Projections of Economic Impacts Resulting of Demographic Change in Brazil for the Period 2010 to 2050

Flaviane Souza Santiago
Center for Regional and Development Planning, Department of Economics,
Federal University of Minas Gerais
e-mail: santiago.flaviane@gmail.com

Edson Paulo Domingues
Center for Regional and Development Planning, Department of Economics,
Federal University of Minas Gerais
e-mail: domingues.edson@gmail.com

Mônica Viegas Andrade
Center for Regional and Development Planning, Department of Economics,
Federal University of Minas Gerais
e-mail: mviegas123@gmail.com

Geoffrey J.D. Hewings
Regional Economics Applications Laboratory (REAL)
University of Illinois, Urbana, IL
hewings@illinois.edu

ABSTRACT

One of the possible consequences of the demographic and epidemiological transition that Brazilian population has experienced is the change in the consumption pattern of households. Empirically, it can be observed that consumer spent significantly change over the life cycle, then, the understanding of changes in consumption patterns associated with aging is essential due to its impacts on the productive structure of the country. In this context, the main aim of this thesis is to analyze the long-term changes in the production structure and in sectorial composition from Brazil resulting from the change in consumption patterns. To analyze these effects, this work use a Computable General Equilibrium model (CGE) with recursive dynamics. This model allows highlighting all sectorial linkage effects that changes in the vector of consumption - resulting from demographic changes - will affect in Brazilian economy until 2050. The projected results indicated an increase in demand for some goods and services, especially for health services (medicines, hospital assistance and health insurance), besides services provided to families and energy consumption; and a decrease in others, especially in food and education sectors.

Key words: Demographic Changes, Consumption Behavior, Age Group, Computable General Equilibrium.

JEL Classification: C68; D10; J10.

1. INTRODUCTION

Demographic transition has occurred differently across countries depending on the level of economic development. In most developed countries, the demographic transition process is already completed and took two centuries to occur. By contrast, in some developing economies, such as China and Brazil, this process has been fast and is still in its second stage, which is characterized by declining fertility rates and increasing mortality rates. As other developing economies, Brazil is facing a demographic challenge due to important changes in age structure of its population. In the last fifty years, the proportion of people aged under 10 dropped from 30 to 17% while the proportion of aged over 60 increased from 5 to 10%. According to United Nations projections, in 2050, the proportion of elderly people (aged over 60) will represent 29% of the whole population (United Nations, 2011).

Changes in age structure can affect both demand and supply of goods and services. On the demand side, changes in age distribution can alter the composition of household consumption among types of goods and services. It occurs because preferences usually vary along life-cycle. As a consequence, if population is aging very fast this process might involve changes in household consumption. It is necessary to reorganize the supply of goods and services to face these significant changes in the aggregated demand composition. In turn, such changes are likely to trigger substantial sectorial shifts (Denton and Spence, 1999; Fougère *et al.*, 2007; Lefèbvre, 2008).

Family consumption is one of the mechanisms through which population aging can affect the productive structure, through a change in its composition. Family demand is the main component of final demand in Brazil – which was responsible for 60% of GDP in 2012, according to data from IBGE – and consequently, that is also the main factor that boosts production. Demographic transition leads not only to changes caused by family demand, but also to significant changes boosted by other mechanisms such as changes in labor supply, social security, productivity level, health services and expenses (Börsch-Supan, 2002; Fertig and Schmidt, 2003; Wong and Carvalho, 2006; Yoon and Hewings, 2006; Rodrigues, 2010).

In this paper, the analysis will be done by considering only the change in productive structure due to consumption. All the other mechanisms are not considered. Since family consumption is one of the main components of demand, a possible approach is by overall balance, taking into account that this model encompasses all changes in several segments in the consumption vector. This methodology is able to demonstrate the sector chaining resulted from changes in the consumption vector as a whole.

Some important studies have been done on this topic using Computable general equilibrium (CGE) models. Park and Hewings (2007) used the CGE modeling along with overlapping generations, a specification of household behavior by age group was done over time. The objective was to analyze the dynamic effect of demographic change on Chicago's conditions of economic and intergenerational well-being.

By following this thematic and methodological line, Fougère, Mercenier and Mérette (2007) not only analyzed the sectoral impacts of demographic transition in Canada, but also studied their possible effects on the labor market. Two phenomena were analyzed. The first is a negative shock on the labor market that would arise from the slower growth of the workforce. The second is a change in the composition of demands due to the increase in the percentage of the elderly. The main results showed that labor supply will be reduced over time. Furthermore, there will also be a few significant changes in the sectoral composition due to the alterations in the final demand. In particular, the sectoral participation of health services in the total GDP tends to increase, rising from 4.8% of the GDP in 2000 to 7% in 2050. It is estimated that real wages would also rise two times faster in professions related to health service when compared to the rest of the economy.

In Raush (2009), however, the consequences of demographic transitions processes on the German economy are studied through a dynamic general equilibrium approach with overlapping generations. The main results found indicate that during the projection period (2003-2050), demographic transition in Germany will lead to a decrease of 7% in *per capita* production. That will occur, mainly, due to a 17% reduction in labor supply. In sectoral terms, those in expansion are characterized by higher rates of sectoral growth in capital and labor supply compared to growth rates in the whole economy.

Recently, Kim and Hewings (2011) developed a CGE inter-regional model to estimate the effects of population aging over regions of Korea. The model was developed for seven industrial sectors and two regions, the Seoul Metropolitan Area (SMA) and the rest of the country. The main results showed that population aging has a comparatively negative effect on domestic economy, but regional disparity lowers due to serious reductions in population groups from the SMA.

This article intends to delve more fully into this debate and develop methods and analysis of these phenomena in Brazil. Thus, the main objective of this paper is to analyze the long-term changes in productive structure and sectoral composition due to population aging, through an applied general equilibrium model. In usual specification, general equilibrium models are based on an input-output matrix. These matrix coefficients, in turn, are used in parameterizing the effects of the chaining between sectors. To analyze this change in composition of consumption due to population aging, it is necessary to have the composition of consumption vector, considering different age groups. Thereby, this paper contributes to the disaggregation of the input-output matrix consumption vector by age groups. Therefore, it becomes possible to work with demographic scenarios of population aging.

In the first part of this work, aiming to capture these effects, the strategy will be to use *household- type semi-elasticity,* calculated through econometric models estimated on Santiago *et al* (2014) in order to desegregate the consumption vector of input-output matrix. Next, this vector will be used as a shock simulation for computing a general equilibrium model, considering the possible impacts on relative prices, from which the economy will be able to attain a new equilibrium. It is worth mentioning that only aspects directly related to family consumption were addressed, considering the projections of Brazilian population growth up to 2050, that is to say, accepting that the change in composition of consumption, and consequently in the economic production level, is only due to Brazil's demographic change.

2. METHODOLOGY

2.1 BRIDGE-POP Model

To simulate the impacts on productive structure and the sectoral composition associated to population aging, we used a Computable General Equilibrium (CGE) model. BRIDGE-POP is a CGE model with recursive dynamics developed for the Brazilian economy, with the purpose of analyzing possible economic consequences of the population aging process. This model presents a theoretical structure that comes from *Brazilian Recursive Dynamic General Equilibrium Model- BRIDGE* (Domingues *et al.*, 2010a), which in its turn, follows the MONASH (Dixon e Rimmer, 2002) and ORANI (Dixon *et al.*, 1982) models. Both are Johansen type, where the mathematic structure is represented by a group of linearized equations and solutions are presented along with growth rates (elasticities) and several types of conclusions are allowed.

To meet the objectives proposed by the article, BRIDGE-POP encompasses three important improvements compared to *BRIDGE*: i) specific parametrization of economic consumption vector, ii) use of demographic variables in the model, and iii) a structure of recursive dynamics and temporality[1]. By inserting the two first elements in the model, it is possible to break down the consumption vector in terms of demographic variables represented by age groups, in order to explore the relationship between the change in demographic structure in Brazil and the consumption structure, considering different macroeconomic and demographic scenarios over time.

[1] Through mechanisms of capital accumulation, and adjustments in the labor market. CGE models with recursive dynamics are not new in Brazilian literature. See, for instance, Domingues *et al.* (2010a) and Haddad e Domingues (2001).

The third element inserted in the model is the structure of recursive dynamics. Since it is a long-term issue, implications of demographic changes in economy depend on projections for several years of a base case, containing growth rates of determining variables such as the GDP, consumption, investments, exportations and importations, not to mention a demographic scenario of population growth, desegregated from age groups whose growth is pre-determined according to the economy. Additionally, the model has mechanisms of recursive dynamics of capital accumulation and adjustment in the labor market, constituting one of the first CGE models for the Brazilian economy, empowered to analyze population aging and its impacts on the economy.

BRIDGE-POP's theoretical specification follows the pattern in national CGE models. Its central structure is made up of equation blocs that determine the relationships between supply and demand, derived from optimization hypothesis and market equilibrium conditions. In these blocs, some national aggregated are defined, such as labor supply level, commercial balance and price index. Productive sectors minimize production costs liable to a constant scale return technology, in which the combination of intermediate inputs and primary factor (aggregated) is determined by fixed coefficients (Leontief).

There is a substitution in the composition of inputs by prices between domestic products and imported ones, through functions of constant elasticity of substitution (CES). There is also a substitution via price between capital and labor supply by CES functions. While all sectors present the same theoretical specification, the effects of substitution by process differ according to the domestic/imported composition of the inputs used.

Household demand is specified from a non-homothetic Stone-Geary utility function (Peter *et al.*, 1996), in which a consumption composition by product between domestic and imported is controlled by CES functions. Sectoral exportations react to demand curves negatively, associated to domestic costs in production, and positively affected by exogenous expansion in international income, supposing we're taking into account a small country in the international market. The government consumption is typically endogenous, and can either be associated or not to household's consumption or to tax collection. The inventory accumulates according to the variation in production.

Recursive dynamics are specified through a modeling of the intertemporal behavior and results of previous periods (backward-looking). Economic conditions such as availability of capital are endogenously dependent on subsequent periods. However, they are not affected by forward-looking expectations (Magalhães, 2013). Therefore, capital investment and stock follow mechanisms os acummulation and intersectoral displacement from pre-estabilished rules associated to depreciation and return rates. The labor market also presents an element of intertemporal adjustment, which envolves variables with real wages, actual and tendencial labor.

Appendix A displays the mathematic formalization of the model in a more detailed manner. Next, the specification of households' demand in the model is detailed, since it is the most important part for the simulations in this article.

2.2 Specification of households' demand in BRIDGE-POP model

In the CGE model present in this study, households demand is specified based Stone-Geary or Klein-Rubin non-homothetic utility functions (Peter *et al.*, 1996), dividing consumption of goods and services into "luxury" and "subsistence" categories, in a way that a fixed installment of the expense is reserved to subsistence consumption, and residual installment is reserved to "luxury expenses", which allows modifications in the income to cause differentiated changes in product consumption.

