Available online at www.sciencedirect.com

ScienceDirect

EconomiA 17 (2016) 77–95

ECONOMIA

www.elsevier.com/locate/econ

Effects of interest and exchange rate policies on Brazilian exports

Cláudia Maria Sonaglio [a,*], Antonio Carvalho Campos [b], Marcelo José Braga [b]

[a] *Department of Economics, State University of Mato Grosso do Sul (UEMS), BR 463, km 4,5 – Julia Cardinal, 79900-000, Ponta Porã, Brazil*

[b] *Department of Rural Economics, Federal University of Viçosa (UFV), Avenida Purdue, s/n°, Campus Universitário, 36570.900 Viçosa – MG, Brazil*

Received 11 September 2015; accepted 8 January 2016

Available online 11 February 2016

Abstract

In heterodox literature, the industrial sector is considered strategic for economic development. Consequently, reducing the contribution of this sector in the production of the country before it has reached the stage of economic maturity, affects the productive dynamics and slow technical progress. The appreciation of the real exchange rate is seen as one of the factors responsible for the reduction of the external competitiveness of Brazilian manufactures, and this exchange rate valuation may be occurring due to the differences between domestic and international interest rates. Given this context, the aim of this study is to evaluate the impact of changes in the monetary and exchange rate policy and in the composition of the total exports on the performance of the Brazilian economy using a structuralist model. The results reinforce the importance of the manufacturing sector to economic growth, especially in a competitive exchange rate environment.

JEL classification: E19; F41; O24

Keywords: Exports; Economic growth; Economic policy

Resumo

Na literatura heterodoxa, o setor industrial é considerado como estratégico para o desenvolvimento econômico. Consequentemente, a redução de participação deste setor na produção do país, antes deste ter alcançado o estágio de maturidade econômica, afeta a dinâmica produtiva e atrasa o progresso técnico. A apreciação da taxa real de câmbio é apontada como um dos fatores responsáveis pela redução da competitividade externa das manufaturas brasileiras e, esta apreciação cambial, poderia estar ocorrendo em função dos diferenciais entre as taxas de juros doméstica e internacional. Nesse contexto, o objetivo deste estudo é avaliar os impactos de mudanças na política monetária e cambial e de alterações na composição da pauta de exportações sobre o desempenho da

* Corresponding author. Tel.: +55 6781479404.

E-mail addresses: claudia.sonaglio@gmail.com (C.M. Sonaglio), accampos@ufv.br (A.C. Campos), mjbraga@ufv.br (M.J. Braga).

Peer review under responsibility of National Association of Postgraduate Centers in Economics, ANPEC.

http://dx.doi.org/10.1016/j.econ.2016.01.002

economia brasileira utilizando um modelo estruturalista. Os resultados obtidos reforçam a importância do setor de manufaturas para o crescimento econômico, principalmente em um ambiente de taxa de câmbio competitiva.

Palavras-chave: Exportações; Crescimento Econômico; Política Econômica

1. Introduction

The industrial sector is considered strategic for the development of capitalist economies, through economies of scale, its development raises the productivity of the economy and contributes to the catching-up process of the technological development of the country (McCombie and Thirlwall, 1994). According to Kaldorian assumptions, the industrial sector is responsible for leading the economy to the stage of economic maturity.

Associated with this discussion is the question of productive structure. The more diverse the latter is, the greater the share of high-technology sectors, as well as the economic performance and competitiveness of country. Consequently, there is also an improvement in output growth capacity, since this economy could relax the restrictions associated to growth with external balance. Industrial goods are characterized by having coefficients of exports income elasticity higher than the output of primary sectors. More specifically, the expansion of exports reflects the performance of the most competitive sectors of the economies. Among these, noteworthy is the influence of the industrial sector, since this is an important diffuser agent of technology, responsible for generating external economies and linkage effects on the others (Kaldor, 1968). This relationship between the productive structure and the economic growth was expressed by Thirlwall (1979), who showed that no country can grow faster than the rate compatible with balance of Balance of Payments (BOP). In this context, changes in the exports – to minimize the participation of the industrial sector – have negative effects on the productive dynamic, and consequently for the economic development.

The analysis of series of exports made by SECEX/MDIC, in the period from 1996 to 2010, provide some evidence on the changes in the total exports of the Brazilian economy. Industrial goods lost sixteen percentage points in total exports in the period 2003–2010. And in relation to the participation of each component classified by technological intensity, we can note that high-tech industrial goods accounted for about 12% in 2000, representing approximately 4.6% in 2010. On the other hand, medium-high and medium-low technology industrial goods, which kept their share in approximately 23% and 19% in the period 1996–2007, recorded a reduction to 18% and 14.6%, respectively, of total exports in 2010. Lower technology goods have a downward trend over time of approximately 10 percentage points. In turn, non-industrial goods had an upward trend over the period and accounted for 36.4% of total exports in 2010. These evidences awaken the need to deepen discussions on the effects of this process, specially, of the loss of share of the manufacturing sector in the total exports of the Brazilian economy.

The economic literature suggests that the loss of representativeness of the industrial sector in exports from Brazil is associated with the effects of overvaluation of the real exchange rate, recorded since 2003, and this process would have occurred through the maintenance of a very high nominal rate of interest. The differential between domestic and international interest rates attracts speculative capital, which, in turn, contributes to the valuation of the exchange rate. It is further argued that the growth trajectory of exports of primary goods would be contributing to the appreciation of the real exchange rate, which reinforces the negative effects on the manufacturing sector. In recent years, the overvaluation movements of the exchange rate have been reflected in the loss of external competitiveness of the industrial sector and, consequently, in investment decisions, considering the uncertainty of expected profits, which, in turn, block the channel of technical progress and increased productivity of the country.

Specifically, with regard to the role of the exchange rate policy, on the one hand, the level of the exchange rate is a key price for developing countries, therefore, when defining the profitability of production by the ratio of prices between tradable and non-tradable goods, the exchange rate directly affects the definition of viability economic of sectors that can leverage the growth of overall productivity of the economy (Gala and Mori, 2009). Accordingly, the maintenance of appreciated exchange rates prevents the transfer of employees to the most dynamic sectors of high productivity, since the prices of non-tradable goods are artificially high. This implies low incorporation and small development of technical progress, as well as in maintaining high levels of unemployment or underemployment of labor in low productivity activities and therefore low incomes, which affects the absorption capacity (demand) of the economy.

On the other hand, the variability of the exchange rate also affects industrial competitiveness, since uncertainty about the exchange rate behavior affects investment decisions. Davidson (2002) argues that fluctuations in the exchange rate affect the competitive position of the domestic industry and limit its external insertion, given the uncertainty that impedes the calculation of the potential profitability, the entrepreneurs end up postponing investment decisions. Thus, these fluctuations impose negative effects on trade and investments, especially for developing economies. This determines the economic dynamism of a country and affects its long-term growth. However, for the economy to grow enough in the long term, it is essential that such productive structure is formed by a competitive export sector, especially regarding the export of products technology-intensive due to the higher income-elasticity of demand for exports associated with them.

In this context, the aim of this paper is to show the impact of changes in monetary and exchange rate policy, and changes in the composition of exports on the performance of Brazilian economy. In order to do so, we developed a model based in structuralist approach, considering the financial flows. The choice for this approach is due to the possibility of including an investment equation independent of savings, in addition to allowing the use of nominal variables that enable the analysis of the interrelationships between the real and financial sides of the economy. This would not be possible to be modeled when considering only those changes in real flows and investments derived from the level of savings, such as the neoclassical models.

Model calibration was made from the Financial Social Accounting Matrix (SAM) developed for the base year 2003, and the links between the real side and the financial sector are held by an intermediation fund responsible for flows of capital income among agents. This simplification was necessary because of the non-availability of disaggregated data of portfolios, but this limitation does not affect the objectives of this study.

This paper is structured in five sections, the first being this introduction. Section 2 briefly presents the relationship between the industrial sector and economic growth. Next, it presents the analytical model calibrated for the study. Section 4 presents the simulated results and, finally, the main conclusions.

2. Relationship between the manufacturing sector and economic growth

In the heterodox economics literature, the sectoral composition of the economy is important for the economic growth. This is because the manufacturing industry, according to the Kaldorian model, operates with increasing returns to scale, generating spillovers through interaction with other sectors of the economy, which is reflected in the increase in labor productivity and, therefore, in the real wage. More specifically, the increase in industrial production shifts the labor allocated in other sectors, raising the total productivity of the economy. Moreover, it stimulates the growth of the output, given the resulting increase of demand. Thus, according to McCombie and Thirlwall (1994), the manufacturing sector is considered as an "engine of growth".

The relationship between the growth process of economies involving the growth rate of output, employment and productivity in different sectors was presented by Kaldor (1968), consolidated in the economic literature as "Kaldor's Laws". These generalizations manifest that: (i) there is a positive relationship between the growth of industry and the growth of real output, and than higher the industry growth rate, the greater the national product growth rate; (ii) there is a positive relationship between productivity growth rate in the industry and growth of industrial output, with the causality relation implying that the higher the growth rate in the industry, the higher the growth rate of productivity; and (iii) there is a positive relationship between growth in Gross Domestic Product (GDP) and industrial productivity growth.

