An integrated econometric + input-output model for the Brazilian economy: an application to the energy sector[1]

Fernando Salgueiro Perobelli[♦]
Rogério Silva de Mattos[♣]
Eduardo Amaral Haddad[♠]
Marcos Paulo Novaes Silva[•]

ABSTRACT

The principal aim of this paper is the construction of an integrated econometric + input-output model for the Brazilian economy for long-run forecasting of energy consumption by type and by sector. The model shows results for five types of energy (electricity, natural gas, renewable energy sources, diesel and other sources). Yearly forecasts are produced for 2006-2010. The approach integrates a time series econometric model with an input-output model. A relevant result is a connection established between vector autoregressive models with or without error correction mechanisms and closed or open input-output models. Two forecasting scenarios are set-up: an expansionist scenario that predicts a faster economic growth; and a damped scenario that predicts a smoothed growth.

Key words: econometric models, input-output models, energy sector

Introduction

Energy is an essential input for growth and development for the modern economies. If we take energy as a proxy for economic development and compare per capita consumption at industrialized countries at OECD with the Brazilian consumption we verify that there is a great difference. The numbers for OECD countries are around 5,5 tep while for Brazilian economy is around 1,39 tep. Furthermore the structure of energy consumption of OECD and Brazil is very dissimilar. At OECD fossil fuels are responsible for 81% of total consumption. For the Brazilian economy they represent only 42%.

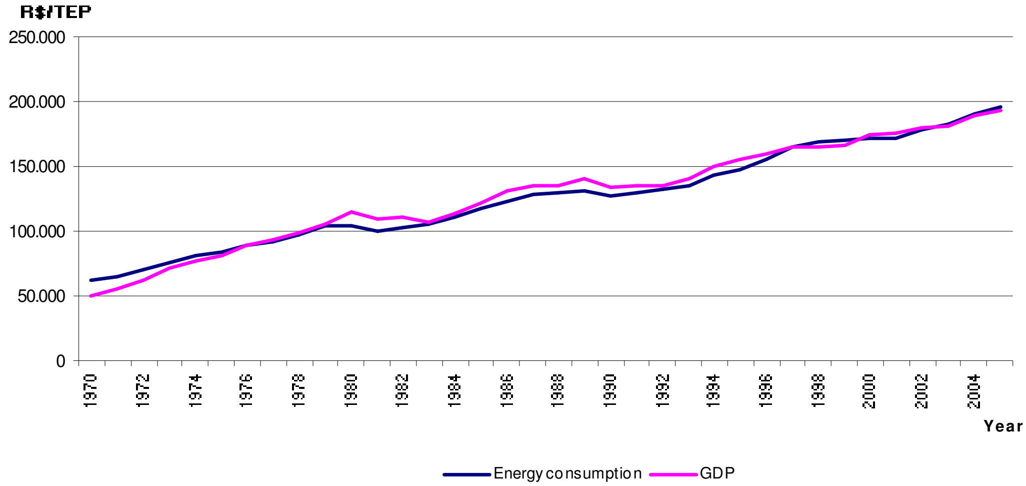
The growth of energy consumption per year in the world is around 2% and the expectation is that in 30 years it will double. The growth process is not uniform. The index at developed countries is around 1%. On the other hand at developing countries the index is around 4%

As we mentioned early energy is an essential input for the modern economies. The literature uses the energy consumption as a proxy for the economic growth. The Figure 1

[1] The authors would like to thanks the financial support of FAPEMIG and CNPq.
[♦] Professor at Federal University of Juiz de Fora; CNPq Scholar.
[♣] Professor at Federal University of Juiz de Fora.
[♠] Professor at University of Sao Paulo; CNPq Scholar.
[•] Research Assistant – FAPEMIG.

shows the direct relationship between energy consumption and GDP. The figure enables us to verify that both variables have the same pattern.[2]

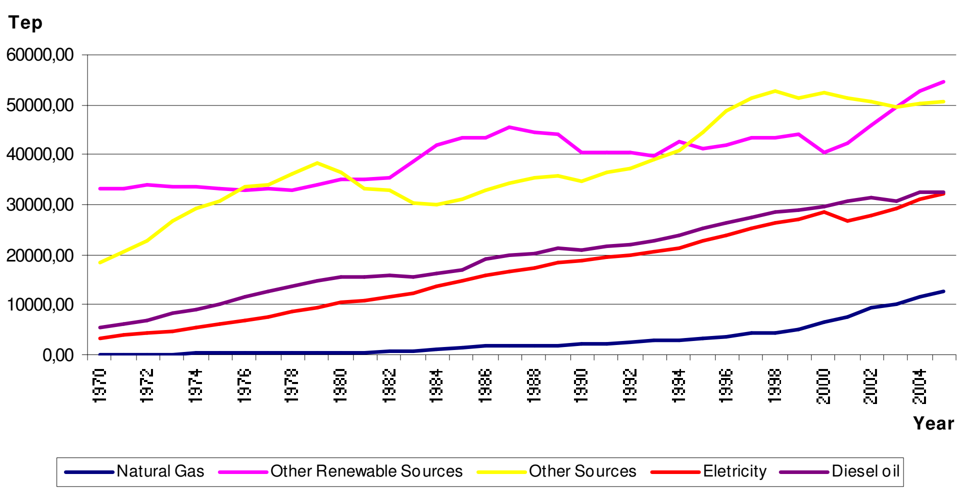
Figure 1. Brazil: Energy consumption and GDP: (1970-2005)