The Stone–Geary or Klein-Rubin utility function takes the form:

$$\begin{gathered} U = \sum_{i=1}^{c} \beta_i \ln\left(B_i - N_i\right) \\ Com \quad \beta_i \geq 0, \quad \sum_i^n \beta_i = 1, \quad B_i - N_i > 0 \end{gathered} \tag{1}$$

Where B_i is the household consumption of goods i $(i = 1, \dots c)$, N_i is a parameter that represents the quantity of subsistence. The family is subject to the following budget restriction:

$$\sum_{i=1}^{c} P_i B_i = \mu \tag{2}$$

Where μ is the total expense of households, and p_i are the market prices. The maximization condition implies that the amount of good i demanded by household is represented by the following equation:

$$B_i = \frac{\beta_i}{P_i}\mu + N_i - \frac{\beta_i}{P_i}\sum_{i=1}^{c} P_j N_j \tag{3}$$

The equation (3) implies that the amount of the income spent on each good ($E_i = P_i B_i$) takes the form:

$$E_i = P_i N_i + \beta_i \left(\mu - \sum_{i=1}^{c} P_j N_j \right) \tag{4}$$

Therefore, if the amount spent on subsistence is always positive and the income is higher than the amount spent on subsistence ($\sum_{i=1}^{c} p_j N_j$), an individual will buy the necessary amount of each good, and then will divide what remains from their income among the other goods, in fixed proportions equal to β_i. The resulting demand system implies that the amount spent beyond subsistence is a constant participation in total expend, represented by the equation:

$$\beta_i = \frac{P_i(B_i - N_i)}{\sum P_i(B_i - N_i)} \tag{5}$$

By adding the equation (5), we obtain:

$$D_i P_i = \beta_i D \tag{6}$$

Where $D_{h,i} = Q(B_{h,i} - N_{h,i})$ and $D = \sum D_{h,i} P_{h,i}$. As a percentage variation, we have:

$$d_i + p_i = d \tag{7}$$

Thus, the total demand for each good X_i is given by:

$$X_i = QB_i = D_i + QN_i \tag{8}$$

Where X_i represents the total houlsehold consumption expenditure on good *i*, Q is the population, D_i corresponds to the total amount above the household subsistence expenditure on I , and N_i is the amount of subsistence expenditure *per capita* on good *i*.

As an alternative the equation may be represented as the following:

$$x_i = \alpha_i d_i + (1 - \alpha_i) q \tag{9}$$

Rewriting we have:

$$x_i = \alpha_i (d - p_i) + (1 - \alpha_i) q \tag{10}$$

Where $\alpha_i = D_i P_i / X_i P_i$, represents participation above the subsistence of all household expenditures on good *i*. The problem with Linear Expenditure System - LES form is that parameters N_i are measured by physical units. Then, utilized to parameterize the system, the level of price would affect the values of the coefficients. A strategy that can be used to circumvent the problem is to divide the input-output consumption flows $QB_i P_i$ into part of subsistence and above the level of subsistence – which means, $QB_i P_i$ e $D_i P_i$ -- and update each low vector separately. Then, α_i are, therefore, simple proportions of two vectors.

Thus, the initial value for each α_i can be deducted from Frisch's parameter estimations, ω, and from expenditure elasticity, ε_i:

$$\alpha_i = -\frac{\varepsilon_i}{\omega_i} \qquad (11)$$

Where α_i is the expenditure participation on luxury goods related to the total household expenditure on good i, ε_i corresponds to the household basic expenditure elasticity on good i, and ω_i is the Frisch's parameter for the family. In LES the participation of the total expenditure on subsistence in the total expenditure is given by $-1/\omega_i = \sum D_i P_i / X_i P_i$.

2.3 Database and parameters

BRIDGE-POP model basic structure follows the BRIGDE model structure. BRIDGE database was calibrated from the national accounts input-output matrix supplied by the IBGE (Brazilian Institute of Geography and Statistics), and is compounded by 110 products and 55 economic sectors for the year 2005. Aiming to analyze the implications of population aging on the economy, a bigger disaggregation in the health sector becomes necessary. Thus, the BRIDGE-POP model utilizes an input-output matrix that identifies the expenses in health sectors. For this purpose, the information from National Health Accounts was utilized, regarding the year 2005 and supplied by IBGE. The procedure adopted in the process of matching the input-output matrix is detailed in Andrade *et al* (2011). The input-output matrix version which encompasses the disaggregation of expenses in health sectors presents 60 sectors (the 55 original sectors and other five sectors of health), and 117 products (the original 110 and other seven from health).

From this desegregated input-output matrix for health products and sectors, the 117 products and 60 sectors were aggregated into 15 products and 15 sectors, respectively, taking into account the level of homogeneity of their individual activity. This aggregation was necessary so that the general equilibrium model database could be compatible to the 15 categories of expenditure used in the microsimulation model. The aggregation adopted is shown in Appendix B and aims to preserve, as much as possible, the information supplied by the matrix (database from the CGE model) and by the Family Budget Survey (POF).

Therefore, BRIDGE-POP acknowledges 15 productive sectors, 15 products, five components of the final demand (household consumption, government consumption, investments, exportations and inventory), three primary factor element (land, capital and labor supply), two boundary fields (commerce and freight transportation), importations of products for each one of the 15 sectors and five components of final demand, in addition to a disaggregation by types of taxes that are levied on the flow of purchases (IPI, ICMS and others), work remuneration (INSS and FGTS) and production (COFINS and others). Such disaggregation in taxes, contained in the database and the theoretical structure of the model, makes it possible to project politics of tax exemption by tribute, sector and even by occupation.

As described previously, in addition to data from the input-output matrixes, the EGC models use in their calibration, estimations of elasticities and parameters, called behavioral parameters. Such values are generally extracted from literature, which is justified by the shortage of data for the estimation. In this paper, most estimations for elasticity parameters were obtained from econometric estimations contained in the Multi-Regional Computable General Equilibrium Model TERM-CEDEPLAR (Domingues, Magalhães and Faria, 2009), such as, for exemple, the elasticity of substitution between primary factors and the elasticity of substitution between domestic and imported goods[2].

Armington elasticity (elasticity of substitution between imported and domestic goods) is defined by product and identical both for intermediate and investment goods and for the household demand. Such parameters come from Tourinho, Kume and Pedroso (2007). To measure the sensitiveness of marginal utility of the income, the structure of household demand follows the Frisch Parameter (Frisch, 1959). It is estimated as a negative number and is higher, in module, depending on how poor the population being analyzed is. In other words, the higher the parameter, the lower the "luxury" consumption and the higher the level of "subsistence" consumption. The BRIDGE-POP uses the value -2,48, estimated for the Brazillian economy in the multi-regional TERM-CEDEPLAR (Domingues, Magalhães e Faria, 2009) model. In order to complement the structure of the household demand, a parameter is used to measure the elasticity of its expenditure (EPS). These values were obtained in Pintos-Payeras (2009)[3].

3. DISAGGREGATION OF CONSUMPTION VECTOR IN AGE GROUPS

The association between household age structure and consumption composition was estimated through econometric models on Santiago *et al.* (2014). For each household group and each type of product a model, was run allowing the estimation of *household- type semi-elasticity*. All consumption items present in Expenditure Consumption Survey were aggregated into 15 groups of products. Seven types of households were defined: households with only two adults; households with two adults and one child (0-4 years old, 5-9 years old, 10-14 years old); households with two adults aged from 15 to

[2]For more details on TERM-CEDEPLAR model, see Domingues, Magalhães e Faria (2009).
[3] Pintos-Payeras (2009) calculates the expenditure elasticity for 27 groups from POF micro-data from 2002-2003. For this purpose the author uses a non-linear version of the almost ideal demand system (NL-AIDS).

49 and one adult aged from 50 to 59; households with two adults aged from 15 to 49 years and one elderly aged from 60 to 69 and finally two adults aged from 15 to 49 years and one elderly over 70´s. Households including only two adults (15-49) were considered as the reference category for the comparison of expenditure composition. In fact, 13 semi-elasticity's coefficients were estimated for each type of household. *Semi-elasticities* on food and housing expenditures are not estimated because these types of expenditure are common to all individuals living in the household, therefore it is not adequate to assume that elderly or children living in the domicile can cause variations in the budget share of these consumption items. In this case, the consumer vector disaggregation was made using the share of each age group in the total population[4].

For groups of products which are considered as individual expenditure (13 products), initially it was calculated the average cost of each product, represented as:

$$gm_i = \frac{gt_i}{pop_{2005}} \tag{12}$$

Where: gm_i is the average spent on product i, gt_i corresponds to total spent on product i and pop_{2005} represents the Brazilian population in the year 2005.

Thus the estimated cost with product i can be represented by the equation:

$$\begin{aligned} G_i^* = {} & (NA^{(15-49)} \times gm_i) + \left[NC^{(0-4)} \times gm_i(1+\alpha_i)\right] + \left[NC^{(5-9)} \times gm_i(1+\beta_i)\right] + \left[NC^{(10-14)} \times gm_i(1+\mu_i)\right] + \\ & + \left[NI^{(50-59)} \times gm_i(1+\delta_i)\right] + \left[NI^{(60-69)} \times gm_i(1+\lambda_i)\right] + \left[NI^{(70+)} \times gm_i(1+\eta_i)\right] \end{aligned} \tag{13}$$

Where: α_i is the marginal effect of spent for children of 0-4 years old on product i measured as a percentage. The other coefficients – β_i, μ_i, δ_i, λ_i, and η_i – correspond to the marginal effects of spent for the other group ages on product i. The coefficient that captures the marginal effect of adult spent among 15-59 years old is equal to zero, since this group is used as a reference, so the estimated spent will be equal to the average spent. The respective weights of the seven age groups are calculated as:

$$P_i^{A(15-49)} = \frac{(NA^{(15-49)} \times gm_i)}{G_i^*} \tag{14}$$

$$P_i^{C(0-4)} = \frac{(NC^{(0-4)} \times gm_i)(1+\alpha_i)}{G_i^*} \tag{15}$$

[4] For more details see Santiago *et al*. (2014).

$$P_i^{C(5-9)} = \frac{(NC^{(5-9)} \times gm_i)(1+\beta_i)}{G_i^*} \tag{16}$$

$$P_i^{C(10-14)} = \frac{(ND^{(10-14)} \times gm_i)(1+\mu_i)}{G_i^*} \tag{17}$$

$$P_i^{A(50-59)} = \frac{(NA^{(50-59)} \times gm_i)(1+\delta_i)}{G_i^*} \tag{18}$$

$$P_i^{I(50-59)} = \frac{(NI^{(50-59)} \times gm_i)(1+\delta_i)}{G_i^*} \tag{19}$$

$$P_i^{I(60-69)} = \frac{(NA^{(60-69)} \times gm_i)(1+\lambda_i)}{G_i^*} \tag{20}$$

$$P_i^{I(70+)} = \frac{(NI^{(70+)} \times gm_i)(1+\eta_i)}{G_i^*} \tag{21}$$

$P_i^{A(15-49)}$; $P_i^{c(0-4)}$, $P_i^{c(5-9)}$, $P_i^{c(10-14)}$; $P_i^{I(50-59)}$, $P_i^{I(60-69)}$ and $P_i^{I(70+)}$ P_i^A, P_i^c and P_i^I are the weights of adults, children and elderlies, respectively, in the consumption of the good or service i. By construction, $P_i^{A(15-49)} + P_i^{c(0-4)} + P_i^{c(5-9)} + P_i^{c(10-14)} + P_i^{I(50-59)} + P_i^{I(60-69)} + P_i^{I(70+)} = 1$

Thus, the estimated spent distribution, weighted by each age group, is expressed as:

$$\begin{aligned} gt_i = {} & \underbrace{gt_i.P_i^{A(15-49)}}_{G_i^{A(15-49)}} + \underbrace{gt_i.P_i^{c(0-4)}}_{G_i^{c(0-4)}} + \underbrace{gt_i.P_i^{c(5-9)}}_{G_i^{c(5-9)}} + \underbrace{gt_i.P_i^{c(10-14)}}_{G_i^{c(10-14)}} + \\ & + \underbrace{gt_i.P_i^{I(50-59)}}_{G_i^{I(50-59)}} + \underbrace{gt_i.P_i^{I(60-69)}}_{G_i^{I(60-69)}} + \underbrace{gt_i.P_i^{I(70+)}}_{G_i^{I(70+)}} \end{aligned} \tag{22}$$

Where $G_i^{A(15-49)}, G_i^{c(0-4)}, G_i^{c(5-9)}, G_i^{c(10-14)}, G_i^{I(50-59)}, G_i^{I(60-69)}, G_i^{I(70+)}$ are the consumption of the referring age groups with product i.