The first law incorporates the idea of industry as an "engine" of growth as the most innovation-diffuser and dynamic sector; the second, known as the Kaldor–Verdoorn law, establishes a causal relation between the rate of productivity growth and the rate of output growth. Thus, an increase in the outcome induced by demand causes an increase in productivity in sectors where there is the presence of economies of dynamic scale (Blecker, 2009).

The existence of mutual feedback between growth and increasing returns to scale, associated with greater technical progress driven by the growth of product, is associated with the idea of cumulative causation, formalized by Dixon and Thirlwall (1975). The model emphasizes the importance of autonomous component of aggregate demand to growth, especially the growth of exports; it also assumes that labor productivity is partly dependent on the output growth rate (Verdoorn's law).

In this context, the regional differences of growth are associated with the Verdoorn effect, because a region with growth advantage tends to maintain it through the process of increasing returns induced by growth. Thus, the dependence of productivity growth to the growth rate is not enough to cause regional differences in growth rates, unless the Verdoorn coefficient varies among the regions. Therefore, the Verdoorn relationship turns the model circular and cumulative, and so, the possibility increases that, as a region obtains an advantage, it tends to perpetuate itself (Setterfield, 2010).

Dixon and Thirlwall (1975) also show that the price and income elasticity of exports depend on the nature of the exported products, and the rate of autonomous productivity growth and the Verdoorn coefficient will depend on the technical dynamism of productive agents in the region and on the extent to which capital accumulation is induced by growth and technical progress. In this case, since the determinants of productivity and Verdoorn coefficient varies among industries, these parameters may vary among regions, depending on their industrial composition.

Thus, the argument placed to provide a higher rate of growth is fundamentally a matter of bringing the regions to be more competitive and/or changing the industrial structure in order to produce goods with higher income elasticity of demand for exports and higher Verdoorn coefficients, which would stimulate the expansion of the manufacturing industry and increase productivity. This would help to accelerate the rate of technological change throughout the economy, increasing its competitiveness in the foreign market.

This increasing competition is a stimulus to exports, which plays a fundamental role within the Kaldorian theory, since exports are the only autonomous component of demand able to stimulate sustainable economic growth (King, 2010). This is because the main constraint to growth led by demand is in the equilibrium condition of the Balance of Payments.

According to this approach, Balance of Payments constraints can influence the growth rate of the economy, because it is possible that before the supply constraints begin to operate, conditions that restrict the demand will do so, determining the economy will always operate below the point of full employment, i.e., fixing a slower rate of growth compared to the potential output. That is, no country can grow – at least in the long term – at rates greater than those, which ensure balance in the Balance of Payments, because increasing deficits financed by capital inflows lead to rising expectations of devaluation and/or because growing deficits require increases in interest rates to stimulate capital inflows, which encourages appreciation of financial capital to the detriment of real economic growth (Porcile and Curado, 2002).

The existence of an external constraint on growth is explored in more detail by growth models with external constraints derived from the Thirlwall seminal model (Thirlwall, 1979). According to this class of models, there is a direct correlation between the growth rate of the long-term product and the ratio of income elasticities of demand for exports and imports. Thus, a country cannot grow in the long run at a higher rate than that which ensures equilibrium of Balance of Payments (Setterfield, 2010).

In these models, the issues concerning the provision of goods are associated with the productive structure, since, even though the growth is led by demand, the different elasticities also reflect features are not associated with prices of goods that capture the yield structure. In other words, long-term growth of economies is explained by the structural characteristics reflected by the income elasticities, and changes in the productive structure (and therefore in elasticities) alter the product growth trajectory of long-run equilibrium.

Studies on the structural economic dynamics of Pasinetti (1981, 1993) advances this discussion. The author demonstrates that changes in the productive structure lead to changes in the growth rate due to the different growth rates of sectoral demand. That is, each sector has a particular ability (different elasticities) to take advantage of the increase in output. This view, together with an external restriction operation to growth, has been incorporated by Araújo and Lima (2007) in a formal model analogous to Thirlwall, which keeps the Pasinetti multi-sector dynamic. The derived equation is called the Multi-Sector Thirlwall's Law, according to which the growth rate of *per capita* income of a country is directly proportional to growth rate of exports (given by the sectoral income elasticities demand multiplied by the growth rate of the world economy) and inversely related to sectoral income elasticities of imports; and these elasticities were weighted by the relative participation of the sectors in the trade agenda. Thus, changes in the demand composition or in the productive structure – not captured by elasticities, but reflected in each sector of aggregate exports and imports – are important for growth. That is, unlike the original Thirlwall model – in which the growth rate of the countries could only increase with the rise in world income – the multisectoral approach of the countries can grow at higher rates, in compliance with external constraints from changes in the relative share of each sector in the total exports.

In short, the share of high-technology and higher value-added sectors resumes the importance of pattern of productive specialization and trade of the country, firstly by generating spillovers and improving productivity, and also by achieving a higher economic growth rate supporting the external balance. Therefore, changes in the composition of the foreign trade affect the productive structure, because the magnitude of the economic effects will depend on which segments are gaining and which are losing share in the exports.

Missio and Jayme (2012), the basic hypothesis is that maintaining a competitive exchange rate induces investment and structural change in the economy. By enabling changes in the outcome structure, the exchange is able to influence the long-run supply, especially in exports-related business. The authors pointed out that the income elasticity of the demand for imports and exports is endogenous to the level of the real exchange rate, insofar as keeping an undervalued currency stimulates research and innovation. These stimulates would occur through effects on self-financing conditions and access to credit, which would allow for the diversification of the production capacity, in turn enabling the increase of export capacity and reducing the dependence on imports in the long run. Thus, the authors conclude that structural change resulting from the maintenance of a competitive exchange rate generates a structure of expertise that improves the external balance conditions, promoting growth.

In the similar vein, Oreiro et al. (2015) to show at theoretical level that maintaining a competitive real exchange rate positively affects the economic growth of developing countries by means of a Keynesian-Structuralist model that combines elements of Kaleckian growth models with the Balance of Payments constrained growth models. In this setting, the level of real exchange rate is capable, due to its effect over capital accumulation, to induce a structural change in the economy, making endogenous income elasticities of exports and imports. For reasonable parameter values it is shown that if monetary authorities run exchange rate policy in order to target a competitive level for real exchange rate, than undervalued equilibrium is stable and the economy will show a high growth rate in the long-run.

It is clear, therefore, that the maintenance of a competitive exchange rate is of great importance for growth of developing countries, because their direct effects via aggregate demand, and indirect effects via structural change. Thus, in terms of economic policy, it is important to know the determinants of this growth rate and, especially, how it is possible to relax this restriction. On the one hand, these models show that the growth rate is associated with income elasticities of exports and imports. Consequently, higher income elasticity of exports and lower income elasticity of imports, greater is economic growth rate considering the equilibrium in the Balance of Payments. In this case, the export can be stimulated by exchange devaluations or implementation of specific policies. The most important implication derived from this analysis refers to the need for change in the export agenda, with emphasis on the export of goods with high income elasticity.

In summary, the external constraint can block economic growth. One way to relax this restriction is to stimulate the production and export of goods with high income elasticity, and to do so, it is necessary that the specialization pattern of the economy allows the adoption of this strategy.

3. Analytical reference

Productive specialization in high technology sectors and the maintaining of competitive exchange rates aggregate gains to economic growth, as discussed above. In this sense, to capture the impacts on Brazilian economy of using of monetary and exchange rate policy and of the change in the share of high technology sectors in total exports, a structuralist model was structured to address the interactions between the real and financial side. According to Thissen (1998), these models are the evolution of input–output analysis (IP), with endogenous adjustment of quantities and prices. These tools are appropriate to explain the economic mechanisms or to predict the possible outcomes of the adoption of policies due to this structure or in an alternative scenario, calibrated from a Social Accounting Matrix (SAM) for a given base year. And because it is a static calibration, the results are adequate for the medium-term analyzes opposed to general equilibrium models with Walrasian closure, wherein the optimization behavior prevails.

In this study, the description of the equations of model was based on the research of Gibson and Van Seventer (1997) for the real side, as well as on the study of Maldonado et al. (2010) as a simplification of financial balance, due to unavailability of data for the construction of the matrix of flows and funds for the Brazilian economy.[1]

[1] The matrices relating to the financial account of the Brazilian economy are being prepared by IBGE, following the methodology of the System of National Accounts.

Table 1
Breakdown structure of the analytical model.