Source: Elaborated by the authors.

A detailed analysis of energy consumption by source (Figure 2) enables us to affirm that there is a high degree of concentration in the energy consumption of renewable and other sources of energy. Since 1970 those sources are the most important ones. The diesel oil and electricity present an increasing pattern. On the other hand the natural gas has an increase in its consumption mainly after 1999. Those energy sources will be examined in more detail in the other sections of this paper.

Figure 2. Brazil: Final consumption of energy by source



Source: Elaborated by the authors

[2] Energy consumption is represented in 10^3 and GDP in 10^4.

In the last tem years the energy consumption has increased by an average rate of 3.3% per year. At the beginning of the 70´s the energy consumption was around 60,595 millions of tep and during all decade the average growth was 5.4% by year. At 80’s there was a decrease in the growth of energy demand (average growth was 2%). This could be due to the decrease in the economic growth. During the 90’s there was not any significant difference at the behavior of energy consumption.

It is important to highlight that in 2005 the consumption was 182,612 millions of tep that represents 1 tep per capita. A comparison with 1998 enables us to indicate that there was a decrease in the consumption per capita.

According to Mukhopadhyay and Chakraborty (2005) the energy requirement of an economy is sensitive to the rate of economic growth and energy intensity of producing sectors. The energy intensity is the function of technological progress and it varies from sectors to sectors. Continued economic development and population growth can drive energy demand faster than a country, like Brazil, can produce it.

Brazilian’s electricity sector faces capacity problems and frequent blackouts in the recent period. Moreover, in the majority industry cities power supply could be one of the biggest limitations on progress. The shortfall means the country will increasingly have to look to alternative sources of energy supply or imported sources of energy. Thus, this paper try to contribute to better understand the energy discussion in Brazil through a specification of an integrated econometric input-output model that will enable us to measure the sectorial energetic pressures.

This paper presents a literature review in the second section. The third section discusses the methodology and the fourth section presents the main results. And we made some final remarks at the last section.

2. Literature Review

Rey (1999) affirms that one of the advantages in the implementation of an EC+IO model consists on the restrictive assumptions of each component model (i.e, EC and IO) when used in isolation. It is important to highlight that during the early development of the field of regional science the classic regional IO model became a very popular instrument of analysis. Despite the widespread application some limitations inherent of the IO models was discussed in the literature. Chief among these were the assumptions of linear production technologies; constant returns to scale; homogeneous consumption functions; and price inflexibility. On the other hand, the Econometric (EC) models did not became as popular as IO models. This is because, in part, by the necessity of data and calibration requirements of these models.

According to Beaumont (1990), the IO and EC models are macroeconomic in nature. The author affirms that the difference between these models is based on their respective views of regional economies. IO models are classified as a general equilibrium one in the sense that the markets clear. This process is represented into the IO framework through the supply adjustments to demand shocks. It is important to emphasize that prices play no role in the market response. On the other hand the EC component often depicts regional economies in a partial context. The focus of these models is on the dynamic adjustment path of the economy to exogenous shocks. However, despite this fundamental theoretical difference between the IO and EC models, both are essentially demand driven when applied at the regional scale.

According to Rey, West and Janikas (2005) two versions of the EC+IO model can be specified: a closed model and an opened model. The closed and opened terms are closed related to the input-output module that is one of the parts of EC + IO model. At closed model an ECM is integrated with the input-output framework. At this structure the household consumption é endogenous. On the other hand, the VAR is integrated with a regular input-output model, which means that the input-output model will be opened for the final demand components.

The econometric model is the first step in the construction of an EC+IP model. The EC part is used to represent the final demand components Y, C, G, I and NE

3. Methodology

The methodological approach used in this paper is based on the integrated econometric + input-output model (EC+IO) of Mattos et al (2005). Building upon approaches described in Ray, West e Janikas (2005), these authors developed an EC+IO model for the Brazilian economy extended to incorporate an (aggregate) energy sector. The model was structured hierarchically under a top-down strategy. At the top of the hierarchy, an econometric model (EC) was set up to describe the behavior of final demand components. These components then enter as exogenous variables to an input-output (IO) model designed to describe the production by sector. By its turn, the production vector variables enter as exogenous variables to an energy demand module designed to describe the (aggregate) energy consumption by sector.

