competitive and those that are not. Subsequently, he needs to list the sectors in order of the ratio of income elasticities of exports and imports. By organizing information in this way, the government will be better able to assess which sectors need to be taxed and which need to be strengthened in order to change the trade agenda towards greater economic growth. In most cases, it is possible to increase the domestic per capita growth rate through changes to the sector share of government spending than to let the companies themselves increase their relative share in exports. Because it is easier to make an internal political decision than it is to gain market share when there is serious external competition.

Therefore, an efficient government expenditure should be organized according to the ratio of the income elasticity of exports and imports. In order to stimulate the growth rate, the government should therefore follow the following rules: i) tax sectors in ascending order according to the ratio between the income elasticity of exports and imports and ii) spend on

sectors in descending order according to the ratio between the income elasticity of exports and imports. In this case, the government drains resources from the more backward sectors, which contribute the least to domestic growth (sectors with a low-income elasticity ratio), and transfers them to the modern sectors that can contribute to growth (sectors with a high-income elasticity ratio). This result is suitable with one found by Cripps and Godley (1978), which they sustain that fiscal and commercial policy together is the only way to achieve sustainable income growth and to recover full employment. According to them, protectionism can reduce world trade if it is done to protect inefficient companies. This result is predicted by our model, if the government allocates real flows of goods towards less advanced sectors.

Efficient sectors, which nevertheless have a low-income elasticity ratio, would therefore lose competitiveness, giving way to sectors which are less efficient but which have a high ratio of income elasticity. In practice, it would function as if the government were transferring resources from the primary sector (the lower ratio of income elasticity) to the industrial or services sector (the higher ratio of income elasticity).

4. Numerical Simulation

The model in this article has one characteristic that hinders econometric analysis[1]. For this reason, we preferred to use a numerical and stochastic simulation to evaluate the model's potential growth paths. Following the Pasinettian approach, this model includes the dynamic of structural changes.

The government aims to change the production structure through the dynamics of sectoral public spending and taxation. It sets out from the premise that when the government increases spending on a specific sector, this sector starts to manifest economies of scale and can therefore produce at a lower cost. Moreover, since the analytical framework we are using considers goods in their physical quantities, public spending may be understood as a real increase in the supply of goods, while taxation, for its part, provides a real reduction in the supply of goods. Thus, when the government taxes any sector i, it reduces the real supply of i-th goods to a given demand, raising the price of those goods. On the other hand, when this resource is destined for any other sector j, there

[1] The econometric estimation of this model is difficult because it works through structural change using sectors that already have structural parameters (income elasticity) but which do not export (or do not import). In this way, it is not possible to estimate a value using an econometric approach.

is an expansion of supply in the j-th sector and, therefore, a price reduction in any given demand. Consequently, if the government taxes and spends the same amount on the same sector, there will be no change in the actual supply of those goods, and therefore no price changes will occur. Producing goods at lower cost means that they can be traded on the international market, according to the import and export equations presented above. Note that income elasticity is a structural parameter. These are the parameters that will make the government change its spending behavior. A simple example can be seen in high-tech goods. These goods, in general, have high income elasticity[2], but if the country does not maintain a domestic price lower than the international one, they cannot be exported. The only way for this sector to become competitive is through falling prices. In this model, this is achieved by increasing sectoral production through sector spending.

The simulation was conducted as follows: we generated random values for the income elasticity of exports and imports[3]. In a similar way, we generated an initial Boolean variable for price competitiveness[4]. This defined the sectors that were initially importers and exporters. At a second point, we created a government reaction function, which is summarized in equation (21) and (22). The government selected Z, with Z<N, import sectors where there was a higher ratio of income elasticity, and Z export sectors for the lower ratios. In this way, the government taxed the lower ratio sectors (which already export) and spent in the higher ratio sectors (which do not export).

Thus, equation (21) states that the government spends on sector i if its income elasticity ratio is higher than the z sectors and its price is non-competitive. In turn, equation (22) states that the i-th sector is taxed if its elasticity ratio is lower than the z sectors and if the price is not competitive. We did not impose budgetary constraints on the government, so it was able to fully intervene in the Z sectors. Following this, we evaluated the growth trajectories obtained in the government's presence and absence. Table 1 demonstrates the model's structure and the parameters of the simulated routine. Notice that the shares generated in this economy have the same weight in each sector, $\frac{1}{(n-1)}$.