Table 1 presents the weighted weights of each age group in terms of percentage and the new consumption vector by age groups. The last line of the table shows the population´s distribution in 2005 by age group. When estimated weights are used, there are different weights for each product. Although there is no wide variation between these weights, this difference shows impact on the composition of consumption in each age group, especially for goods related to health.

Table 1 also presents unpublished data on national literature. The results indicate the heterogeneity of consumption by age group. It can be highlighted:

i. Greater participation of elderlies and children in health goods (medicines, health care and health insurance);

ii. The expenditures on private education and financial services and insurance are higher for children and young adults;

iii. The expenditures on energy, housing and food are higher for adults.

Table 1 - Disaggregation by product (in %) and by types of households, Brazil 2005

Products	Types of households							Total
	2 adults and			Only	2 adults and			
	1 child (0-4)	1 child (5-9)	1 child (10-14)	2 Adults 15-49	1adult (50-59)	1 elderly (60-69)	1 elderly (70+)	
Food	9.29	9.31	8.91	55.07	8.39	5.04	4.00	100.00
Textiles and clothing	10.55	10.70	11.54	46.83	10.31	5.53	4.54	100.00
Fuel and transportation	10.56	11.89	10.61	44.00	13.16	6.59	3.19	100.00
Medicines	12.36	11.04	9.11	37.86	13.08	8.67	7.87	100.00
Health insurance	20.63	14.48	12.18	29.22	10.15	6.81	6.53	100.00
Health assistance	12.65	14.57	11.92	31.95	13.94	7.63	7.34	100.00
Durable goods	11.71	11.55	11.11	41.63	11.37	6.99	5.64	100.00
Other goods	11.00	10.84	11.28	45.37	10.11	6.49	4.92	100.00
Energy	10.14	10.79	10.59	47.92	10.01	5.50	5.05	100.00
Private education	9.60	19.74	17.21	33.05	14.98	3.02	2.40	100.00
Financial services and insurance	14.03	14.00	11.14	35.55	13.34	9.35	2.58	100.00
Services	11.95	13.40	13.39	37.12	12.44	6.81	4.89	100.00
Services provided to families	10.76	11.33	10.74	43.72	12.10	6.78	4.56	100.00
Food out of the household	8.70	12.53	13.37	42.64	12.72	6.96	3.09	100.00
Housing	9.29	9.31	8.91	55.07	8.39	5.04	4.00	100.00

Source: Authors' calculation from the model results

In Table 2 the new consumption vectors disaggregated by age groups are arranged. The sum of each product in the line is the total consumed by households in 2005. With these new vectors and using demographic projections it will be possible to estimate the production needed to satisfy the demand for these age groups. This allows connecting the household consumption to demographic scenarios.

Table 2 - Composition by product (in million R$ from 2005) and by types of households, Brazil 2005

Products	Types of households							Total
	2 adults and			Only	2 adults and			
	1 child (0-4)	1 child (5-9)	1 child (10-14)	2 Adults 15-49	1adult (50-59)	1 elderly (60-69)	1 elderly (70+)	
Food	21.479	21.533	20.599	127.319	19.394	11.645	9.239	231.208
Textiles and clothing	6.933	7.032	7.585	30.774	6.775	3.634	2.987	65.72
Fuel and transportation	12.07	13.594	12.127	50.301	15.042	7.534	3.65	114.318
Medicines	4.44	3.968	3.274	13.602	4.7	3.114	2.828	35.926
Health insurance	1.781	1.25	1.051	2.522	876	588	563	8.632
Health assistance	3.73	4.297	3.514	9.419	4.111	2.248	2.164	29.482
Durable goods	14.148	13.951	13.423	50.292	13.741	8.444	6.81	120.809
Other goods	13.41	13.219	13.757	55.318	12.323	7.912	5.996	121.935
Energy	5.184	5.518	5.415	24.499	5.116	2.813	2.581	51.126
Private education	3.354	6.898	6.012	11.548	5.232	1.056	838	34.939
Financial services and insurance	12.293	12.272	9.759	31.153	11.693	8.194	2.261	87.624
Services	13.546	15.196	15.181	42.089	14.103	7.726	5.546	113.389
Services provided to families	6.56	6.906	6.545	26.643	7.374	4.13	2.781	60.938
Food out of the household	5.471	7.883	8.411	26.823	8	4.378	1.946	62.912
Housing	14.851	14.888	14.243	88.029	13.409	8.052	6.388	159.859

Source: Authors' calculation from the model results.

4. CLOUSRES AND SIMULATION

4.1 The closure of the model

The model is closed by the determination of the group of endogenous and exogenous variables from the simulations made. This closure represents the hypothesis about how the economy works and about its adjustments and politics. The mechanisms of recursive dynamic used in BRIDGE-POP, allows its explicitly temporal utilization, in which the endogenous variables adjust themselves, during the evaluation period, after an initial shock, or after consecutive shocks. Thus, simulations and analyses are performed from two closings: they are i) the closure of the Baseline Scenario, and ii) the closure of Politics. Based on these scenarios, BRIDGE-POP can project the effect of the participation of the elderly on population, its impact on productive structure and on consumption composition.

In both closures the following hypothesis are adopted: i) the real household consumption is endogenous and follows a projection of the GDP; ii) the real government consumption is endogenous and follows household consumption; iii) the aggregated investment is endogenous; and iv) the external commercial balance is endogenous. The price of importations in foreign currency is fixed and the price of exportations depends on domestic production costs.

The baseline closure institutes a group of shocks and endogenous variables in order to reproduce a reference scenario for the analysis (in this case, the macroeconomic scenario observed between 2006 and 2011 and projected for five-yearly periods from 2005-2050), delimitating the economic trajectory in the absence of any other external changes. Initially, such projections entered as shocks in the simulations that calculate endogenously the whole Brazilian economic scenario (endogenous variables) up to 2050. In this simulation, variables of technologic/productivity changes respond endogenously in order to guarantee that the scenario follows up with the projection. The values obtained for these variables show that an estimative of how much must be changed in preferences and technology over the period. Next, a new simulation of the baseline scenario is performed, using the values found for technological variables, which become exogenous, obtaining endogenously the GDP and other macroeconomic variables. This phase is called "baseline-rerun."

Table 3 summarizes the main macroeconomic indicators of the scenario between 2005 and 2050, which are used in the simulations using the BRIDGE-POP model in the Brazilian economy[5]. As we can see, in the quinquennium between 2011 and 2015, the economic behavior reflects the international crisis occurred from 2009: decrease of growth rates in GDP, exportations, and household and government consumption. The investment, in its turn, accelerates in the quinquennium, reaching a 17.06% increase. In the following quinquennium, the economy recovers itself, with projections of a more stable growth, showing small oscillations, except for the exportations which rise 24% in the quinquennium.

Table 3 - Reference scenario for the Brazilian economy, from 2005 to 2050 (var. % accumulated in the quinquennium)

Years	GDP	Household consumption	Government consumption	Exports	Investiments
2005/2010	24.32	31.70	19.57	22.00	12.88
2011/2015	18.25	18.88	16.56	17.00	17.06
2016/2020	21.08	19.24	19.24	24.00	22.02
2021/2025	24.62	20.20	20.20	24.00	26.39
2026/2030	24.62	21.63	21.63	24.00	31.18
2031/2035	22.58	22.33	19.44	24.00	21.91
2036/2040	22.23	20.45	19.41	24.00	23.71
2041/2045	23.02	20.77	19.98	24.00	25.04
2046/2050	23.41	21.07	20.13	24.00	25.65

Source: Authors' elaboration based on Dominguez et al. (2010b).

It is worth mentioning that between 2011 and 2030, projections for the macroeconomic variables were used. Their estimating methodology is based on a model of macroeconomic consistency, described in Domingues *et al.* (2010b).

[5] The methodology used for the construction of this scenario is a model of macroeconomic consistency, with two different periods: the observed one (from 2005 to 2011) and the projected one (from 2012 to 2050) as described in Domingues et al. (2012b).

The second set of shocks consists of demographic data of total population growth tendency (reference scenario) and age groups (for the changes in the consumption vector in policy simulations). The projections performed are produced by ONU, and were revised in 2010. Table 4 presents an average growth rate in total population and by age groups, accumulated in five-yearly periods (2005 to 2050). It is possible to observe that the growth rates of the groups are very distinct, with a growth reduction in the adult (15 to 59 years) and child population (0-14 years). In groups with ages from 0-4 and 5-9, there is a negative growth in the very first period, and the group with ages between 10 and 14 begin to present a negative growth in the 11-15 quinquennium. The biggest growth occurs for the group with ages above 60 years, which presents a positive growth up to 2050. This reflects directly the total growth rate of the population (Table 4), which presents a positive growth up to 2040, however, as we can see, this same growth drops progressively over the period, reaching not much more than 0.5% in the quinquennium from 2035 to 2040, dropping later and tending to negative variations from 2040 to 2050.

Table 4 – Demographic scenario: population growth rate by quinquennium in Brazil, from 2005 to 2050 (var. %)

Years	0-4	5-9	10-14	15-49	50-59	60-69	70+	Total
2010	-12.28	-0.79	4.25	4.09	19.91	17.74	20.91	4.82
2015	-3.84	-12.17	-0.72	3.31	17.32	24.47	18.69	4.28
2020	-4.08	-3.79	-12.15	2.78	9.48	21.20	21.95	3.51
2025	-4.51	-4.05	-3.78	0.22	4.83	18.19	24.25	2.76
2030	-5.74	-4.48	-4.04	-1.68	9.47	10.05	23.35	1.97
2035	-5.53	-5.71	-4.47	-3.43	10.88	5.46	22.18	1.23
2040	-4.50	-5.51	-5.71	-3.51	2.68	10.07	15.93	0.55
2045	-3.65	-4.48	-5.51	-3.66	-3.72	11.32	12.79	-0.07
2050	-3.13	-3.64	-4.48	-5.16	0.46	2.97	12.69	-0.64

Source: Authors' elaboration based the data from ONU (United Nations, 2011).

The political scenario establishes specific shocks for determined variables and periods that are analyzed and have impacts on the baseline scenario constructed. The demographic shocks performed by age are applied in the closure of politics[6]. In this paper, the same baseline-rerun is used, but now it will take into account the deviation in demographic growth by age groups.

The demographic change simulation has two shock vectors: the population growth by age group and the change in consumption vector that it causes. The values used in building the shock vectors were calculated taking the results from econometric model described in Santiago et al (2013). From it we obtained the marginal effects of each age group on domicile and later used to desegregate

[6] Although demographic change is not a "politic", this denomination was maintained since it is standard in the CGE literature.

the consumption vector of households by age groups. From this desegregated consumption by age groups, shocks for the simulations were calculated.

Considering one more time the real values projected for the Brazilian population, the growth rate by age group $\Delta_{t,t+n}pop^j$ is given by:

$$\Delta_{t,t+n}pop^j = \left[\left(\frac{pop^j(t+n)}{pop^j(t)}\right)-1\right]\times 100 \tag{23}$$

Where $pop^j(t)$ corresponds to the age group population j in the beginning of the period; $pop^j(t+n)$ is the age group population j in the end of the period; j varies from 1 to 7, since the indexes 1 to 7 refer, respectively to children (0-4 years), children (5-9 years), children (10-14 years), adults (50-59 years), elder (60-69 years) and elder (70 or more); t corresponds n is the number of years in the period (five years).