In the present application, a slight extension of Mattos et al's model was developed: The energy demand module was disaggregated to describe the energy consumption according to five categories of energy usage. In this section, a brief presentation of the model is made (further details, see Mattos et al, 2005).

3. Basic Identities

Mattos et al (2005) started from a set of identities upon which the overall structure of their EC+IO model was developed. These identities are the following:

$$Y_t = C_t + G_t + I_t + E_{X\,t} \qquad (1)$$

$$F_t = h_C C_t + h_G G_t + h_I I_t + ne_t \qquad (2)$$

$$ne_t = h_{Ex} E_{X\,t} - h_M M_t \qquad (3)$$

$$X_t = AX_t + F_t \quad (4)$$

$$E_t = PX_t \quad (5)$$

In the equations above, Y is the gross domestic income, C the household consumption, G the government purchases, I the private investment, Ex the exports, and M the imports, all measured in monetary terms. X, F and ne are, respectively, $n\times1$ production, final demand and net exports vectors by sectors. h_C, h_G, h_I, h_{Ex} *and* h_M are $n\times1$ vectors that will enable the sectorial disaggregation of the final demand components, following the structure presented below:

$$\Sigma_{i=1}^{n} h_{C,i} = \Sigma_{i=1}^{n} h_{G,i} = \Sigma_{i=1}^{n} h_{I,i} = \Sigma_{i=1}^{n} h_{Ex,i} = \Sigma_{i=1}^{n} h_M = 1$$

P is a $n\times n$ diagonal matrix that the principal diagonal are formed by the sectorial energy coefficients measured in tep/R$ and E is a $n\times1$ sectoral energy consumption measured in tep. The subscript t is used to show time.

3.2 The econometric module

The econometric model is the first hierarchical module of Mattos et al's model. The econometric model is used to characterize the data generation process for the final demand components, represented by *Y, C, G, I, Ex* and *M.* The Y and C components are regarded as endogenous variables and the others as exogenous. As explained earlier, all final demand components are exogenous variables in the IP module, but in the EC module only C and Y variables are regarded as endogenous.

The main aim was the estimation of a relation between C and Y as a Keynesian specification:

$$C_t = c_o + c_1 Y_1 + \varepsilon_1 \quad (6)$$

and taking into account the Y_t identity, represented by equation (1). At the specific case represented by the equation (6) it is important to highlight that is not convenient to estimate the relation C and Y in level, mainly if they were co-integrated (*e.g* Enders, 2003). It is possible to have estimation and inefficient use of information upon the generator data process. Thus is recommended by the literature to estimate equation (6) for stationary variables in differences and using a Vector Error Correction (ECV) or a Vector of Autoregressive (VAR) model specification (see Enders, 2003).

The decision to specific a VAR or ECV model is based on the hypothesis of co-integration. If the variables are not co-integrated it is recommended to specific a VAR model. And, if the variables are co-integrated the literature recommends to specific an ECV model.

The general specification of a model to estimate the relation between *C* and *Y* is showed by the equation (7). The equation shows an ECV model. The VAR model has the same structure but the first term.

$$\Delta W_t = -\alpha(C_{t-1} - c_0 - c_1 Y_{t-1}) + \Theta_1 \Delta W_{t-1} + \Psi_0 \Delta Z_t + \Psi_1 \Delta Z_{t-1} + e_t \qquad (7)$$

where: $W_t = \begin{bmatrix} C_t \\ Y_t \end{bmatrix}$, $Z_t =$ a vector (mx1) of exogenous variables, $\alpha = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix}$, $\Theta_1 = \begin{bmatrix} \theta_{11} & \theta_{12} \\ \theta_{21} & \theta_{22} \end{bmatrix}$

$\Psi_0 = \begin{bmatrix} \gamma_{0,11} & \cdots & \gamma_{0,1m} \\ \gamma_{0,21} & \cdots & \gamma_{0,2m} \end{bmatrix}$, $\Psi_1 = \begin{bmatrix} \gamma_{1,11} & \cdots & \gamma_{1,1m} \\ \gamma_{1,21} & \cdots & \gamma_{1,2m} \end{bmatrix}$ e $e_t = \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}$.

Mattos et al (2005) showed that there are two ways of integrating the EC module (represented by equation 7) and the IP module. In the first, if *C* and *Y are* co-integrated, we must use a closed IP module where household consumption is endogeneized, while in the second, if C and *Y are not* co-integrated, we must use an open IP module[3].