[2] According to the econometric results of Romero and McCombie (2016), high-tech goods have higher income elasticity than simple goods.
[3] Structural elasticity was first extracted from Gouvêa and Lima's (2010) tables and the ranges for the maximum and minimum values were then analyzed. Based on this data, we used a function of random numbers with uniform distribution to simulate similar data.
[4] A Boolean variable was randomly generated to define each new simulation when the price of sector i was, or was not, competitive.

$$gk_i = \begin{cases} gk_i > 0 if \frac{\beta_i}{\phi_i} > TopZSectors \wedge ep_{\hat{t}} < p_i \\ 0 if \frac{\beta_i}{\phi_i} < TopZSectors \vee ep_{\hat{t}} > p_i \end{cases} \quad (31)$$

$$h\tau_i = \begin{cases} h\tau_i > 0 if \frac{\beta_i}{\phi_i} < InfZSectors \wedge ep_{\hat{t}} > p_i \\ 0 if \frac{\beta_i}{\phi_i} > InfZSectors \vee ep_{\hat{t}} < p_i \end{cases} \quad (32)$$

Table 1 summarizes the data obtained in the simulation. The number of total sectors in the economy is $N-1$, while the number of sectors where government intervention will occur is Z. Each sector's share is identical, and it is $\frac{1}{(n-1)}$ for both importers and exporters. The β_i elasticity is randomly generated within a uniform range from 1 to 4, as well as ϕ_i elasticity. The elasticity ratio is calculated for each sector, dividing β_i by ϕ_i and prices are competitive or not according to a random binary variable with equal probability.

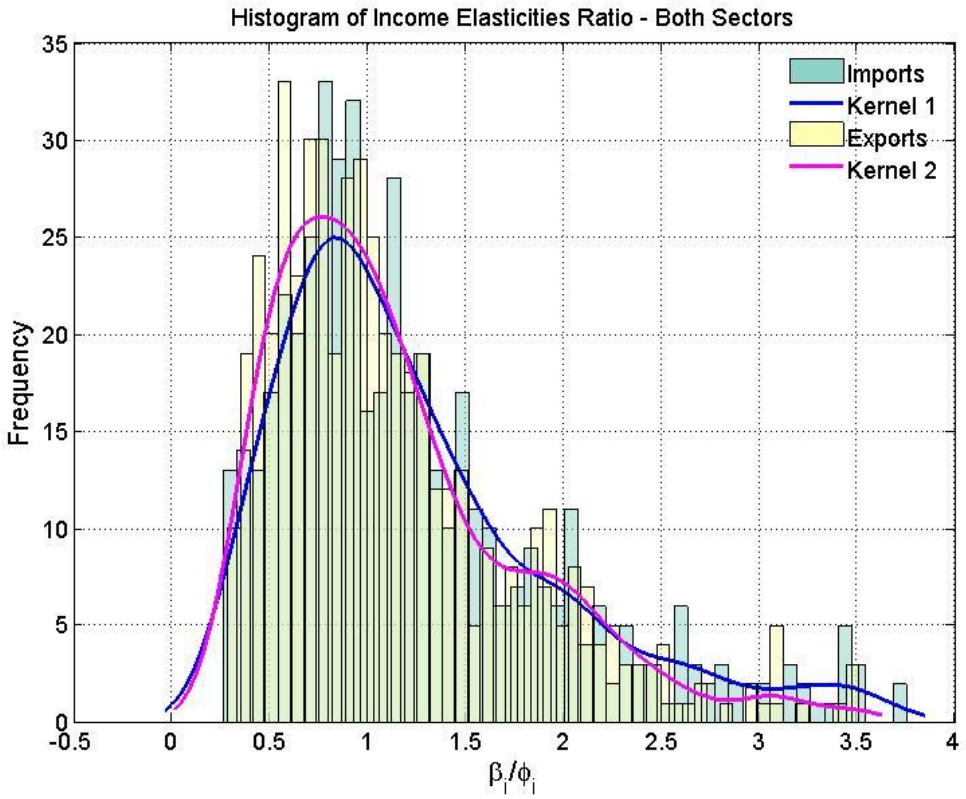
Table 1- Numerical simulation of sectors - government present

Sectors	*Exports*		*Imports*		β_i/ϕ_i	$p_i < e.p_i$
	Share	β_i	Share	ϕ_i		
1	*1/(n-1)*	[1; 4]	*1/(n-1)*	[1; 4]	β_1/ϕ_1	1
2	"	"	"	"	"	"
…	"	"	"	"	"	"
Z	"	"	"	"	"	1
…	…	…	…	…	…	…
n-1	*1/(n-1)*	[1; 4]	*1/(n-1)*	[1; 4]	β_{n-1}/ϕ_{n-1}	0 v 1

Source: Compiled by the authors.