To obtain the consumption variation due to demographic changes in the quinquenniums (2010-2050), the consumption by types of households observed in 2005 (see Table 2) and the population growth rates are used as follows:

$$\Delta_{t,t+n}gt_i^j = gt_i^j(t)\times\Delta_{t,t+n}pop^j \tag{24}$$

Where $\Delta_{t,t+n}gt_i^j$ corresponds to the total expenditure variation (%) by product i by age group j, $gt_i^j(t)$ is the consumption of each product i by age group j between t and $t+n$; t corresponds to the initial year and n is the number of years in the period (five years). Thus, the consumption of each product i by age group j in the following years is given by:

$$gt_i^j(t+n) = gt_i^j(t) + \Delta_{t,t+n}gt_i^j \tag{25}$$

By construction, the sum of each product's consumption by all age groups is given by:

$$\sum_{j=1}^{7} gt_i^j(t+n) = gt_i(t+n) \tag{26}$$

The percentage variation of the total expenditure by product i can be obtained for each quinquennium. Such variances are the shocks of politics, that is to say, the shocks of demographic changes. Thus, the consumption vector shock represents the difference between a situation of homogeneous population growth (with no difference in age) and a differentiated growth (by age groups).

Table 5 presents the variances (accumulated in each quinquennium and in the total) of consumption vector, due to demographic changes. It is observed that all products present a reduction in Percentage variation over the periods, being negative for some. The variation of the estimated adjustments reflects the effects of the composition by age group consuming each product. Products that are traditionally more consumed by the elder, such as medicines, health insurance, health assistance, services, services provided to the family, and energy suffer more elevated variations in the total (last column of Table 4). That occurs because this age groups presents a higher growth rate in the period. Lower growth rates occur in products that can be considered as less consumed by the elder, such as education, housing service, food out of the household, textiles and clothing, fuel and transportation, housing and food.

Table 5 – Percentage variation of total consumption in each quinquennium and the accumulated in 2050, due to the change in the age of the population (in %)

Products	Cumulative rate in each five-year period									Accumulated in period
	2010	2015	2020	2025	2030	2035	2040	2045	2050	
Food	4.82	4.28	3.51	2.76	1.97	1.23	0.55	-0.1	-0.6	19.82
Textiles and clothing	5.01	4.42	3.42	3.04	2.5	1.93	1.03	0.26	-0.1	23.52
Fuel and transportation	5.32	4.75	3.65	2.99	2.49	1.88	0.87	-0.1	-0.5	23.31
Medicines	6.12	6.11	5.43	5.11	4.69	4.25	3.15	2.18	1.71	46.00
Health insurance	3.66	3.87	3.41	3.71	3.37	3.08	2.24	1.55	1.27	29.37
Health assistance	5.81	5.27	4.56	4.58	4.41	4.11	2.82	1.77	1.59	40.74
Durable goods	5.33	4.95	4.09	3.82	3.33	2.81	1.88	1.06	0.63	31.49
Other goods	5.09	4.64	3.74	3.41	2.79	2.19	1.39	0.68	0.17	26.71
Energy	5.11	4.5	3.67	3.23	2.68	2.12	1.23	0.47	0.09	25.47
Private education	4.77	2.7	1.42	1.45	1.61	1.38	-0.3	-1.6	-1.1	10.74
Financial services and insurance	4.95	4.79	3.83	3.35	2.66	1.94	1.24	0.43	-0.3	25.16
Services	5.22	4.57	3.53	3.46	3.09	2.64	1.6	0.7	0.41	28.11
Services provided to families	5.4	4.93	3.95	3.47	2.96	2.39	1.43	0.54	0.12	28.04
Food out of the household	5.56	4.65	3.36	2.99	2.45	1.8	0.85	-0.1	-0.5	22.98
Housing	4.82	4.28	3.51	2.76	1.97	1.23	0.55	-0.1	-0.6	19.82
Total	5.11	4.57	3.66	3.2	2.63	2.02	1.16	0.36	-0.1	24.89

Source: The authors'.

Given the specification of the model, this shock is reflected in the demand for the consumption of the goods, which will also be affected by the effects of general balance in the price of products. The strategy used in the simulation consisted in the calibration of a preference shock which reflected an additional growth by product in the quinquennium due to the change in age. Such shocks affected directly the subsistence demand and, consequently, the total consumption of goods. The results represent the changes in the market for goods and factors from exogenous changes.

In this paper, variations in consumption composition (vector) due to demographic changes (age groups) observed and projected for Brazil, in the period from 2005 to 2050. The simulations chained together, from one quinquennium to another, allow us to analyze the results up to 2050, from accumulated deviation in relation to the baseline scenario. The next section presents the hypotheses and the implementation of the simulations.

4.2 Summary of the simulations

In this paper, there will be performed three groups of simulation, for nine Five-yearly periods each (Frame 1). The first group, called "baseline", refers to the observed growth (2005 and 2011) and to the estimated growth (2012 to 2050) for macroeconomic variables (Table 4) in addition to the even increase in the population growth (accumulated population growth rate according to data available in the last column of Table 5).

The second group of simulations, "baselinererun", reproduces endogenously this scenario. In the third group, called "politics", there are only the demographic shocks by age groups (deviance in relation to average growth) reflected in the consumption by product. Thus, the consumption vector shock represents the difference between a homogeneous growth situation (with no difference in age) and the differentiated growth situation (by age groups) [7].

Frame 1 summarizes the experiment figure and the chaining of the simulations. The simulation's objective is to assess the impact of aging on the macroeconomics and sectoral indicators. The increase of elder participation in the population can affect the sectoral composition of production and consumption. The simulation of the demographic heterogeneous scenario presumes that the total household consumption is determined by the macro scenario and maintained in the same rate even for the heterogeneous consumption scenario. Thus, the effects of the differentiated demographic scenario do not alter the consumption of the economy nor its growth trajectory, only the composition of this consumption (since these initial consumption vectors are heterogeneous and growth rates for these groups are very distinct).

Frame 1- Closure details for aggegated variables

Simulation	Description	Period	Closures
“Baseline” and “Baseline Rerun”	1. Macroeconomic scenario observed (2005-2011) and projected (2012 to 2050) (Table 9). 2. Uniform population growth according to the average rate of total population for the five-year period (last column of Table 10).	From 1 to 9	“Baseline” and “Baseline Rerun”
Policy: Demographic change	3. Percentage change of total consumption in each five-year period (considering the difference by age group) in differentiated rates (Table 11).	From 1 to 9	“Baseline-Rerun”

Source: Authors' elaboration.

By working with this shock, we have the option to capture the effect of this differentiated growth of age groups in a relatively homogeneous growth scenario. Secondly, the scenario with an heterogeneous growth can also be observed, for the sum of the average population growth (“Baseline”) plus the difference (“Politics”) is the projected scenario itself. This experiment requires a group of 27 simulations, one for each one of the nine periods and three phases (“Baseline”, “BaselineRerun” and “Politics”)[8].

5. RESULTS

The results represent the difference between baseline scenario and “politics”, and must be interpreted as deviation in relation to a Brazilian economy trajectory (baseline scenario) where no demographic change happens. Initially the sectoral results are presented and, subsequently, the macroeconomic results.

It is expected that the consumption shock has a positive effect on the level of the economic activity, which will need to accommodate the new demand that is growing heterogeneously. The consumption composition varied due to the demographic change, since the scenario considers the projections for different age groups. The consumption of each age group changes with age, which would impact the demand of each product, especially goods related to health, since these products becomes more important in an aging society.

[8] All simulations were performed using *Gempack*, version 11. *RunDynam* 3.6 was used in scenario simulations, a Gmepack's app specific for simulations using dynamic CGE models. For more details, go to http://www.monash.edu.au/policy/gempack.htm.

The result on the economy will depend on the magnitude of this initial effect and will be influenced by a series of factors: the impact on the demand of products (domestic and imported), on the price of products and factors (labor and capital), and input-output relationships. The advantage of working in a general equilibrium framework is that these effects are considered simultaneously.

Table 6 illustrates the deviation in relation to the reference scenario, accumulated in 2050, for household consumption and prices of products. It is worth mentioning that the results do not represent absolute decreases in consumption, but reductions related to the baseline scenario. The results show that the scenarios that were most affected in the simulations, are the products aimed at the elder. The model projects a modified consumption vector (which considers a differential in consumption due to preference changes) which, in its turn, alters the trajectory of aggregated consumption. Hence, the preference shock is reflected in the results of consumption by product, with a few modifications, due to the effects of relative price. Since the elderly group is growing more (see Table 6), the biggest deviation are observed in medicines (12.13%) and health assistance (9.16%), which also presented a modification in price, as shown in Table 6. There is also a positive consumption deviance in market and services, services provided to the family, health insurance and energy.

Because of this modification in consumption, there is a reallocation in the household expenditure. Therefore, some sectors will have a negative deviance (households that will have a bigger percentage of elders in their composition will consume less products). Among these products, the expenditure on education will present a greater deviance in 2050. In the demographic changes scenario, the education is a product that reduces its demand (-10.7%), since the participation of children in the population is decreasing and the population of elders is increasing over time. Thus, considering only the population aging, the demand for education services will decrease. In this case, it is as though the family were reallocating its production in these sectors.

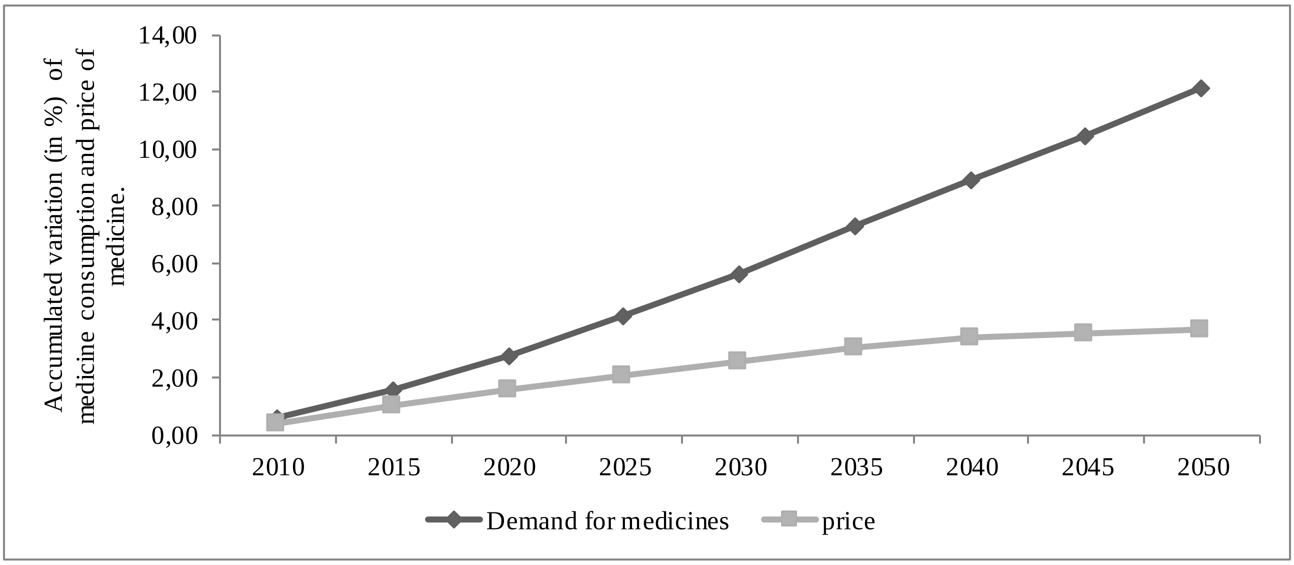
Table 6 – Impacts on consumption and on the price of products in 2050, due to demographic changes (accumulated percentage deviance in relation to the baseline scenario)

Products	Change in consumption	Change in prices
Food	-3,97	-0,08
Textiles and clothing	-1,19	0,01
Fuel and transportation	-1,21	-0,15
Medicines	12,13	3,67
Health insurance	1,21	2,35
Health assistance	9,16	2,70
Durable goods	4,84	0,07
Other goods	1,30	-0,06
Energy	0,16	0,16
Private education	-10,70	-0,23
Financial services and insurance	0,10	-0,03
Services	2,14	0,15
Services provided to families	1,59	0,73
Food out of the household	-1,43	-0,19
Housing	-2,15	-2,33

Source: Authors' elaboration from the simulation results.