Goods (activities)	Institutional sectors (demand agent)
1. Agriculture and fishing (AGROP)	1. Household (FAM)
2. Mining (MIN)	2. Government (GVT)
3. Low intensity technological industry (MBIT)	3. Foreign Sector (FGN)
4. Medium-low intensity technological industry (MMBIT)	
5. Medium-high intensity technological industry (MMAIT)	
6. High intensity technological industry (MAIT)	
7. Financial intermediation and insurance (IFS)	
8. Construction (CONST)	
9. Public Administration (ADMP)	
10. Other Services (OSERV)	
11. Imports	

Source: prepared by the author.

Table 2
Equations and variables of the real side – the demand block.

Name	Description		i
Aggregate demand	$X_i = \sum_{k \in set} (a_{ik} X_k + C_i + G_i + E_i) + \sum_{i \in d} d_{ik} I_i$	(2.1)	Asset
Consumption	$C_i = \mu_i + \frac{m_i}{P} \left[Y(1-\sigma)(1-t^d) - \sum_{k \in set} P_k \mu_{ik} \right]$	(2.2)	Asset
Household savings rate	$\sigma = \sigma_\sigma + \sigma_r i - \sigma_\rho \hat{\rho} + \sigma_u u$	(2.3)	1
Firm investments	$I_{bi}/K_{i,t-1} = if_{oi} - if_r(i-\hat{\rho}) + if_u u + if_\pi \pi + if_e e_r$	(2.4)	Set
Household investment	$I_w/K_{i,t-1} = ih_o - ih_r(i-\hat{\rho}) + ih_y Y_w + ih_8 u_8$	(2.5)	1
Government investment	$p_g^k I_g = s_p Y + S_g$	(2.6)	1
Government spending	$G_i/Y = G_{oi} + G_u u$	(2.7)	Asset
Exports	$E_i = E_{oi} Y_f^{\varepsilon_y} e_r^{\varepsilon_e}$	(2.8)	Qty
Utilized capacity	$u_i = X_i/Z_{i,t-1}$	(2.9)	Set
Utilized aggregated capacity	$u = \sum_{k \in set} X_i / \sum_{k \in set} Z_{i,t-1}$	(2.10)	1
GDP	$Y = \sum_{i \in set} \left(P_i X_i - \sum_{k \in set} P_i a_{ik} X_k \right)$	(2.11)	1
Real GDP	$Y_r = \sum_{i \in set} \left(X_i - \sum_{k \in set} a_{ik} X_k \right)$	(2.12)	1

Description of the variables (references ( ) denote the index/group of equations):
a_{ik} – coefficient of intermediate inputs; X_i – product (asset); C_i – consumption (goods); G_i – government spending (goods); E_i – exports (qty); d_{ik} – proportion of investment per agent; I_w – household investment (1); I_g – government investment (1); I_{bi} – firm investment (set); μ_i – subsistence consumption levels of each good (asset); $\frac{m_i}{P}$ – marginal propensity to consume; t^d – direct taxes (firms and households); P_i – price in the domestic market (goods); σ – household saving rate (1); Y_i – income (set + 1); i – nominal interest rate (1); $\hat{\rho}$ – inflation rate (1); u_i – sectoral used capacity (Qty); u – used aggregate capacity (1); π_i – profit rate (set); e_r – real exchange rate (1); s_p – borrowing of the public sector; S_g – government savings (1); ε_y – income elasticities of exports; ε_e – price elasticities of exports; – GDP (1); Y_r – Real GDP (1); P_i^k – prices of capital goods (set + 1); Z_i – potential output

Source: developed by the author, adapted from Gibson and Van Seventer (1997).

For the real equilibrium of the economy, it is assumed, that the firms operate in a single sector. Throughout the description of the equations presented in Tables 1–5, the *asset* index indicates the goods (productive activities of firms); *set* index indicates sectors in general, and *qty* index indicates *quantity clearing* sectors, i.e., it refers to those who do not operate at full employment and have their prices determined by the markup rules over costs.

Table 3
Equations and variables of the income block.

Name	Description		i
Household income	$Y_w = \sum_{k \in set} w_k b_k X_k + \sum_{i \in set} s_i Y_{bi} + T_i + T_{fi} + r_{p_i} Y_{fin,i}$	(3.1)	1
Government transfers	$T_i/(Y) = T_{0i} - T_{ui} u$	(3.2)	1
Firm income	$Y_{b,i} = \left[P_i/(1+t_{x,i}) - \sum_{j \in ativ} P_j a_{ij} - \sum w_j b_j \right] X_i + r_{p_i} Y_{fin,i}$	(3.3)	S
Government income	$Y_g = \sum_{i \in set} \frac{t_{x,i} P_i X_i}{(1+t_{x,i})} + \sum_{i \in set,1} t_i^d Y_i + r_{p_i} Y_{fin,i}$	(3.4)	1
Foreign income	$Y_f = P_{e,i}^* X_i + r_{p_i} Y_{fin,i} + wL^*$	(3.5)	1
Household savings	$S_w = Y_i(1-t^d) - \sum_{k \in ativ} P_k C_k$	(3.6)	1
Firms savings	$S_{b,i} = Y_{b,i}(1-t^d) - \sum_{j \in set} s_j Y_{b,j}$	(3.7)	1
Government savings	$S_g = \sum_{i \in set} \frac{t_{x,i} P_i X_i}{(1+t_{x,i})} + \sum_{i \in set,1} t_i^d Y_i + r_p Y_{fin,i} - \sum_{i \in set} P_i G_i - T_i$	(3.8)	1

Description of the variables (references ( ) indicate the indexes/groups of equations):
w – wages (set); b – inverse of the product-labor ratio (set); s_i – share of distributed profits (set); T_i – government transfers to households (1); T_{fi} – transfers from the external sector to families (1); r_{pi} – rate of return on financial assets (set + 1); Y_{fin} – property income (set + 1); wL – working abroad factor payment (1)

Source: developed by the author, adapted from Gibson and Van Seventer (1997).

Table 4
Equations, price block variables and interest rate.

Name	Description		I
Domestic prices	$P_i = (1+t_{x,i})(1+\tau_i)\left(\sum_{j \in ativ} P_j a_{ji} + \sum_{i \in ativ} w_i b_i \right)$	(4.1)	Set
Markup (financial)	$\tau_f = \tau_{of} + \tau_{rf} i$	(4.2)	1
Imports prices	$P_{11} = eP_e^*$	(4.3)	1
Capital price	$P_i^k = \sum_{j \in ativ} P_j d_{ji}$	(4.4)	Set + 1
Profit rate	$\pi_i = \frac{\{[P_i/(1+t_{x,i})/(1+t_{x,i}) - \sum_{j \in ativ} P_j a_{ji} - \sum w_i b_i] X_i - t^d Y_{b,i}\}}{P_i^k K_i}$	(4.5)	Set
Nominal interest rate	$i = i_0 + i_\rho \hat{\rho} + i_u u$	(4.6)	1
Nominal exchange rate	$e = \lambda_o - \lambda_1(E_i - M_i) - \lambda_2(i - i^*)$	(4.7)	1
Real exchange rate	$e_r = eP_e^*/P$	(4.8)	1
Sectoral real exchange rate	$e_{ri} = eP_e^*/P_i$	(4.9)	Qty
Inflation	$\rho = (P/P_{t-1} - 1)$	(4.10)	1
GDP deflator	$\hat{P} = Y/Y_r$	(4.11)	1
Nominal wage	$w_i = (1+\omega_i) w_{i,t-1}$	(4.12)	Set
Nominal wage growth	$\omega_i = \omega_{oi} + \omega_{\rho j} \hat{\rho}_{t-1} + \omega_{ui} u + \omega_{wi}(\partial_i - \alpha_i^r)$	(4.13)	Set
Productivity growth	$\partial_i = -(b_{oj} - b_{uj} u_j - 1)$	(4.14)	Set
Real wage growth	$\alpha_i^r = \frac{(\omega_i - \hat{\rho})}{(1+\hat{\rho})}$	(4.15)	Set

Description of the variables (references ( ) indicate the indexes/groups of equations):
τ_i – markup rate (set); τ_f – markup rate of the financial sector (1); M_i – imports (goods); $\hat{P}$ – GDP deflator; ω_i – growth of nominal wage (set); ∂_i – productivity growth (set); α_{ij}^r – real wage growth (set)

Source: Developed by the author, adapted from Gibson and Van Seventer (1997).

Table 5
Equations and variables of the financial block.

Technology of intermediation of financial capital	$\prod_i^n D_i^{\vartheta} \geq FI \geq \left(\sum_i^n \beta_i H_i^{\beth}\right)^{\frac{1}{\beth}}$	(5.1)	1
Agent balance	$S_i + \Delta H_i = I_i + \Delta D_i$	(5.2)	1
Intermediation fund balance	$\sum_i^n D_i = \sum_i^n H_i$	(5.3)	1
Return assets rate	$AR = \Lambda J_{D,i}$	(5.4)	1
Foreign interest rate	$J_{D,ex} = i^* + \Delta e^e + Ris_P$	(5.5)	1
Indebtedness level of the agent	$H_i \leq \eta_i (S_i / J_{D,i})$	(5.6)	1

Description of the variables (references ( ) denote the index/group of equations):
FI – volume of funds intermediated by the fund (1); ϑ – elasticity of substitution of financial deposits; $\beth$ – elasticity of loans substitution in the brokerage fund; H_i – volume of loans provided by the brokerage fund; $\Delta H_i = H_i - H_i^0$ – change in loans over the period; $\Delta D_i = D_i - D_i^0$ – change in deposits over the period (1); Λ – risk margin on productive investment; AR – rate of return on real assets; $J_{D,i}$ – rate of return on deposits in the brokerage fund; Ris_P – country risk; η_i – agent's ability to pay (1)

Source: prepared by the author, adapted from Maldonado et al. (2010).