Following this simulation, we separated the data in order to analyze the model's general behavior. To this end, we separated the import and export sectors and plotted a histogram for the elasticity ratio distribution, generated in simulation. Figure 1 presents two histograms for the elasticity ratio of the sectors that were initially importers and exporters. The yellow columns represent the export sectors, while the green columns represent the import ones. For both data sets a non-parametric probability density function (PDF) was estimated (the Kernel line in the legend). We initially observed that the distributions were almost identical, meaning that in the final MSTL equation this economy should have a multiplier effect close to one.

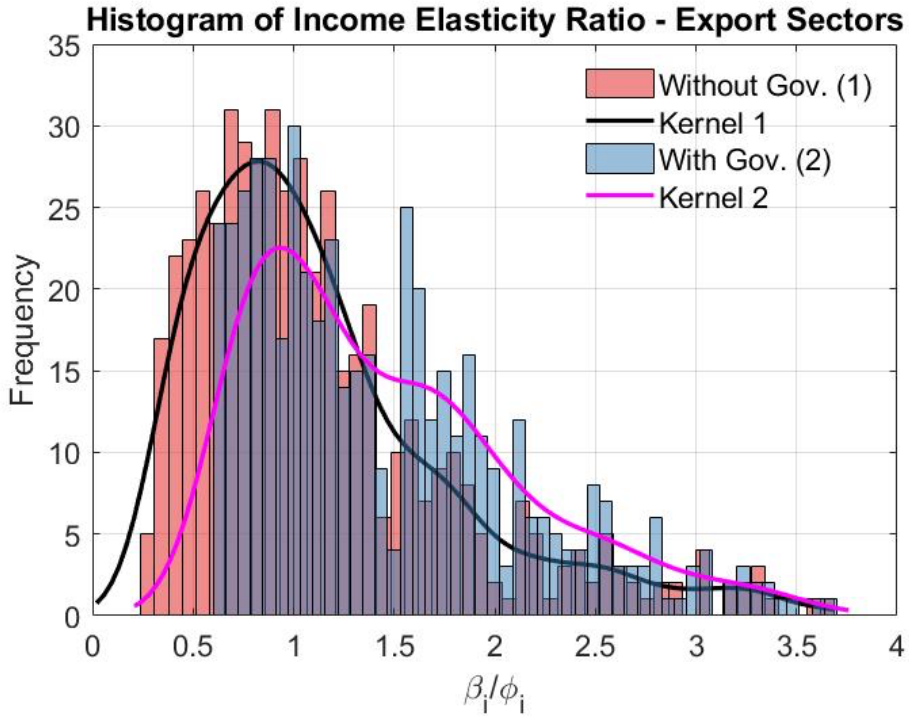
Figure 1- Histogram of the Income Elasticity Ratio for both sectors.



Source: Compiled by the authors.

Figure 2 shows the export sectors in both the absence and presence of government. As stated previously, in the presence of government, taxation affects the sectors that both export and have a lower ratio of income elasticity. Public spending is aimed at the sectors that do not export but have a higher ratio of income elasticity. This promotes structural change, so that the sectors that did not export (and only imported) begin exporting, while the sectors that used to export (and did not import) no longer do so. In the simulation carried out for this article, we arbitrarily determined that the government would effect a change of 10% of total sectors. Its intervention would therefore be to tax 10% of the worst exporters and spend on the top 10% importers (in terms of income elasticity ratio).