In the consumption equation of the model, the households spend a portion of their income on goods considered as subsistence goods, which means, the necessary amount of each good, these amounts being purchased regardless the price. What remains from the consumer's budget after these subsistence expenditures is called luxury consumption or supernumerary. In the simulation performed, the shock of consumption is made on the variable that represents the "change of consumption preference" of households. This variable directly affects the subsistence demand that, consequently, affects the Household final demand. The shock vector is by construction, the percentage spent by product in each quinquennium, considering an age differential of growth projection of the age groups. Since the elderly age group grows more, the demand for goods related to the elder will have bigger shocks of demand, which reflects in the results of the model.

As shown in Table 6, the products most affected in the simulations are the ones related to health. Among them, medicines stand out representing the biggest part of household consumption (55% of total consumption in 2005). Such behavior is directly related to positive demand shock in this sector. For a better illustration of these effects, Figure 1 presents the deviance behavior for the consumption of medicines and their relative price. As we can observe, during the whole period of analysis, the percentage deviance in the consumption of medicines is positive. Therefore, the model also considers the effect on prices, which leads to a reallocation of the consumption vector.



Source: Authors' elaboration from the simulation results.

Figure 1 – Impacts on consumption and on the prices of medicines affected by the change in consumption preferences due to demographic changes (cumulative percentage deviation relative to the base scenario)

The change in consumption due to demographic changes leads to significant modifications in the production sectoral composition. The effects on this production induced by population aging are boosted by the household consumption side[9].

As expected, it is possible to observe that sectors that are more beneficiated by the shock are those linked to household consumption (Table 7). In terms of production variance, the biggest impacts are in goods, health insurance, health assistance and medicines; followed by those services provided to the households (which encompasses caregivers for the elderly). Within these sectors, medical service and services provided to the families are intensive in the labor factor, since medicines use in their productive process an equal proportion of labor supply and capital.

The consumption shock reflects in the factor market. In general, there are positive shocks of demand in labor-intensive sectors or in sector that use an equal proportion of factors; in addition to negative shocks in the labor-intensive sector and also in capital-intensive sectors. Those sectors with positive shock will be demanding more work and those negatively affected are "liberating" the labor factor (lower demand). Since demand is higher in labor-intensive sectors, it is natural that the price of labor decreases in relation to the price of capital. Therefore, the capital stock and the investment

[9] This is evident that demographic transition leads to significant changes boosted by factors from the supply side, such as for example, the reduction in the intensive-labor supply (Börsch-Supan, 2005). However, this analysis is beyond the scope of this paper.

reduce, for sectors need less capital and more labor in their process (Table 7). Thus, it is natural that the economy replaces capital with labor in its adjustment.

Table 7 – Sectoral results for Production, Labor Supply, Investment and Price of Labor and Capital in 2050, Due to Demographic Changes (cumulate deviation related to the base scenario)

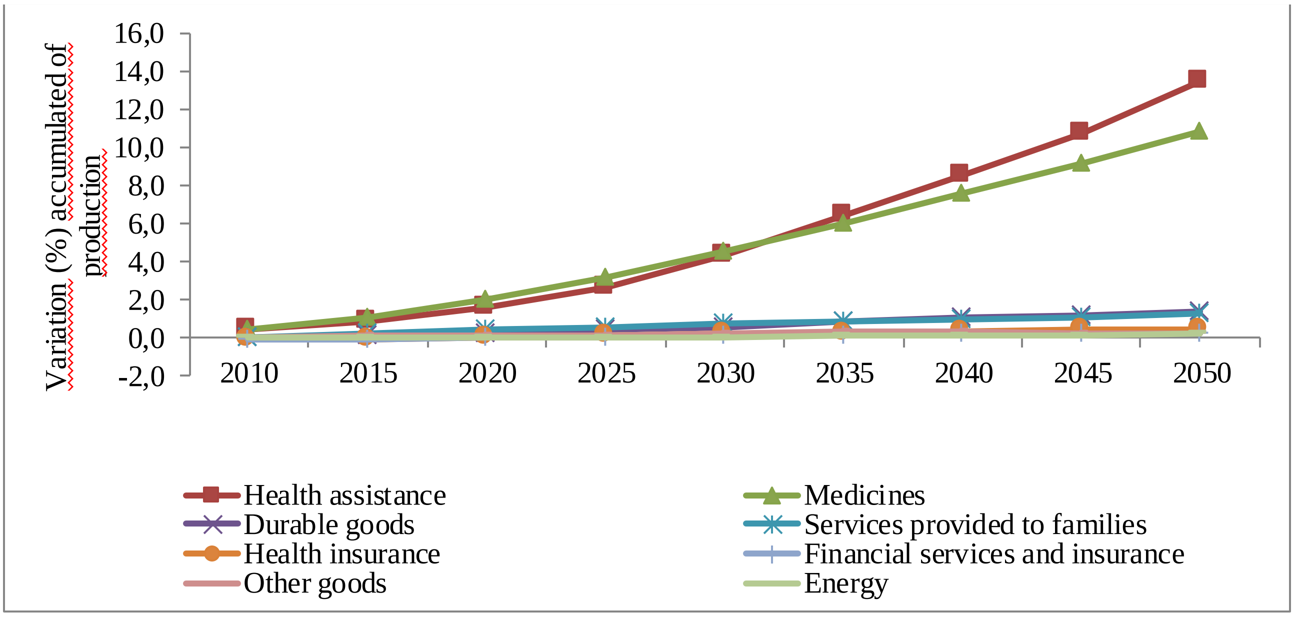
Sectors	Production	Employment	Investment	Labor	Capital
Food	-1,51	-1,96	-1,17	-1,96	-0,63
Textiles and clothing	-0,41	-0,51	-0,29	-0,51	-0,20
Fuel and transportation	-0,27	-1,28	-0,27	-1,28	0,08
Medicines	10,09	15,67	12,53	15,67	6,45
Health insurance	0,37	0,37	0,81	0,37	0,37
Health assistance	12,43	13,73	11,16	13,73	5,00
Durable goods	1,16	1,45	0,59	1,45	0,25
Other goods	0,16	0,19	0,22	0,19	0,09
Energy	0,17	0,20	0,30	0,20	0,16
Private education	-10,91	-11,38	-10,39	-11,38	-5,79
Financial services and insurance	0,19	0,16	0,35	0,16	0,21
Services	0,14	0,17	0,18	0,17	0,04
Services provided to families	1,23	1,37	1,18	1,37	0,72
Food out of the household	-0,35	-0,74	-0,25	-0,74	0,03
Housing	-1,33	-2,91	-2,88	-2,91	-1,32

Source: Authors' elaboration from the simulation results.

The education sector presents a greater negative deviation in relation to the base scenario. The negative shock in education is due to a decrease in the number of children and an increase in the number of the elderly in population. This is an important result because it indicates that, in the future, there must be a relative reduction in the education sector, which means, considering only the population ageing, the demand for education services would decrease. Additionally, the education sector uses more work force in relation to capital in its productive process. Thus, since its demand decreases, it "dismisses" the labor factor, absorbed in the other sectors.

Figures 2 and 3, respectively, present a greater detailing of the sectoral results, in terms of variation in the sectoral production level, selecting 8 among the 15 sectors that are more and less beneficiated. It is observed that the changes in the production level in 2010 vary between -0.29% and 0.40%, and are even higher in 2050, varying between -10.91% and 12.43%. In Figure 2 we can see that sectors whose sales are destined to household consumption are more beneficiated, as is the case with sectors related to health (health assistance service and medicines). It is worth mentioning that until 2030, deviation in growth of medicines is similar to medical service (about 4%), but from 2035, the medical service's growth accelerates in relation to the medicines. This behavior arises from the demographic scenario.

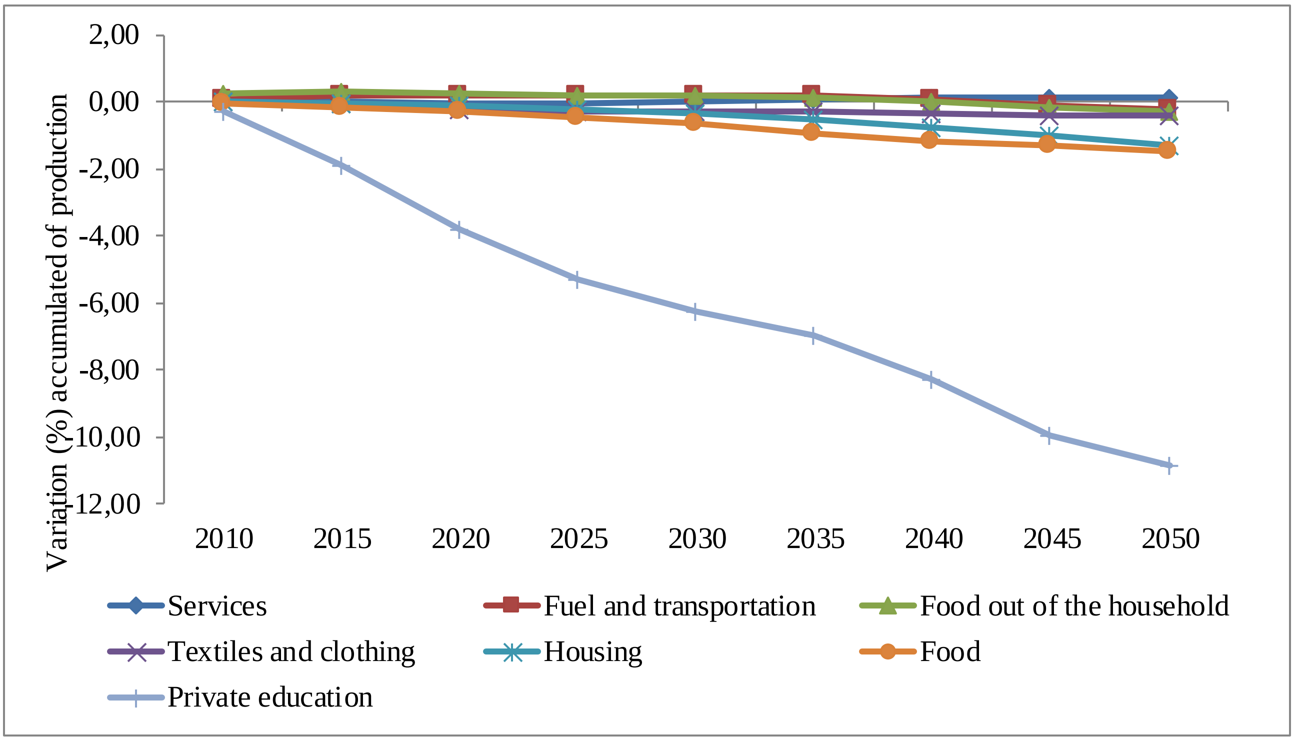
The sectors of services provided to the families, health insurance, durable goods, financial services and insurance and energy (Figure 2) are among the most beneficiated (although substantially smaller). In this case, the first two products are also directly related to demographic changes. The impact on health insurance is expected, as literature indicates. In an aging population, the consumption for goods related to health is higher (Dewhurst, 2006; Lefèbvre, 2006; Albuquerque e Lopes, 2010).