Table 1 shows the sectoral breakdown of the model. Knowing that the main point of this study focuses on the analysis of the manufacturing sector, this segment was disaggregated by technological intensity, according to the classification provided by the OECD.[2]

The agriculture and mining industries are assumed to operate at full capacity. Imports are included as a specific good, but are not part of the production of firms; this is assumed to facilitate the description of the demand system of agents. There are three institutional sectors: families, government and foreign sector. These demand-agents are identified by the index (1) over the blocks of equations described below. Thus, the total number of agents considered in the model is given by the number of activity and institutional sectors, totaling 13 agents to be represented by the i sub-index throughout the description of the equations. The equations subsystems that make up the model used in this study are described below.

3.1. *The real side*

Table 2 presents the set of equations that comprise the block of demand in the model. Because it is subset, not all variables expressed in equations are described in this block. However, for the model to be determined, the number of variables must be equal to the number of independent equations. Thus, at the end of the model description, all variables will be identified.

The aggregate demand equation (2.1) is defined for the group of goods (*asset*) – eleven in all – when imports are considered a specific good. That may be so expressed, as the rectangular matrix of input–output is considered, wherein the last row records the intermediate imports and, thus, the last equation corresponds to the total imports, including intermediate and final import, with no difference being observed between competitive and non-competitive imports, for simplicity.

Product (X_i), determined by the aggregate demand, is then expressed by the sum of intermediate ($\sum_{k \in s} a_{ik} X_k$) and final ($C_{ik}$) consumption, government spending (G_i), exports (E_i) and investments ($\sum_{i \in d} d_{ik} I_i$). The participation of households, firms and government in the total investment is determined as a scalar and multiplied by a fixed vector (d_i). The columns of the matrix ($d = d_{ij}$) are investment proportions and differ in accordance with the performing agent, that is, these coefficients transform investments by destination in investments made by the source, according to Taylor (1990).

[2] OECD, Directorate for Science, Technology and Industry, STAN Indicators. International Standard Industrial Classification of All Economic Activities. Available at: http://unstats.un.org/ (accessed on December 12, 2009).

Consumption is given in Eq. (2.2), expressed by a linear expenditure system (LES).[3] The intercepts (μ_i) determine the subsistence consumption levels of each good (*asset*) and are independent of income or prices. These are calibrated to the SAM of base year, and allow to produce different income elasticities of demand. The term $\left(\frac{m_i}{P}\right)$ represents the marginal budget shares, the term $(Y_i(1-\sigma)(1-t^d))$ is the available income and the term $(\sum_{k\in s} P_k\mu_{ik})$ is the share of income spent on subsistence levels.

Eq. (2.3) refers to the households saving rate and is expressed by an intercept (σ_σ), calibrated to SAM of base year. The term $(\sigma_r i - \sigma_\rho\hat{\rho})$ indicates that the savings rate is a direct function of the real interest rate and of the utilized aggregate capacity ($\sigma_u u$). Firms' investments – Eq. (2.4) – is expressed by a negative relationship with the real interest rate ($if_r(i-\hat{\rho})$) and positive relationship with the utilized aggregate capacity, argument introduced as an accelerator of investments, because as the economy registers growth in the utilized aggregate capacity rate, there will be incentive to invest. Similarly, the net profit is included as an indicator of future return and is directly related to investments. The term ($if_e e_r$) is introduced to capture the effects of the real exchange rate of formation of the productive structure.

Household investment (Eq. (2.5)) is expressed with an inverse relationship with real interest rate ($ih_r(i-\hat{\rho})$) and a direct relationship with income level ($ih_y Y_w$) and the utilized capacity in the construction sector ($ih_8 u_8$). This is because it is assumed that household investment focuses on the residence sector, following the predicted by the Brazilian national accounts system.

Government investments and their spending are expressed in Eqs. (2.6) and (2.7). For simplification, government investments ($p_g^k I_g$) adjust themselves to maintain a fixed rate of financing need of the public sector in relation to GDP ($s_p Y$). Government spending on goods and services as a proportion of the product (G_i/Y) are linked to the utilized capacity by ($G_u u$). Just as in the equation of public investment, expenditures are adjusted to maintain constant the borrowing need of the public sector. This specification follows the study of Gibson and Van Seventer (1997), and was taken due to the downtrend need for public sector loans in the Brazilian economy in the calibration base year.

Eq. (2.8) describes the behavior of exports from sectors that adjust balance by quantities (except mining and agriculture). Exports (E_i) depend on the real exchange rate ($e_r^{\varepsilon_e}$) and real income of the rest of the world ($Y_f^{\varepsilon_y}$). The term (E_{oi}) can be used to capture exogenous shocks in demand for exports; (ε_e) and (ε_y) represent the price and income elasticities of exports, respectively. Elasticities estimated for the Brazilian economy are used in the calibration of the model, from the growth approach with restriction of BOP, made by Carvalho (2011). In sectors that operate at full capacity (agriculture, fishing and mining), exports adjust themselves according to Eq. (2.1), which implies lower exports before the increase in domestic demand for the same product level.

Sectorial utilized capacity (u_i) is represented in Eq. (2.9), expressed as the ratio between the actual (X_i) and potential ($Z_{i,t-1}$) output and, the utilized aggregate capacity (2.10) is obtained by adding utilized capacity from all sectors.

The last two equations in Table 2 represent the definition of the nominal (2.11) and real (2.12) GDP. Thus, the product is determined by the level of aggregate demand, expressed in (2.1), minus the intermediate consumption, in order to avoid double accounting.

3.2. Income

Table 3 presents the equations that determine the income of the agents. Household (Eq. (3.1)) have their income derived from the ownership of factors of production (labor and capital), domestic (T_i) and foreign (T_{fi}) transfers, also receiving income from property (Y_{fin}). These are derived from the ownership of financial assets or non-performing assets[4] and disclosed by the Integrated Economic Accounts system by IBGE.

Eq. (3.2) describes the transfer of the government, as an inverse function of utilized capacity, which tends to stabilize output fluctuations and are described following the prediction of maintaining a constant the financing need of the public sector, according to specification of Gibson and Van Seventer (1997). The economic intuition is that the government acts anti-cyclically and operates based on an expectation (whether declared or not) of outcome.

[3] The linear demand system was calibrated according to the methodology provided by: Norton and Scandizzo (1981). And the methodology for estimation of elasticities followed: Nganou (2005).

[4] The Brazilian National Accounts system distinguishes these incomes for generation of categories, such as interest, dividends and withdrawals, reinvested earnings of foreign direct investment, income insurance policy and land rent (Feijó et al., 2008).

Eq. (3.3) describes the firm income calculated by income minus costs and indirect taxes $\left(\left[\frac{P_i}{(1+t_{x,i})} - \sum_{j \in ativ} P_j a_{ij} - \sum w_j b_j\right] X_i\right)$. Firms also earn income from property (Y_{fin}).

The government income, expressed in (3.4) shows, in the first term, revenues from indirect taxes, provided that $\left(\frac{P_i X_i}{(1+t_{x,i})}\right)$ represents the total revenue (see (4.5) – firms profit); the second term refers to the direct taxes on all productive sectors and demand agents ($\sum_{i \in set,1} t_i^d Y_i$). Income from property ($r_{p_i} Y_{fin}$) supplement the income of this agent.

Foreign income (Eq. (3.5)) is given by revenues from imports from payment of labor input abroad and from income from property, discounting the transfers to households. Eqs. (3.6)–(3.8) define the savings of agents, such as revenues minus expenses.

3.3. Interest and prices equations

Table 4 shows the set of equations that determine the pricing system. The set of equations (4.1) describes the prices of domestic goods, in accordance with the markup (τ) rule over costs, also considering indirect taxes (t_x). Costs are determined by intermediate inputs – including imports – and wages. Markup rates are considered fixed, as it is assumed that the sectors operate below full capacity. Except for the financial sector, where the markup (τ_f) is expressed by Eq. (4.2) and reflects the differential between the cost of obtaining the funds and the lending to institutions, i.e., it reflects the bank spread; the increases in interest rates imply a rise in the financial markup.

Eq. (4.3) defines the domestic price of imports (P_{11}), given by the foreign price (P_e^*), multiplied by the nominal exchange rate (e). Eq. (4.4) describes the price of capital (P_i^k) as a fraction of the investment assets relevant for each agent (firms, households, government).