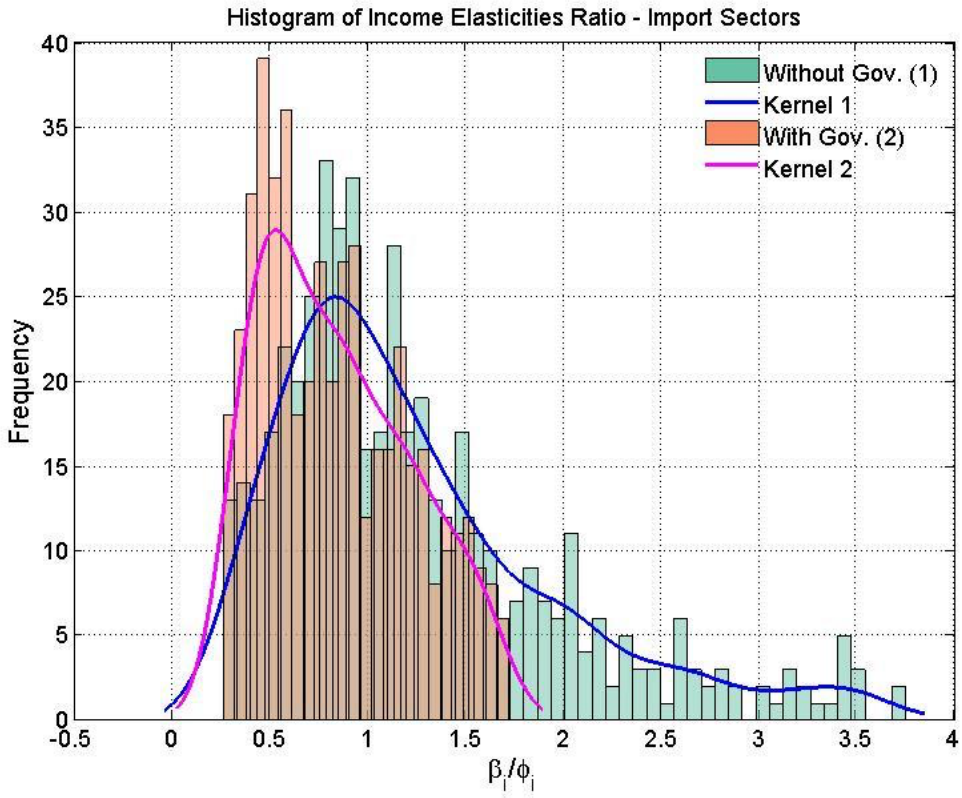
Figure 2- Histogram of the Income Elasticity Ratio - Export Sectors



Source: Compiled by the authors.

This change led to a structural change in the export sectors, which in turn changed the data distribution. Now we have a PDF that has shifted to the right, which indicates an average increase in the ratio of income elasticity that constitutes the exporting sectors. In Figure 2, the columns in red represent the export sectors in the absence of government, those in blue represent the export sectors in the presence of government, while purple represents the overlap between these two. The black kernel line is the non-parametric PDF estimated in the absence of government, while the magenta is the PDF in the presence of government. An analysis of the graph allows us to confirm this shift.

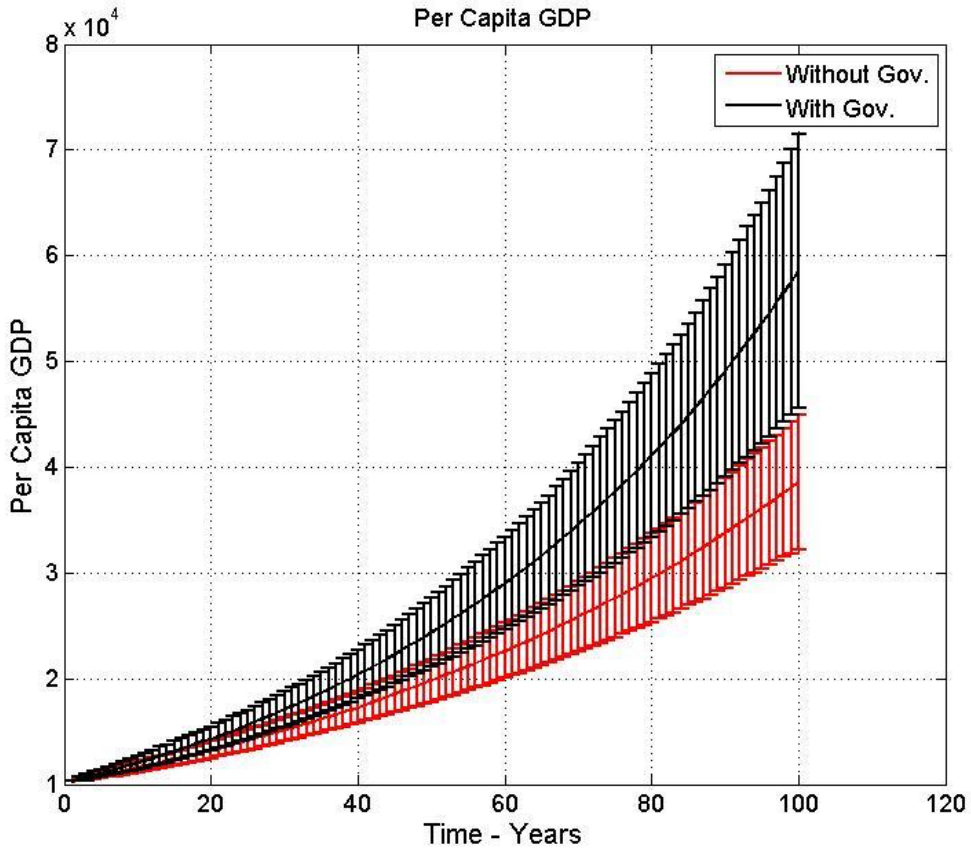
Figure 3- Histogram of the Income Elasticity Ratio - Import Sectors



Source: Compiled by the authors.