Source: Authors' elaboration from the simulation results.

Figure 2 - Sectoral impact of demographic changes in the sectoral production level (cumulative percent deviation in relation to the baseline scenario)

Figure 3 presents the sectors with negative differentials of growth in relation to the baseline scenario: services, fuels and transportation, food out of the household, textiles and clothing, housing and private education. This negative deviation is explained by the negative shock of the demand and the other price adjustments and productive factors.



Source: Authors' elaboration from the simulation results.

Figure 3- Impacts of the demographic changes on the sectoral production level. (cumulative percent deviation in relation to the baseline scenario)

In addition to the sectoral results, the CGE model provides macroeconomic results. The analysis of the macroeconomic aggregates' behavior has as its goal to present an overview of the impacts on economy and the sectoral linkage and interdependencies. As mentioned before, the impacts represent the difference between the changes obtained with a baseline scenario and changes in the political scenario. The result should be read as deviations related to a trajectory of the Brazilian economy (baseline scenario) where the demographic change would not occur.

Growth differentiated by age groups causes a change in the demand for product in household consumption. The factors (capital and labor) are relocated in the economy, creating impacts on the system of relative prices and production costs, but with little added effect. Since the macroeconomic aggregates present a positive growth in the baseline scenario, the negative impact shown in the Table 8 and figures 4 and 5 are reductions related to that scenario.

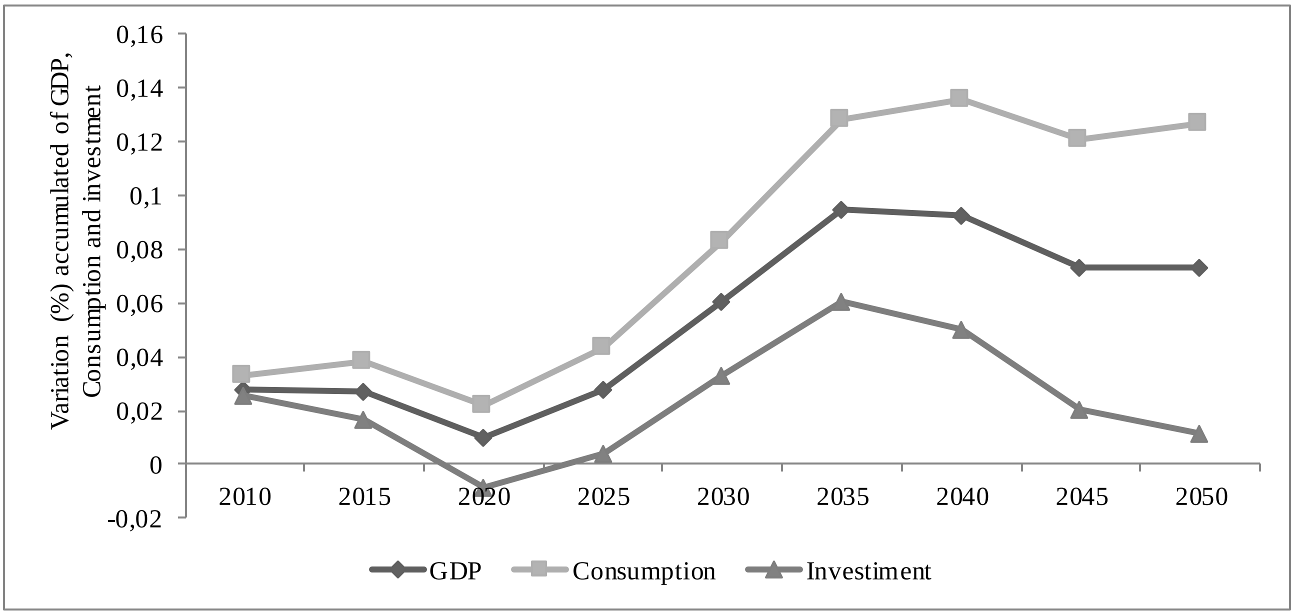
Table 8- Macroeconomic impacts of demographic changes (cumulative percent variation in 2050)

Variable	Percent change
GDP	0.07
Household consumption	0.13
real wage	0.26
employment	0.07
Investment	0.01
Export	0.06
Import	-0.33
Price of capital	-0.34
Price of labor	0.19
GDP deflator	-0.01

Source: Authors' elaboration from the simulation results.

In Figure 4 it is possible to observe that as a result of the displacement in demand for goods and services, the GDP increases at the beginning (2010-2010), then it accrues a drop in the subsequent quinquennium, growing again in subsequent periods. That trajectory is strongly associated to the behavior of consumption and investment. The investment, which in the quinquennium from 2030 to 2035 comes to represent a cumulate deviation of 0.06%, returns to the trend over time (recursive adjustment in the capital module). Although being small, the results indicate the need for more investments to absorb the structural change of consumption.

Figure 4 shows that there can be an initial period where the demographic change causes little impact on the aggregate (2010-2025). The impacts reach a maximum percentage by 2040. This behavior is caused due to the demographic scenario and adjustments in the economy.

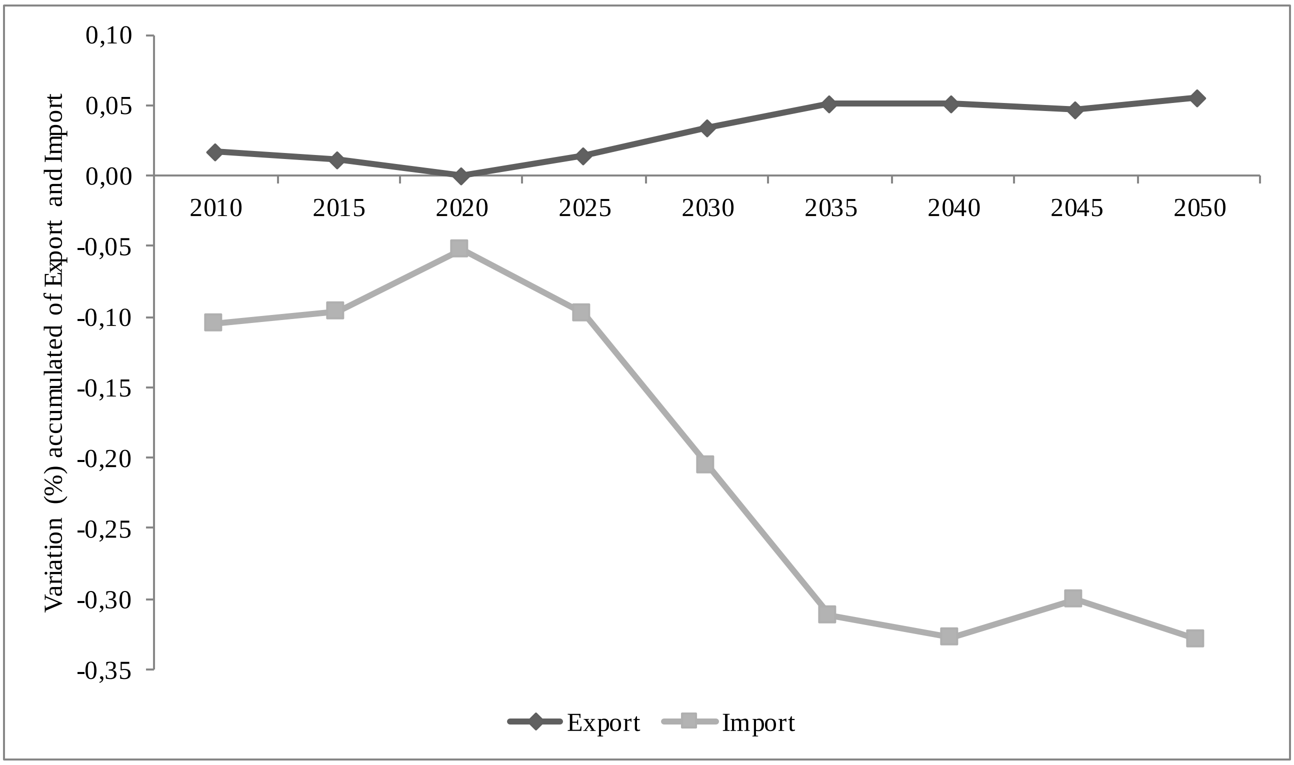


Source: Authors' elaboration from the simulation results.

Figure 4- Trajectories of accumulated variation of GDP, consumption and investment, affected by the preference shock, given the demographic changes in Brazil (cumulative percent deviation in relation to the baseline scenario)

The small positive impact in exports (Figure 5) can be explained by an effect of sectoral composition. In the sectors positively affected by the demand shock, even if there is an increase in domestic prices for those products and, consequently, an increase in the productions costs, the participation in exports is very small. On the other hand, the sectors with negative consumption shocks export more. In them, changes in domestic prices are negative (production costs are reduced), as they use more labor than capital in their production process.

Reductions of importations can also be explained by the sectoral composition. (Figure 5). Among the most affected sectors by the demand shock (medicines, health insurance and health assistence) just medicines have a plot of imported consumption. However, even increasing the importation of medicines by household consumption, their relevance in the imports of the economy is very small (only 2% of the total importation).



Source: Authors' elaboration from the simulation results.

Figure 5- Cumulative variation of the exports and imports affected by demographic changes (cumulative percent deviation in relation to the baseline scenario)

In short, when the consumption vector is disaggregated by age group and adopts a demographic scenario, it is reflected in the economy and can be related to a change of preference on consumption. Since the elderly group has the highest growth rates, the consumption vector of economy now has more influence over the consumption vector of the elderly. This change of preference will have to be accommodated in a growth trajectory of the economy[10].

6. FINAL CONSIDERATIONS

Understanding the changes in the household consumption pattern associated to the population aging is fundamental, since they impact the production structure and the sectoral composition of the country. In order to understand the process, this paper aims to analyze these issues for the Brazilian economy, through the integration of an econometric model to a Computable General Equilibrium model (CGE). The advantage of the general equilibrium analysis is to address the problem of the

[10] It is worth mentioning that, in this work, we do not adopt changes in labor supply or productivity of the resulting factors of the demographic scenario.

aging population in a consistent scenario of interconnected markets and repercussions that were extended over time.

Based on the results from the household type semi-elasticities, it was possible to disaggregate the consumption vector from the input-output matrix (CGE model database), considering the age groups. These vectors were used to form the shock vector in the CGE model. It was observed, through the general equilibrium model that the growth differentiated by age groups changes the household consumption composition.

The model shows a modified consumption vector (considering a differential in the resultant consumption of the changes in preferences) which, in its turn, changes the trajectory of aggregated consumption. The sectoral results of the simulation showed that the most affected markets are the products directed to the elderly, especially health services (medicines, health assistance and health insurance), as well as services provided to the families and energy consumption. As a result of that change in consumption, there is a reallocation of the household expenditure, causing reductions in some sectors, such as education, which showed the biggest negative deviation in 2050.