Eq. (4.5) defines the net profit rate, given by revenue, discounting indirect taxes, minus costs and direct taxes, divided by the price of capital employed. The interest rate (Eq. (4.6)) describes the reaction function of the Central Bank to control inflation. The interest rate increases as the inflation rate and utilized capacity increases. It is because, an increase in utilized capacity approximate the actual output to the potential output, which generates inflationary pressures. The parameters of this function can be changed to reflect a more or less aggressive monetary policy by the Central Bank.

The nominal exchange rate, expressed in Eq. (4.7) is an inverse function of the differential between the domestic interest rate and the foreign interest rate ($\lambda_2(i - i^*)$). The parameter (λ_2) captures the sensitivity of the differential interest rates and can be considered a measure of the degree of opening of the capital account. The effects of the trade balance are captured by the term ($\lambda_1(E_i - M_i)$), and the term (λ_0), it captures the other variables that affect the nominal exchange rate and can be used to model exogenous shocks.

The real exchange rate is presented in (4.8), where (P_e^*) is the level of foreign price; (e) is the nominal exchange rate; and (P) is the domestic price level. In (4.9), the sectoral real exchange rate is presented, where its parameters follow the description of (4.8), however, the price level of each sector is considered (P_i).

Eq. (4.10) describes the behavior of the price movement (inflation) in the model, and (4.11) expresses the deflator of the GDP according to standard description of the product at current prices divided by the product at constant values.

The wages movement is described by the four final equations of Table 4, where in (4.12), the nominal wage is set from a growth rate, which, in turn, is modeled in (4.13) on the lagged wage. The nominal wage growth rate depends on the history of inflation ($\omega_{\rho j}\hat{\rho}_{t-1}$) and on the level of utilized capacity ($\omega_{ui}u$), included as a measure of the bargaining power of workers. It is because the increases in utilized capacity reduce unemployment, implying pressures for higher wages. The term $\omega_{wi}(\partial_i - \alpha_i^r)$ expresses the difference between productivity growth and the reference wage of workers, indicating the claim about the level of nominal wages due to productivity growth. If growth in the recent period has been incorporated in terms of wage gains, the pressures for growth in nominal wages will be lower; instead, there will be pressure to increase the nominal gains.

Productivity gains in each activity are measured by the decrease of the labor-product ratio, as expressed in (4.14). The equation indicates that productivity increases more rapidly when the level of economic activity is high, because the sub-allocated factors are transferred to more efficient productions, increasing productivity, in compliance with the Kaldorians assumptions.

Growth of the real wage (4.15) includes nominal growth adjusted for inflation – and as it is a model formulated in discrete time, division by the term $(1 + \hat{\rho})$ is required.

Tables 2–4 summarize the equations on the real side of the economy to a static model, with the assumption that the lagged values are already established parameters. Thus, all variables expressed in equations should be determined so that the model reaches a feasible solution.

3.4. Equations of the financial block

The financial block unites periods wherein, separating the effects of the interest rate, no other financial magnitude will have *feedbacks* in the current period on the variables of the real economy. Therefore, the interaction of real and financial variables of the current period determines, for the following period, the initial (or lagged) value for the allocation of revenue. The size of the portfolio of the private sector is given by the lagged value of wealth over the savings made in the current period.

The description of the equations that determine the financial side of the economy follows the study of Maldonado et al. (2010). Due to the unavailability of disaggregated data per active and institutional sector, it was not possible to structure the matrix of flows and funds for the Brazilian economy, which makes it impossible to present a disaggregated portfolio. However, this simplification does not compromise the study, since the composition of the portfolio aggregates information from the financing sources and the changes in stocks of wealth of agents, and this information is also obtained with the use of a single intermediation fund.

Thus, transactions with financial capital, that is, payments between agents corresponding to loans, reinvestment, dividends and interest payments, among other transactions, are incorporated into the SAM through a fund intermediation. This fund transfers savings among the economic agents, and the equality between the sum of the row and column represents the balance between resources and usages of the financial capital. For Brazil, the information about the remuneration of financial capital is disclosed by IBGE in the Integrated Economic Accounts as income from property.

The intermediation fund that represents the financial market shows the agents' decisions in relation to lending or borrowing. These decisions represent the transfer of purchasing power between the present and the future, and depend on the net position (deficit/surplus) and on parameters such as: investment return rate, interest rate on debt, risk involved in the transaction, degree of risk aversion of the agent, among others. In addition, mergers of this type of transaction do not occur daily in general equilibrium models, as they involve dimensions of time and uncertainty, which makes the solution of the resulting model extremely complex. However, Maldonado et al. (2010) simplify the presentation through a representation that describes both the supply and demand of resources transiting through this market, as described below.

The intermediary fund receives proceeds as deposits (D_i) and distributes them in the form of loans (H_i), wherein index (i) represents the institutional sector. For deposits, a Cob-Douglas function is assumed (the substitution elasticity between funds is constant and equal to the unity), and for loans, a CET function is assumed – in which elasticity of transformation is constant, however, it is not necessarily equal to one, as shown in Eq. (5.1). The variable (FI) represents the volume of funds intermediated by the fund.

It is assumed that the intermediation fund operates competitively maximizing the profits, given by the interest income from lending minus the costs of obtaining the funds. Since the operating technology expressed in (5.1) exhibits constant returns of scale, the maximum profit is null in equilibrium. The maximization is performed in two stages, firstly being the level of deposits established to minimize funding costs and, in sequence, the maximization of the fund profits is performed. The rates ($J_{D,i}$) and ($J_{H,i}$) represent, respectively, interest on deposits and loans, and are considered exogenous.

Since the savings of each agent is determined in the real side of the economy and this may be invested in real or financial assets, the balance sheet requires that the difference between savings and investment is financed by the net change in the balance of deposits and loans of the agent, as shown in (5.2). This equation expresses the interaction channel between the real and the financial side of the economy and expands the concept of macroeconomic equilibrium between savings and investment, with the inclusion of financial flows. The balance of the intermediation fund is represented in (5.3) as the equality between total inflows of deposits and loans.

Since investments in the financial market, applied to the intermediation fund, compete with real investments, the interest rate of financial assets should be consistent with the rate of return of the (real) productive investment. Thus, it is assumed that the balance of market rates, in order to make agents indifferent between uses of its capital, is represented by a relationship similar to a CAPM – Capital Asset Pricing Model, expressed in (5.4). Where (AR) is the return on

Table 6
Dynamics equations.

Name	Description		
Capital stock	$K_i = I_i + (1-\phi)K_{i,t-1}$	(6.1)	s,1
Production capacity	$Z_i = (1+\propto_i)Z_{t-1}$	(6.2)	S
Productive capacity growth rate	$\propto_i = \propto_{oi} + \dfrac{\aleph_i(I_i - \phi K_{i,t-1})}{Z_{i,t-1}}$	(6.3)	S
Agent Wealth	$\Omega_i = \Omega_{i,t-1} + S_i + [P^k_{i,t} - (1+\phi)P^k_{i,t-1}]K_{i,t-1}$	(6.4)	s,1

Description of the variables (references ( ) denote the index/group of equations):
$\propto_i$ – capacity growth (set); Ω_i – wealth (set,1); ϕ – depreciation rate

Source: developed by the author, adapted from Gibson and Van Seventer (1997).

real assets and should be increased by a margin (Λ) on the return on the financial market in order to offset the risk of carrying out productive investment.

It is assumed that the interest rate on deposits of foreign capital to the intermediation fund is determined by the ratio of uncovered interest parity, shown in Eq. (5.5), where (i*) is the foreign interest rate, (Δe^e) is the expected change in the exchange rate and (Ris_P) is the country risk.

Moreover, as the credit markets often limit the indebtedness of private agent, (η_i) represents a fraction of ability to pay, represented by their economies, as shown in Eq. (5.6). Therefore, the debt ratio indicates the value of fraction that the credit market is willing to anticipate to the agent.

3.5. Dynamics

The static model depends on some lagged variables that change according to the equilibrium values of the variables for which the model is solved. Among these, we highlight the stock of capital, (K_i) production capacity Z_i() and wealth (Ω_i). Table 6 shows the adjustment equations that characterize the dynamics of the model.

The capital stock (6.1) naturally changes with investment, after deducting a fixed depreciation percentage ($(1-\phi)K_{i,t-1}$). Production capacity (6.2) is a function of the productive capacity growth rate, expressed in (6.3). This, in turn, it depends on a parameter that measures the marginal ability to produce $\left(\frac{\aleph_i(I_i-\phi K_{i,t-1})}{Z_{i,t-1}}\right)$. This term expresses the effectiveness of investment in creating new production capacity.

The wealth in the current period (6.4) is equal to the wealth of the last period increased by savings and capital gains, less the depreciation. Capital gains are simply the change in the price of capital multiplied by the lagged capital stock ($[P^k_{i,t} - (1+\phi)P^k_{i,t-1}]K_{i,t-1}$). The change in wealth equation ensures that variations in financial stocks are consistent with the savings flows obtained from the flow matrix in the real side.