Figure 3 shows the histogram for the import sectors in both the presence and absence of government. We can see that, through the action of public intervention, the PDF is displaced to the left, compared to the original obtained in the economy without government. By identifying the shift in PDF exports to the right and the shift in PDF imports to the left, we conclude that the presence of government leads to a long-term growth trajectory higher than that originally obtained through the MSTL. In order to confirm this conclusion, it is necessary to numerically simulate the net impact on the denominator in the presence of spending and taxation.

Figure 4- Long-term GDP per capita growth



Source: Compiled by the authors.

In order to investigate all the possible trajectories for per capita GDP over the long term, we performed exhaustive simulations (10,000), calculating standard deviations and average behavior. To calculate each GDP per capita pathway, we used the following equation:

$$Y_{L_T} = Y_{L_1}\left[\prod_{t=1}^{T}(1+g_t) - 1\right] \tag{23}$$

where Y_{L_T} is the per capita GDP at the end of the period, Y_{L_1} is the per capita GDP at the outset and g_t is the income growth rate in period t. We used 10,000 US Dollars for the initial per capita value and the world growth rate was randomly (normal distribution) generated with a mean of 1.3376% and a standard deviation of 1.3225% (these values were taken from the historical average obtained from the World Development Indicators (WDI) database - 1960 to 2013).

Figure 4 presents these trajectories. The black lines represent the average GDP per capita behavior with error bars demonstrating the confidence interval (1.5 and 0.5 for with government against no government at the last simulation period) obtained from the simulation in the presence of government. In red, we have the same average behavior and error bars for the absence of government. In all these simulations, the presence of government generated more robust growth rates and had an impact on the economy's long-term trajectory. This result also demonstrates that, numerically, government intervention enables higher growth rates for a given degree of intervention (in the simulations, 10% of total economic sectors).

Although not presented here, we also found that the greater the degree of intervention (the number of sectors in which there was intervention over the total number of sectors), the greater the distance between accumulated growth in the presence of government, compared to economic growth when there is no government.

5. Concluding Remarks

The aim of this work is to consider the presence of government in the macroeconomic aggregates using the Pasinettian approach, as well as to verify how sectoral taxation and governmental sectoral spending affect the domestic economic growth rate. In addition, we aimed to demonstrate that the growth constraint generally faced by economies is not limited to the external sector, but that restrictions from the public budget should also be considered. In this sense, we have shown that the public budget and the balance of payments together provide constraints to economic growth.

The formal structure of the proposed model, as well as the simulations carried out, generates insights into the possibility of public intervention through taxation (or via tariffs) and public spending (through subsidies) can alter the price competitiveness of goods that have high income elasticity. Managing this type of strategy is capable of influencing the export and import agenda towards greater aggregate income elasticity ratios. By relaxing external constrains via the sectoral composition effect, the simulated country is able to obtain a higher level of average accumulated income in the long term when compared to the same country that has a neutral fiscal policy.

Although much of the Mainstream economic literature defends neutral sectoral policies (taxation and public spending), with the aim of not creating distortions to the market cleaning equilibrium, as well as generating results below the socially optimal, what

this paper suggests here is precisely the opposite way. If there are no interventions to select sectors with greater income elasticity, the "vocation" of this simulated country generates a growth trajectory below that in which there is active policy making to select sectors.

However, it is clear that this work has theoretical limitations as it disregards other important channels for economic growth, such as the role of technological progress, as well as sectoral public spending policy for this technological progress. Other short-term macroeconomic channels are also left aside from this work, such as the role of the real exchange rate, interest rate and other factors that may have a direct relationship with the price effect via spending/taxation.

However, the choice to leave such channels aside is precisely to obtain a first test in which the direction is strictly related to the long run government's role in the structural change of this economy.

Finally, this work leaves open possibilities for subsequent tests that can econometrically check government action as the key to structural change through their sectoral policies. No less important, short-term channels must also be explored in conjunction with the fiscal policy proposed in this work.

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