In relation to the effects on sectoral production, it was possible to observe, as expected, that the sectors that should be more beneficiated from the demographic change shock are those linked to the household consumption and to the elderly. In terms of variation in the production, the biggest impacts should be observed in the sectors of health products: hospital assistance and medicines, followed by services provides to families (covering the caregivers for the elderly). The less beneficiated sectors should be food and private education. The reduction observed in the educational sector is directly related to the negative shock in education, resulting in the reduction of children and the increase of the elderly population.

The simulation results for the macroeconomic variables point to a positive displacement of the Brazilian economy trajectory after the demographic changes. Since the growth differentiated by age groups causes a change in the demand for products in the household consumption, the factors (capital and labor) should be relocated in the economy, creating impacts on the system of relative prices and in the production costs, but with little aggregated effect. Thus, the effect of the change increases in 0.07% the growth of the GDP in the cumulative until 2050, accompanied by an increase of 0.01% in the investments and 0.13% in the household consumption.

As mentioned before, those changes tend to increase the demand for some products and services (with an emphasis on health products) and to reduce the demand for others (for example food and education). That suggests that some industries will face a demand increase (or reduction) in its services and products. Therefore, the results obtained in this article contribute to identify what are the sectors that, in the future, should receive more investments.

Under these conditions, it is evident the need to make investments in the industries that must face the demand increase of theirs productions in the future, especially the health sector, ensuring the expansion of the production capacity, in order to embrace the consumption growth. On the other hand, it is also necessary the intervention to support or promote the development of sectors for which the projections suggest that demand will reduce, such as education. In addition, public policies become necessary referring particularly to segments of age structure such as policies on education, health, labor market and pension plans that take into account the transition in age structure.

It is important to highlight that for the simulation performed, only changes in the age structure of the population on consumption and population were considered. However, as pointed out in Rausch (2009), the population aging can also affect the performance of the economy, due to its impact over the labor supply, savings rate and capital accumulation and also on the capital market. Therefore it is possible that an analysis where other shocks are used for the simulations can generate different results for the Brazilian economy.

As extensions to this work, it is relevant to explore the use of other functional ways for the system in the household expenses, such as the Almost Ideal Demand Systems (AIDS). Also, the use of alternative population scenarios such as IBGE or CEDEPLAR must be explored. Finally, another issue that will make part of future developments in this article is the analysis of how changes in the age structure generate changes in the labor supply and what its impact on the economy is. Those extensions may bring significant additional benefits to the design of policies that take into account the transition in the age structure and the possible consequences of those demographic changes in Brazil.

This article did not intend to institute definite projections for changes in Brazil pattern of consumption and its productive structure, but it is believed that the results obtained are important information for making decisions related to population aging. Furthermore, it is expected that spaces for new discussions and new studies are opened, generating additional contributions to the understanding of the aging process in the Brazilian population and its possible impacts on the economy.

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Appendix A - Model and Database

The BRIDGE database and equations require the calibration of the parameters and coefficients. The structure of the BRIDGE input-output database was calibrated for Brazilian economy's data from 2005. Figure 1 provides the BRIDGE database in three parts: an absorption matrix, a joint-production matrix, and a vector of import duty. In the first row is the absorption matrix (V1,…,V6) and it presents basic flows in year *t* of commodities to producers, investors, households, exports, government and inventory variation.

Each basic flows matrix contains C x S rows. *C* is number of commodities in the model (i.e. 116 for the year 2005 database) and *S* is absorption's source (domestic and imported). Thus, the basic flows show demand at basic prices[11] (production cost) for goods (c) of domestic or imported origin (s) by firms (i) or final consumers (final demand). The V2BAS coefficient, for example, is the value of (c,s) used to create capital for industry *i*. This coefficient was distributed according to the V1CAP (remuneration of capital), because Brazilian investment data is not disaggregated by firms. V3BAS to V6BAS each, in turn, have one column. Worth mentioning that no imported good is exported directly (V4BAS (c,"imported") is zero).

The margin matrices, V1MAR,…, V6MAR, have CxSxN rows and represent the values of *M* margin commodities used in facilitating the flow of goods between origin and destination. In the model there are two margin types demanded by sectors and final users: trade and transportation services. Thus, for example, V1MAR and V2MAR are the values of margin commodity *m* required in facilitating the flow of (c,s) to industry *i* for current production and for capital creation. The Brazilian margins data are not distributed by users (industries and final users) and the solution was to use a rate (trade and transportation margin / total basic value)

[11] It should be noted that basic prices plus margins and net taxes correspond to the flows at market prices.

weighted V1BAS to V6BAS each. This procedure was not applied for Government and changes in Inventories, since both users are not, in practice, margin demanders.

Figure 1: Bridge Model: Core Database Structure

		Absorption Matrix					
		1	2	3	4	5	6
		Producers	**Investors**	**Household**	**Export**	**Government**	**Inventories**
	Size	*I*	*I*	1	1	1	1
Basic Flows	*CxS*	V1BAS	V2BAS	V3BAS	V4BAS	V5BAS	V6BAS
Margins	CxSxM	V1MAR	V2MAR	V3MAR	V4MAR	V5MAR	V6MAR
Taxes	*CxS*	V1TAX	V2TAX	V3TAX	V4TAX	V5TAX	V6TAX
Labor	*O*	V1LAB_O					
Capital	1	V1CAP					
Land	1	V1LND					
Production Tax	1	V1PTX					
Other Costs	1	V1OCT					

C = Number of Commodities
I = Number of Industries
S = 2: Domestic,Imported,
O = Number of Occupation Types
M = Number of Commodities used as Margins

	Joint Production Matrix
Size	*I*
c	MAKE

	Import Duty
Size	1
C	V0TAR

The sales taxes matrices, V1TAX, …, V6TAX, in turn, are aggregated values (IPI, ICMS and Other taxes minus subsidies) for all users (except inventories) and have C x S rows. For example, V1TAX is the sales tax in the flow of commodities (c,s) to industry *i*. The Brazilian sales taxes data also are not distributed by users (industries and final users) and we used a same solution of the margins. We also calculated a rate (sales taxes / total basic value) weighted V1BAS to V6BAS. Although the model allows dealing with tax incidence on export flows, these flows are tax exempt by law in the Brazilian case (V4TAX = 0).

The value added matrices show payments by industries for their use of labor, capital and land, as well as their payments of taxes on production and other costs.

V1LAB_O was calibrated with Brazilian wages and payroll taxes. In this model, there is only one labor type. Using the same database, we also calibrated the V1CAP with gross operating surplus information and the V1PTX with "other taxes on production" values. V1OCT denotes other costs and it was calculated as residuals. It is worth noting that the elements of the coefficient V1LND (land rents) had zero value, due to the absence of information in the tables used.

The other two data sets in Figure 1 are MAKE and V0TAR. V0TAR is a C x 1 vector and it represents tariff revenue by imported goods (import duty). The multiproduction matrix MAKE, in turn, is the output (valued in basic prices) of commodity (c) by industry (i) (joint production matrix). Both coefficients also were calibrated with the Brazilian input-output matrix's data. In the BRIDGE database the absorption and joint-production matrices satisfy the balance conditions, so that the test of homogeneity is verified.

Table 1 provides a stylized version of BRIDGE equations. The first group (1) represents the composition of industry outputs and inputs. Each industry (i) might produce several goods (c), using locally as inputs domestic and imported commodities, as well as primary-factor composite [labor (L) and capital (K)]. In (1), the output of each firm (i) is a function of prices (P_1) of domestic commodities and activity level [X1TOT(i)], The sum over industries of output represents total output (see 2, X0COM(c)). Assuming constant returns to scale in function production, an increase in X1TOT(i) permits industry (i) to produce proportionally more of all commodities. As the level of manufacturing activity rises, primary-factors and intermediate inputs demands in the sector increase too. Consequently, inputs and primary-factors demands depend on X1TOT (i). The demands for inputs [X1(c,s,i)] and primary-factors (L(i) and K(i)) also is function on technology variables (A_{PFi}) on their prices. The industry (i) might demands for two varieties inputs (domestic and imported) which each has a price [P_s(c), s=1,2]. The primary-factors' prices, in turn, is the wage rate (W) and the capital's rental price [Q(i)]]. Changes in the relative prices of thee primary-factors and inputs induce substitution in favor of relatively cheapening factors (cost-minimizing assumptions).

The second group (2) shows the capital-creation functions. The inputs used (in 8) to capital creation also subject to the investor's cost-minimization problem. Therefore, the demands for inputs of commodity c from source s for capital creation is function on the quantity of capital creation (X2TOT(j)) in industry j, on the prices of domestic and imported input i, and on technology variables (A_{2j}).These last two factors also determine the cost of a unit of capital (PI(j)), whose value is treated as the price which a unit can be sold (the asset price).

The third group (3) describes household demands for commodities which a single representative household maximize a Stone-Geary utility function (Stone, 1954) subject to a budged constraint. The demand equations that arise from this utility function are a linear function of prices (P3) and household budget (C), known as *Linear Expenditure System* (LES). X3SUB are "subsistence" commodities and they are purchased regardless of price. The total subsistence demand for each good c is proportional to the number of households, q_H, and to the individual household subsistence demands, $A3_{SUB}(c)$. $X3_{LUX}(c)$, call this "luxury" expenditure, are remnant allocated of the consumer budget. Thus, $X3_{LUX}$ are luxury usages, or the difference between the subsistence quantities and total demands (in 12).

The fourth group treats the exports. Basically, in the stylized version, the foreign demand for domestic commodity c (X4) depends to the foreign-currency price [PE(c)] to a shift variable (A_4). Usually the shift variable is exogenous and represents the movements in the foreign demand curve for good c. Thus, as export demand is a decreasing function to the foreign-currency price. Devaluation in the exchange rate causes increases the exports. The fifth group presents the governments demands for commodities. The level and composition of government consumption are exogenously determined by $A_5(c,s)$ and A_{5TOT} variables (shift variables). $A_5(c,s)$ allows changes on composition of government consumption, while A_{5TOT} might adjust government spending subject a budget constraint. In the absence of shocks to the shift variables, the aggregate government consumption (A_{5TOT2}) changes with real household consumption (C) [i.e. we are endogenising (A_{5TOT}) as function to C].

In the six group, the demands for margins are proportional to the commodity flow with which the margins are associated when A3MAR variable is exogenously. A3MAR variables allow for technical change in margins usage (for example, household). The seventh group includes market-clearing equations for locally-consumed commodities, both domestic and imported. The output (supply) of commodity (c,s) is equal the sum of demands for same commodity (c,s). Imported commodities are not directly exported. As balance conditions, zero-pure-profits conditions for production also is satisfied. Equation 19 shows that the revenue in industry *i* is equal to the cost.

The eighth group contains default rules for setting sales-tax for producers, investors, households and government. Sales-tax variables in the linearized model are treated as powers of the taxes. Equation 20 shows the power of indirect taxes as the product of various shift variables. These shift variables allow applying a reduction in the power of tax for a commodity to all users.

In the group 9 are macroeconomic variables. The first equation (21) shows the consumer price index (CPI) being defined by consumer prices for domestic and imported goods ($P3_1$ and $P3_2$). The real wage rate (WR) is determined as the nominal wage rate (W) deflated by the CPI. There is an overall wage shifter for money wages (A_{WR}). LTOT and KTOT are, respectively, total employment and total capital stock as sums across industries. $GDP_{\text{expenditure}}$, in turn, denotes Gross Domestic Product from expenditure side in nominal terms (equation 25). As balance condition, this variable is equal to GDP_{income} (equation 27).