3.6. Source of data and calibration of parameters[5]

The structuralist models require large amounts of data that are obtained from the National Accounts, Economic Census, estimates from other studies, as well as assumptions based on economic theory and on the particularities of the country under investigation. These data are organized by a Social Accounting Matrix (SAM).

The base matrix of this study was drawn from the National Accounts data, provided by IBGE, for the year 2003. The classification by technological intensity based on the description of STAN Indicators[6] provided by OECD was made from the Input–Output Matrix. The SAM was increased by an equity account to discriminate the movements of financial markets. This representation is made by adding a intermediation fund account, in which financial investment flows (loans and deposits) and physical capital of agents are recorded. With the inclusion of the financial market, the current account is aggregated with a factor of intermediary capital, where proprietary rents are registered.

[5] Information on the values assigned to each parameter will be made available on request to the authors.
[6] International Standard Industrial Classification of All Economic Activities, Directorate for Science, Technology and Industry. Available at: http://unstats.un.org/ (accessed on: July 10, 2010).

Thus, to account for the changes (flows) in the equity accounts of institutional sectors, it is necessary to obtain information on capital stocks of each agent. However, this information is not yet available for the Brazilian National Accounts, making it necessary to make inference about these values. This study uses the inventories calculated by Maldonado et al. (2010), as well as the average rates of return/interest representative for each institutional sector. Financial flows are obtained by difference of assets/liabilities of inventory matrices prepared for the period 2002–2003.

The balance between income and expenditure requires, for all accounts included in the matrix, that the summation of each line (income) and each column (payments/expenses) is equal. However, when contemplating the financial flows, the accumulation account should consider the change in inventories (flows) of deposits and loans in the intermediation fund, then creating the main channel of transmission between the real and financial side of the economy. Thus, the macroeconomic identity between savings and investments shall consider the level of savings plus loans to fund financial intermediation equal to the level of real and financial investment, measured by deposits made by the agent, as per Eq. (5.2) (Table 5). A set of parameters and coefficients for the solution model were obtained based on the SAM of the base year and on the official statistics of the country. Yet, those that refer to behavioral equations are adjusted by assumption in order to obtain the initial equilibrium established in the matrix that serves as a basis for calibration. Some equations have an intercept that differentiate the average and marginal variations. Their inclusion allows exogenous shocks to be simulated only with variations in these parameters. The way to determine the values from the SAM is to rewrite the equations by isolating the intercepts. As the other values are determined for the base year, the intercepts can be calculated.

The structuralist models are considered medium-term models, with ability to project the behavior of variables for a period of approximately five years (Taylor, 1990; Thissen, 1998). Thus, as the data base reference is 2003, the results can be compared with the published data. Long-term projections can be obtained with the inclusion of simplifications, such as maintaining constant technological standard of the economy, because the input–output coefficients are determined from the SAM of the base year.

The model programming was made with the aid of the General Algebraic Modeling System software (GAMS), version 23.6, and the solution was obtained by the CONOPT solver.[7] Estimates of the results obtained for the endogenous variables, when compared to official data for the Brazilian economy, indicate that the utilized model reproduces trajectories consistent with the reported statistics, suggesting validation of the model for economic policy analysis.

After reaching initial stable equilibrium, the model can be used to simulate the effects of different economic policies to be applied on the Brazilian economy. The comparative statics allows to check the change in the equilibrium values when any parameter of the model is changed. However, this study does not follow precisely the definition of comparative statics, due to the dynamics established by the model. That is, as the parameters are determined by specific equations, you cannot change them exogenously without exclusion of these equations. Thus, the procedure used in order to maximize the number of equations in the model was to apply shocks to the intercepts of the equations. This strategy, according to Gibson and Van Seventer (1997, p. 58), "is widely used and has secured more success than exclusion of equations".

4. Effects of economic policy and changes in exports agenda of Brazilian economy

4.1. Monetary policy effects

The high interest rate prevailing in the Brazilian economy is attractive to speculative foreign capital, and the inflow of capital arising from the differential in relation to the international interest rate encourages valuation of the exchange rate, which mainly affects trade balances and investment decisions (production). In addition, high interest rates increase the costs of obtaining funds for productive investments. Thus, the economy tends to maintain a financial recovery path instead of the real growth. In order to analyze the effects of the adoption of an expansionary monetary policy in Brazil, a shock reduction of two percentage points in the (nominal) basic interest rate was applied. The (SELIC) interest rate trajectory, utilized as a reference rate in the calibration of the model, presented, in the study period (2003/2007), a reduction of approximately ten percentage points. However, it was decided to examine a median scenario because of

[7] Available at: http://www.gams.com/dd/optconopt.html#RTNWMI.

Table 7
Effects of expansionary monetary policy – selected variables.

	GDP	UAG	Real interest rate	Real exchange rate	Consumer price index	Investments	Household consumption	Profits	Household income
2003	0.48%	1.18%	−11.49%	6.51%	0.00%	0.60%	−0.72%	0.78%	−0.75%
2004	0.18%	0.61%	−11.56%	6.28%	0.08%	0.40%	−0.65%	−0.03%	−0.65%
2005	0.22%	0.62%	−11.49%	6.28%	0.08%	0.36%	−0.63%	0.31%	−0.56%
2006	0.29%	0.62%	−11.49%	6.37%	0.08%	0.32%	−0.53%	0.30%	−0.61%
2007	0.36%	0.50%	−11.49%	6.25%	0.00%	0.59%	−0.70%	0.32%	−0.54%

Source: simulated data.

other factors that are related to the political decision of interest rate cuts that are not modeled in this study, such as the maintenance of inflation targeting, primary surplus and other macroeconomic fundamentals.

The policy of reducing interest rates implies an expansion of economic activity, observed by the positive variation in the index of aggregate capacity used (UAG) and with increase in production in the country, in all periods (Table 7). The price index (measured relative to household consumption) records small upward movement, following the heating of economic activity. Real interest rates have negative variation with reduction in the nominal rate, which is in line with expectations.

The reduction of interest rates and growth in profits are factors that encourage increased investment. An analysis of the sectoral composition indicates that the sectors of low and medium-low technological intensity register larger variations. Since these sectors are important for employment generation, because they are generally labor-intensive, this growth in productive capacity would foster the expansionary effect on the economy over time. The results of the model, when designed for a period of 10 years, reinforce this behavior and also show significant increases in investments of high-medium and high technology sectors. This can be interpreted as a response to the growing demand for higher technology products, which generally occurs with income growth.

Household income and consumption recorded negative growth with the reduction of interest rates, although the income of the other agents present growth. Wages has small positive changes over the years, although the wage share of manufacturing segments does not change when they are analyzed in relation to total wages.

With respect to the real exchange rate, it shows depreciation, which confirms the theoretical expectation that the reductions in interest rates imply increases in the real exchange rate. Exports, in turn, respond positively to depreciation, particularly in the manufacturing sector, as can be seen in Fig. 1.

The negative signs on exports of primary goods occur due to the closure rule used for these sectors, because they are considered to act at full capacity. Therefore, the movements fit themselves by the aggregate demand equation, and as these sectors are suppliers of raw material for manufacturing segments, the increase in domestic demand implies a reduction in exports.

Imports, even with the exchange rate depreciation, indicated growth; however, this is because the sectors use imported inputs in the production process. Nevertheless, the relative share of imports in the product does not record significant growth (about 0.5%).

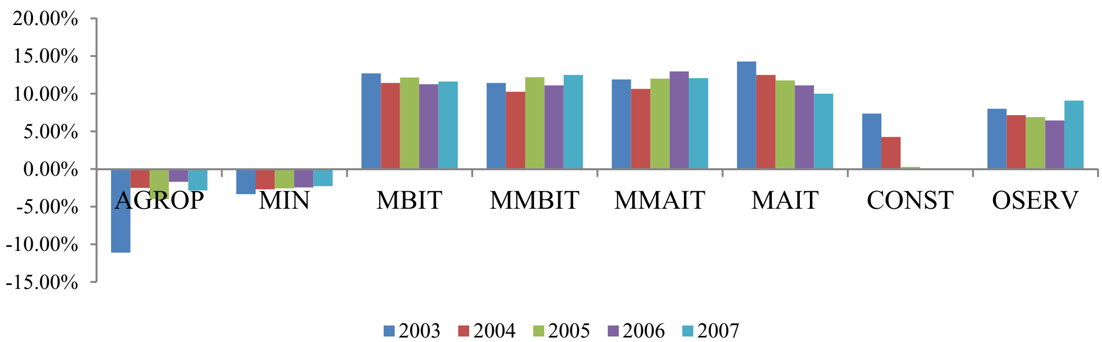

Fig. 1. Effects of expansionary monetary policy on exports. *Source:* simulated data.

Table 8
Effects of exchange rate policy – selected variables.

	GDP	UAG	Real interest rate	Real exchange rate	Consumer price index	Aggregate demand	Household consumption	Profits	Household income
2004	5.36%	7.78%	3.40%	25.53%	1.00%	7.19%	7.81%	16.35%	8.98%
2005	11.66%	11.56%	1.35%	23.87%	2.08%	12.35%	17.37%	10.82%	19.96%
2006	11.87%	10.47%	0.00%	24.15%	2.16%	12.61%	16.92%	5.75%	19.36%
2007	11.85%	9.57%	0.00%	23.99%	2.15%	12.58%	16.59%	4.76%	19.28%

Source: simulated data.

With the adoption of an expansionary monetary policy, manufactures raise their share in the national product (about 2%), as indicated by analysis of the sectoral composition of the product. This occurs mainly by maintaining a depreciated exchange rate, induced by reduction in interest rates, which increases the manufacturing exports and, in turn, their participation in total output, delaying the possible process of deindustrialization.

The effects observed on macroeconomic aggregates are more pronounced when applied to a shock reduction of interest rates by 4 percentage points. The domestic product display growth trend, reaching variation of 1.2% when the result is projected for a long term period (10 years). The relative share of manufactures in total output is growing in all segments of technological intensity, indicating that the Brazilian economy, in an environment of lower interest rates, would aggregate the benefits of the production of industrial goods and would be more likely to reach a stage of “economic maturity”, in Kaldorian terms. This is confirmed by the increase in sectoral investments, especially in the manufacturing and construction industry.

With sharper cut in the nominal interest rate, the real exchange rate remains undervalued by around 12% over the period, and manufactured exports respond positively to this depreciation, with growth of approximately 25%. The increase in the rate of capacity utilization supports the growth of employment and income. Profits register growth (above 7%), and the wages also grows, although they do not register an increase in the relative share of wages in manufacturing over total wage.

However, a contractionary scenario sets in when an increase in the nominal interest rate (2 percentage points) occurs. The GDP is reduced (1.5%) throughout the period, as well as the rate of utilization of the aggregate capacity. The real exchange rate is appreciated by about 6%, and exports, particularly of manufactured goods, register a decline of approximately 12%. Primary goods, in turn, increase their exports due to the contraction of the domestic market. With rising interest rates, investments are reduced in all sectors, which would entail delay in the incorporation of technical progress, limiting the long-term growth.

4.2. *Effects of competitive exchange rate policy*

Expected effects of maintaining a depreciated real exchange rate in export performance and incentives for productive investment are analyzed. It is done as established a depreciated rate by 10% relative to the initial equilibrium. There is no consensus in the technical literature of what would be the optimal real exchange rate in the long-term for the Brazilian economy, although the study of Nassif et al. (2011) affirming that, in April 2011, the real exchange rate of the country would be appreciated by about 80% compared to the optimal long-term level. However, by using a nonlinear model, it was not possible to estimate a shock of such magnitude. Moreover, the model was calibrated for the year 2003, a period that began a continuous path of exchange rate valuation, which justifies the establishment of a shock of the chosen magnitude.

Table 8 shows the results of this exchange rate policy; GDP registered growth after the second period of the simulation, indicating that Brazil does not operate in *wage-led growth* regime, since, after the short-term adjustments, the economy enters a growth regime with currency depreciation. This result is in accordance with the study of Araújo and Gala (2012).

Utilized Aggregated Capacity increased following the evolution of the GDP. A sectoral analysis shows that manufacturing and service sectors register the most significant variations in terms of capacity utilization (above 10%), indicating that these sectors are the most favored with the implementation of the competitive exchange rate policy. A result that, in turn, is reflected in the pattern of specialization of the Brazilian economy. The manufacturing sector

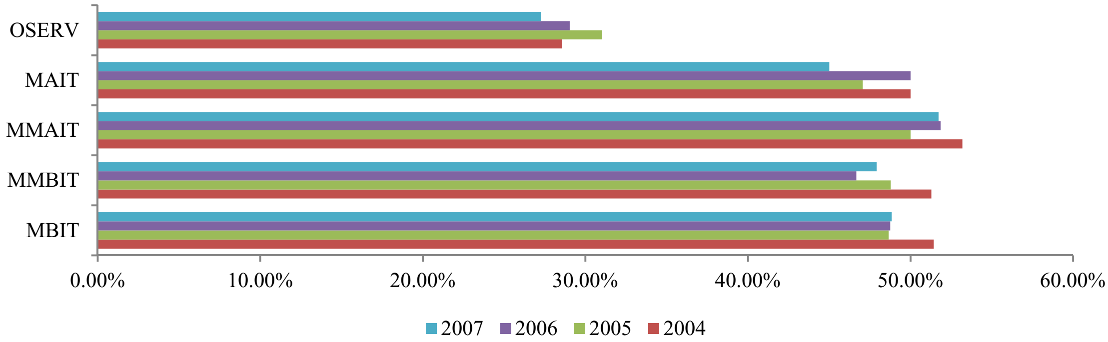

Fig. 2. Effects of exchange rate on exports policy. *Source:* simulated data.

raises the share on GDP, which reinforces the idea that maintaining a depreciated exchange rate would postpone the opening of the deindustrialization process in the Brazilian economy and act as an incentive to increase the supply, stimulating economic growth and employment.

The depreciation of the real exchange rate encourages export growth (Fig. 2), especially in the manufacturing and service. When one analyzes the relative sectoral composition of exports, it appears that industrial segments increase in approximately 18% their share in total exports. Imports record growth, but keep pace with output growth.

The expansionary effects of the exchange rate policy affect the investment decisions, because the exchange rate is an important argument in the formation of expectations, by firms, of expansion of production and demand. The maintaining a depreciated exchange rate is a stimulus to exports and sectoral specialization of the economy. Over the periods (Table 9), positive changes in sectoral investments are noted, except those observed in the services sector. Theoretical arguments support the assertion that investments in the manufacturing sectors influence positively the growth of productivity and external competitiveness of the economy. Therefore, resumption of the industrial growth would be a strategy for the growth of the Brazilian economy.

The growth of this industrial sector promotes a virtuous circle in the national economy, which can be verified by the rates of variations in macroeconomic aggregates (Table 8). The income of agents increases significantly, and the relative share of industrial wages in the total wages rises, indicating that the use of competitive exchange rate policy is an incentive to industrial development and, consequently, to the growth of income. The profit of the industrial segments growth above 10% in all periods, except in the low-technology intensive sector, where growth is 5%. The financial institutions sector, despite earnings, shows decreasing variations over time, indicating a more attractive investment in the productive sectors.

Maintaining a competitive exchange rate influences positively the level of exports and investments, especially in manufactures sectors, which, in turn, is reflected in the specialization pattern of the Brazilian economy. Diversification of production with increased production in these sectors is considered an important strategy, in terms of its technological spillovers, of the increase in productivity and, therefore, of output and employment in the medium/long term. Therefore,

Table 9
Effects real exchange rate policy on sector investments.

	2004	2005	2006	2007
AGROP	0.00%	9.09%	0.00%	8.33%
MIN	0.00%	0.00%	0.00%	20.00%
MBIT	6.45%	9.68%	6.25%	9.38%
MMBIT	4.55%	13.64%	13.64%	8.70%
MMAIT	8.00%	12.00%	11.54%	11.54%
MAIT	10.00%	10.00%	20.00%	9.09%
IFS	37.50%	29.63%	18.52%	23.08%
CONST	0.00%	11.11%	0.00%	10.00%
ADMP	5.88%	5.56%	5.56%	5.26%
OSERV	2.27%	0.00%	−2.38%	−2.44%

Source: simulated data.

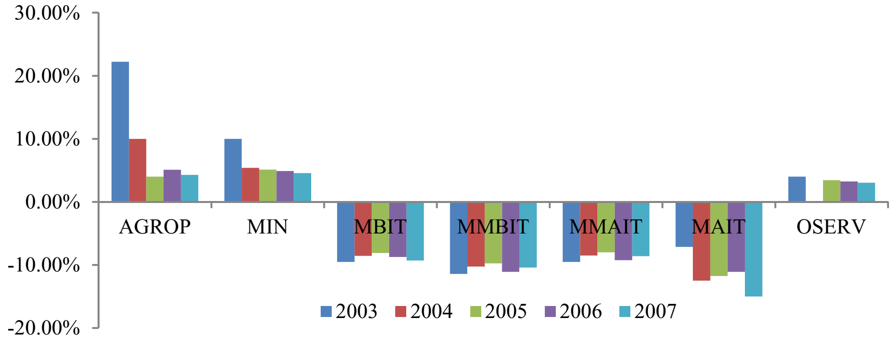

Fig. 3. Effects of a reduction in exports of manufactured goods on the sectoral exports. *Source:* simulated data.

the effects of a policy of competitive exchange economy aggregate a set of positive impacts to economy and, when they are designed for longer periods, it can be said that they elevate the level of competitiveness and development of the country. In this sense, actions to minimize the relative share of the industry in the production of the country, such as those that imply exchange rate valuation, act to delay the introduction of this virtuous circle. The direct effect, in this case, is a slower process of economic development, because the channels of technological progress from industrial development are blocked by uncertainties regarding the growth of demand and production. This is evident when we return to the maintenance setting of high interest and, therefore, overvalued exchange rate, wherein the negative effects predominate in terms of product and income.