The tenth group contains equations about the intertemporal adjustment in the capital stocks[12], investment and rates of return. At end of period t, the amount of new capital stock created for each industry j [K_t(j)] is function to depreciated capital stock [(1-D)(j)*K(j)] and investment [X2TOT(j)] during the year t. Defining the gross rate of investment as the ratio of investment to capital in industry j [IKRATIO(j) = X2TOT(j)/K(j)], then, by algebraic manipulation, we might achieve the capital growth [(K_t(j)/ K(j))-1= IKRATIO(j) - D(j)]. If this rate is 3% and IKRATIO(j) is 6.42%, so the calibrated rate of depreciation [D(j)] in the model results to be 3.42%. The BRIDGE model was calibrated with a steady state growth rate of 3%, with a capital depreciation rate of 3.42%. This percentage is very close to the rate of 3.5% used by Oreiro *et al.* (2005) and Haddad and Domingues (2001). We are assuming that economic growth in the steady state of the Brazilian economy is around 3%.

Changes in the capital growth [(K_t(j)/ K(j))-1] are determined by industry (j) 's expected rate of return [EROR(j)] when shift variable [A_{KG}(j)] is exogenous. The expected rate of return in industry j depends of the current rental rate [Q(j)] and asset price [PI(j)] of j's capital, as well as Normal gross rate of return [ROR(j)]. In the case, expectations are static and adaptive. According to Dixon and Rimmer (1998), it is assumed that the capital growth in industry j (and therefore the levels of investment) are given by the willingness of investors to supply funds to industry j facing limited increases in the expected rate of return in j. In short-term, the growth rate of capital in industry j in year t will only be higher than its normal rate (steady state of capital growth) when the expected rate of return by the investors is higher than the normal rate of return (Dixon & Rimmer, 1998). Similarly to the ORANIG-RD model, we calibrated the normal rate of return [ROR(j)] is based on the relation between capital profitability (V1CAP) and capital stock at current prices [K(j)], whose value was 14.3%.

The eleventh group provides the intertemporal adjustment in the labor market, considering variables such as real wage (WR), current (LTOT) and trend employment ($LTOT_T$). In its adjustment mechanism, when the level of employment in $t+1$ exceeds $x\%$ in relation to the economy's trend employment, the real wage grows $\gamma x\%$. Since there is a negative relation between employment and real wage in the labor market, the increase in $\gamma x\%$ will adjust the level of employment in future periods until it converges to its trend level. For example, while employment is above its forecast level, the real wage deviation (WR/WR_0) will be increasing.

[12] The Institute for Applied Economic Research (IPEA) supplies the data on net capital stock at 2000 prices, estimated by Moranti and Reis (2004). These values are used to the sectoral capital stock [K(j)] adjusted for 2005 prices with base on the implicit deflator of fixed capital.

The final group (12) describes the decomposition on variations in production of a commodity. There are three reasons for these variations. First, the variation might be caused by an effect of the local market; which captures the variations in local use (domestic and imported goods). The equation (33) defines the percentage change in local sales for both origins (domestic and imported) represented by x0loc(c), weighted by the amount of local domestic sales [DOMSALES(c)]. INITSALES(c) corresponds to the initial value of total sales, adjusted by price changes in the model. Second, the variation in production might be explained by the effect of domestic participation, which refers to the change in composition of local demand between domestic and imported commodities. In this effect, the x0loc(c) variable is divided by sdom(c). Finally, the variation in production might be an export effect's result. The exports component [V4BAS(c)] represents the flow of exports weighted by the demand for exports x4(c).

Table 1 - BRIDGE model: Core Equations

Number	Group	Dimension	Identifier
1	**Composition of outputs and inputs**		
	$X0(c,1,i) = X1TOT(i)*\Psi_{0c1i}(P_1)$	N_cN_i	(1)
	$X0COM(c) = \sum_i X0(c,1,i) + A(c)_{PF}$	N_c	(2)
	$X1(c,s,i) = X1TOT(i)*\Psi_{1csi}[P_1(c), P_2(c), A_{1i}, A_{TWIST}]$	$N_cN_SN_i$	(3)
	$L(i)= X1TOT(i)*\Psi_{Li}[W, Q(i),A(i)_{PF}]$	N_i	(4)
	$K(i)= X1TOT(i)*\Psi_{Ki}[W, Q(i),A(i)_{PF}]$	N_i	(5)
	$TOT_{PFc}=\sum_c A(c)_{PF}$	1	(6)
	$TOT_{PFi}=\sum_j A(i)_{PF}$	1	(7)
2	**Inputs to capital creation and asset prices**		
	$X2(c,s,j) = X2TOT(j)*\Psi_{2csj}[P_1(c), P_2(c), A_{2j}, A_{TWIST}]$	$N_cN_SN_i$	(8)
	$PI(j) = \Psi_{PIj}(P_1,P_2,A_{2j})$	N_j	(9)
3	**Household demands for commodities**		
	$X3(c,s)= \Psi_{3cs}[C, P3_1,P3_2, A_3, A_{C/GDP}]$	N_cN_S	(10)
	$X3_{SUB}(c) =q_H*A3_{SUB}(c)$	N_c	(11)
	$X3_{LUX}(c) = X3\_S(c) - X3_{SUB}(c)$	N_c	(12)
4	**Exports**		
	$X4(c)= \Psi_{4i}[PE(c)]+A_4(c)$	N_c	(13)
5	**Government demands**		
	$X5(c,s) = A_5(c,s)*A_{5TOT}$	N_cN_S	(14)
	$A5_{TOT} = C*A5_{TOT2}$	1	(15)
6	**Demands for margin services (example: households)**		
	$X3MAR(c,s,m) = A3MAR(c,s,m)*X3(c,s)$	$N_cN_SN_m$	(16)
7	**Imports and zero-pure-profits conditions**		
	$X0COM(c) =\sum_i X1(c,1,i) + \sum_i X2(c,1,i) + X3(c,1) + X4(c) + X5(c,1) + \sum_c \sum_s \sum_m X3MAR(c,s,m)$	N_c	(17)
	$X0IMP(c) = \sum_i X1(c,2,i) + \sum_i X2(c,2,i) + {}_iX3(c,2) + X5(c,2)$	N_c	(18)
	$\sum_c P_1(c)X0(c,1,j) = \sum_c \sum_S P_S(i)X1(c,s,j) + W*L(j) +Q(j)*K(j)$	N_i	(19)
8	**Indirect taxes (for example: exports)**		
	$T4(c) = A_{OT}(c)*A_{4T}(c)$	N_c	(20)

Number	Group	Dimension	Identifier
9	**Macroeconomic variables**		
	CPI = $\Psi_{CPI}(P3_1, P3_2)$	1	(21)
	WR = (W / CPI)*A_{WR}	1	(22)
	LTOT = $\sum_j$L(j)	1	(23)
	KTOT = $\sum_j$K(j)	1	(24)
	GDP $_{expenditure}$ = C + X2TOT_i *$\sum_j$PI(j) + X5TOT*$\sum_i P_S$(i) + $\sum_i$[PE/Φ]*X4(i) - $\sum_i$[PM/Φ]*X0IMP(i)	1	(25)
	GDP $_{income}$ = W*L(j) +Q(j)*K(j) + A(i)$_{PF}$	1	(26)
	GDP $_{income}$ = GDP $_{expenditure}$	1	(27)
10	**Capital stocks, investment and rates of return**		
	K_t(j) = [(1-D)(j)*K(j)] + X2TOT(j)	N_i	(28)
	IKRATIO(j) = X2TOT(j)/K(j)	N_i	(29)
	[K_t(j)/ K(j)] - 1= Ψ_{KG}[EROR(j)] + A_{KG}(j) + A_{KGT}	N_i	(30)
	EROR(j) = Ψ_{EROR}[Q(j), PI(j), ROR(j)] + A_{EROR}(j)	N_i	(31)
11	**Adjustment in the labor market**		
	$\Delta WR/WR_0 = \Psi_{WR}$ [(LTOT $_0$/LTOT$_{T0}$)-1] + Ψ_{WR} Δ(LTOT/LTOT$_T$) + A_{WRT}	1	(32)
12	**Decomposition on variations in production**		
	INITSALES(c)*DECOMP(c,*"localMarket"*) = DOMSALES(c)*x0loc(c)	N_c	(33)
	INITSALES(c)*DECOMP(c,*"DomShare"*) = DOMSALES(c)*x0loc(c) / sdom(c)	N_c	(34)
	INITSALES(c)*DECOMP(c,*"Export"*) = V4BAS(c)*X4(c)	N_c	(35)

Appendix B

Industrial products aggregates

1. Food	**3. Fuel and transportation**	**8. Other Other goods (continuation)**
Paddy rice	Liquefied petroleum	Wood products - except furniture
Corn in grain	Automotive gasoline	Cellulose and other substances for papermaking
Wheat grain and other cereals	Mixture of gasoline and alcohol	Paper and cardboard, packaging and artifacts
Sugar cane	Fuel oil	Newspapers, magazines, records, and other recorded products
Soybeans	Diesel oil	Oil and gas
Other products and services from farming	Other products of petroleum refining and coking	Iron ore
Cassava	Alcohol	Mineral coal
Tobacco leaf	Cargo transport	Non-ferrous metal ores
Upland cotton	Passenger transport	Non-metallic minerals
Citrus fruits	**4. Medicines**	Materials for medical, hospital and dental use
Coffee in grain	Medicines for human use	Medical-hospital equipment/instruments, measurement and optical
Products of forestry	**5. Health insurance**	Inorganic chemicals
Bovine and other live animals	Health plan	Organic chemicals
Milk	**6. Hospital services**	Manufacture of resin and elastomers
Pigs	Hospital services	Other services related to health care
Live birds	**7. Durable goods**	**9. Energy**
Eggs	Machinery and equipment, including maintenance and repairs	Electricity, gas, water, sewage and urban clean
Fishing and aquaculture	Appliances	**10. Private education**
Abate and preparation of meat products	Office machines and computer equipment	Education private
Meat of swine, fresh, chilled or frozen	Machinery, appliances and electric equipment	**11. Financial services and insurance**
Meat of birds, fresh, chilled or frozen	Electronic material and communication equipment	Financial intermediation and insurance
Industrialized fish	Cars, trucks and utilities	**12. Trade and services**
Canned fruits and other vegetables	Trucks and buses	Construction
Soybean products	Parts and accessories for motor vehicles	Postal service
Other oils and vegetable and animal fat excluding corn	Other transport equipment	Information services
Refined soya oil	Furniture and products of diverse industries	Financial intermediation and insurance
Cooled milk, sterilized and pasteurized	**8. Other Other goods (continues)**	Business services
Dairy products and ice cream	Tobacco products	Private social services
Milled rice and related products	Perfumery, soaps and cleaning	Associative services
Wheat flour and derivatives	Pharmaceutical products	Public education
Cassava flour and other	Medicines for veterinary use	Public health
Corn oils, starches and vegetable diets	Agrochemicals	Public service and social security
Products of plants and refining of sugar	Paints, varnishes, enamels and lacquers	Maintenance and repair services
Roasted and ground coffee	Products and various prepared chemical	**13. Services provided to families**
Instant coffee	Rubber articles	Services to families
Other food products	Plastic articles	Domestic services
Drinks	Cement	**14. Food out of the household**
2. Textiles and clothing	Other products from non-metallic minerals	Accommodation services and meals
Articles of clothing and accessories	Gusa and ferroalloys	**15. Housing**
Preparation of leather and artifacts' manufacturing - except shoes	Semi-finished products, flat-rolled and long steel tubes	Real estate services and rental
Footwear manufacture	Products from the metallurgy of non-ferrous	Imputed rent
Processing of cotton and other textiles and spinning	Steel castings	
Weaving	Metal products - except machinery and equipment	
Manufacturing other textile products	Recycled scrap	

Source: Authors' elaboration from input-output matrix.