4.3. Effects of changes in the composition of Brazilian exports

As the industrial sector has an important role in the economic dynamics to disseminate technical progress and to expand the capacity of growth without pressing the external balance, the inclusion in the export of goods with higher income elasticity (of exports) adds a set of factors that enable economic growth and increase the country's competitiveness. Situations where the economy exports goods with lower added value, such as the tendency to reprimarization of the exports, may compromise the growth path and block the increased productivity channel. Accordingly, in order to analyze the impact of a loss of representativeness of the manufacturing sector in total exports, was simulated a reduction of ten percent (10%) in exports of these goods.

The impact of a reduction in exports of manufactured goods on the domestic product is contractionary; such behavior is also noted by the aggregate capacity index. The price level show a slight drop, following the downturn in economy. A sectoral analysis of investments indicates that industries registers more pronounced negative variations, which can compromise the diversification of the productive structure.

The real exchange rate show depreciation when considering the reduction in the share of manufactured exports. However, exports in the manufacturing sectors propagate negative variations over all periods. Primary goods sectors respond positively to the movement of depreciation, reinforcing the reprimarization movement of the exports guideline (Fig. 3).

This growth in exports of primary goods is reflected in the sectoral composition of the GDP by increasing the participation of these sectors in the product. The reduction in the relative share of industrial sectors indicates that a reduction in exports of manufactured goods accelerates the initiation of deindustrialization. This is confirmed when designing the model results on longer periods.

5. Conclusions

The industrial sector is strategic in the economy's growth, and the reduction of the relative share in the total export of Brazilian economy, in recent years, sparked the need for studies to identify the effects on the economy. In this context, the aim of this study is to evaluate the impact of changes in economic policy and in change in the composition of the total exports on the performance of Brazilian economy using a structuralist model.

When an expansionary monetary policy is simulated, is possible note a depreciation of the real exchange rate, as predicted by the economic literature. Exports, especially of manufactured goods, respond to increasing competitiveness, encouraging investments and generating increased income.

Positive impacts on economic aggregates are also observed in a scenario of depreciated exchange rate. The best performance of external sector implies increase in productive investments, particularly in the industrial segments, which adds the gains from diversification of the productive structure to the country. This expansion of production in the industrial sectors minimizes the effects and slows the de-industrialization process in the Brazilian economy.

However, the reduction analysis of relative share of manufactured goods in the total exports strengthens the contractionary effects obtained in a high nominal interest environment and consequent exchange rate valuation. The loss of competitiveness of manufactured goods on the international scene is reflected negatively on the product, income and investment levels.

The presented results emphasize that the absence of industrial development policies may affect the ability of long-term growth. Although knowing that the problems of Brazilian competitiveness are beyond the exchange rate issues, it is explicit – by the results of the model – that the industrial sector can generate positive effects on output growth and expansion of production capacity. However, investments in infrastructure, tax reform and qualification of labor are latent needs. Furthermore, there is need to adopt trade policies that seek to expand international participation, such as multilateral agreement with technology transfer.

The presented results are the impacts of medium (and long) term on the Brazilian economy of measures that favor the performance of the industrial sector and the growth of the country. Therefore, the adoption of these measures, associated with actions aimed at correcting structural problems, will lead Brazil to a path of growth based on increased productivity and competitiveness, thereby promoting development.

References

Araújo, E., Gala, P., 2012. Regimes de crescimento econômico no Brasil: evidências empíricas e implicações de política. Estudos Avançados 26 (75), 41–56 (online).

Araújo, R.A., Lima, G.T., 2007. A structural economic dynamics approach to balance-of-payments-constrained growth. Camb. J. Econ. 31 (5), 755–774.

Blecker, R., 2009. Long-run growth in open economies: export-led cumulative causation or a balance-of-payment constraint? In: Paper prepared for the 2nd Summer School on "Keynesian Macroeconomics and European Economic Policies", Berlin, Germany, 2–9 August.

Carvalho, H.D., 2011. Exportações e crescimento econômico: uma análise da economia brasileira no período entre 1962 e 2009. Tese(Doutorado em Economia). Universidade Federal de Viçosa, UFV, Viçosa.

Davidson, P., 2002. Financial Markets, Money and the Real World. Edward Elgar Publishing, Northampton, MA.

Dixon, R., Thirlwall, A.P., 1975. A model of regional growth rate differences on Kaldorian lines. Oxf. Econ. Pap. 27, 201–214.

Feijó, C.A., et al., 2008. Contabilidade Social: A Nova Referência das ContasNacionais do Brasil, 3ª ed. Campus, Rio de Janeiro, 326 p.

Gala, P.S., Mori, R., 2009. Sobre os impactos do nível do câmbio real na formação bruta de capital fixo, no produto potencial e no crescimento. In: Michel, R., Carvalho, L. (Eds.), Crescimento econômico: setor externo e inflação. Ipea, Rio de Janeiro.

Gibson, B., Van Seventer, D., 1997. The DBSA Macromodel. Occasional Paper, n.120, Halfway House, Development Bank of Southern Africa.

IBGE, 2010. Classificação Nacional de Atividades Econômicas – Versão 2.0, Available at: http://www.ibge.gov.br/home/estatistica/economia/contasnacionais (accessed on March 2010).

Kaldor, N., 1968. Strategic Factors in Economic Development. New York State School of Industrial and Labor Relations, Cornel University, Ithaca, NY, pp. 83.

King, J., 2010. Kaldor and the Kaldorians. In: Setterfield, M. (Ed.), Handbook of Alternative Theories of Economic Growth. Edward Elgar.

Maldonado, W.L., Tourinho, O.A.F., Valli, M., 2010. Financial Capital in a CGE Model for Brazil: Formulation and Implications, Available at: http://www.eclac.org/comercio/noticias/paginas/4/34614/Financial_Capital_in_CGE_model_for_brazil.pdf (accessed on November 10).

McCombie, J., Thirlwall, A., 1994. Economic Growth and the Balance of Payments Constraint. St. Martin's Press, New York.

Missio, F.J., Jayme JR., F.G., 2012. Structural heterogeneity and endogeneity of elasticities on the balance of payments constrained growth model. In: Soukiazis, E., Cerqueira, P.A. (Eds.), Models of Balance of Payments Constrained Growth. , 1st ed. Palgrave Macmillan, pp. 239–267.

Nassif, A., Feijó, C., Araújo, E., 2011. The Long-term "Optimal" Real Exchange Rate and the Currency Overvaluation Trend in Open Emerging Economies: The Case of Brazil. UNCTAD Discussion Papers. N. 206, December 2011, Available at: http://archive.unctad.org/en/docs/osgdp2011d6_en.pdf (accessed on January 2012).

Nganou, J.P., 2005. Estimation of the Parameters of a Linear Expenditure System (LES) Demand Function for a Small African Economy. MPRA Paper, No. 31450, August.

Norton, R.D., Scandizzo, P.L., 1981. Market equilibrium computational in activity analysis models. Oper. Res. 29 (March (2)).

OECD, 1987. Structural Adjustment and Economic Performance. Organization for Economic Cooperation and Development, Paris.

Oreiro, J.L., Missio, F.J., Jayme JR., F.G., 2015. Capital accumulation, structural change and real exchange rate in a Keynesian-structuralist growth model. Panoeconomicus 62, 237–256.

Pasinetti, L., 1981. Structural Change and Economic Growth: A Theoretical Essay on the Dynamics of the Wealth of the Nations. Cambridge University Press, Cambridge.

Pasinetti, L., 1993. Structural Economic Dynamics: A Theory of the Economic Consequences of Human Learning. Cambridge University Press, Cambridge.

Porcile, G., Curado, M., 2002. Rigidez na balança comercial e movimentos de capital: uma abordagem estruturalista. Revista Brasileira de Economia 56 (3), 483–495.

SECEX/MDCI – Secretaria de Comércio Exterior/Ministério do Desenvolvimento, Indústria e Comércio Exterior – Estatísticas de comércio exterior. Available at: http://www.desenvolvimento.gov.br/sitio/interna/interna.php?area=5&menu=1113.

Setterfield, M., 2010. Endogenous growth: a Kaldorian approach. In: Harcourt, G.C., Kriesler, P. (Eds.), Handbook of Post Keynesian Economics. Oxford University Press, Oxford.

Taylor, L., 1990. Socially Relevant Policy Analysis. Cambridge MIT Press, Cambridge.

Thirlwall, A.P., 1979. The balance of payments constraint as an explanation of international growth rates differences. Banca Nazionale del Lavoro Q. Rev. 32 (128), 45–53.

Thissen, M., 1998. A Classification of Empirical CGE Moldelling, Available at: http://irs.ub.rug.nl/ppn/176969845 (accessed on January 13, 2011).