3.3 The Input-output module

The IO model is the second module in the hierarchy of the EC+IO model. Given numerical information on final demand, it is possible to use the IP module to calculate impacts upon production and energy demand by productive sector. Manipulating expressions (1) to (5), it is possible to develop two versions of IO model: one closed and other opened.

The closed model is based on the idea of household consumption endogenous and can be represented by the following equations:

$$X_t = \Gamma^{-1} F_t^* \qquad (8)$$

$$\Gamma = [I - A - h_C \alpha_1 c_1 i_n' Q] \qquad (9)$$

$$F_t^* = h_C \left[C_{t-1} - \alpha_1 (C_{t-1} - c_0 + c_1 \Delta Y_t) + V_t\right] + h_G G_t + h_I I_t + n e_t \qquad (10)$$

Expressions (8)-(10) provide a method to make forecasts of the impacts upon production by sector using the closed model. The exogenous variables are *G, I,* E_x *and M*. The energy demand is calculated using the equation (5).

The open model is represented by the following equations:

$$X_t = \Gamma^{-1} F_t \qquad (11)$$

[3] For details on this specific topic, see Mattos et al (2005).

$$\Gamma = [I - A] \quad (12)$$

$$F_t = h_C C_t + h_G G_t + h_I I_t + ne_t \quad (13)$$

Expressions (11) – (13) form the open IO model. In this case the exogenous variables are *C, G, I, E_x and M*. Variable C has to be constructed based on the VAR equation (the equation (7) without the co-integration term). Futures scenarios are specific for the other variables. The energy demand is calculated using the equation (5).

4. Data base

This section describes the data base used in the construction of the EC+IP model. In order to estimate the econometric model (EC module), we use annual data, from 1960 to 2005, calculated by the National Account System from IBGE for the final demand components: GDP (Y), household consumption (C), investment (I), exports (E_x) and imports (M). The series was taken from IPEADATA. The G was calculated by resides using the equation (1). In the case of *Y, C, G and I* the series was taken at current prices and transformed to constant prices through GDP implicit deflator. The exports and imports data were obtained in US$mil and converted to R$mil at current prices using the annual average exchange rate. After this the data base was transformed into constant prices of 2005 (R$mil).

In order to construct the IP model we use the IP matrices estimated by Guilhoto and Sesso (2004) for the year 1997 to 2001 and the energy data was taken from the National Energetic Balance (Brasil/MME, 2004). It was necessary to implement a compatibilization (see Annex) between those data base.

The IP matrices enables us to construct the technical coefficient matrices, A, the desegregation vectors h_C, h_G, h_I , h_{EX} and h_M, and the coefficients matrix of value added Q. The matrices A and Q were built using only the 2001 year, that shows the more recent information, but the desegregation vectors are calculated as averages of 1997-2001. The data from National Energetic Balance enables the construction of energy coefficient, P.

5. Results analysis

5.1 Econometric Analysis

This section describes the econometric part of the EC+IP model specified in the equation XX. The econometric model represent the final demand components considering C and Y endogenous and *G, I, E_x* and *M* exogenous. The estimation process followed the pattern in time series econometric. First of all, we analyze the presence of nonstationary variables using the unit root tests; second of all we verify the existence or not of co-integration among the variables and finally we implement the econometric model.

We implement the Augmented Dickey and Fuller (ADF) test for the five variables C, Y, G, I and NE. The results are presented in Table 1. For each variable we implement three models.

a) series in level with a drift;
b) series in level with a drift and tendency, and;
c) series in the first difference.

The number of lags in each case was based in the Akaike (AIC) and Schwarz (SIC) criterion. As presented in Table 1, the variables, C, Y and NX are nonstationary in the models *a* and *b*. For all the variables are stationary in the first difference form.

Table 1: Unit root tests (ADF)

Variable	Model	nº of lags	*t statistic*	Critical Value		
				1%	5%	10%
C_t	drift	0	-0.937	-3.585	-2.928	-2.602
C_t	drift and tendency	0	-1.418	-4.176	-3.513	-3.187
ΔC_t	drift	0	-5.579	-3.589	-2.930	-2.603
Y_t	drift	0	0.171	-3.585	-2.928	-2.602
Y_t	drift and tendency	0	-2.013	-4.176	-3.513	-3.187
ΔY_t	drift	0	-5.206	-3.589	-2.930	-2.603
G_t	drift	2	0.898	-3.592	-2.931	-2.604
G_t	drift and tendency	0	-2.891	-4.176	-3.513	-3.187
ΔG_t	drift	1	-7.515	-3.592	-2.931	-2.604
I_t	drift	0	-1.320	-3.585	-2.928	-2.602
I_t	drift and tendency	0	-3.136	-4.176	-3.513	-3.187
ΔI_t	drift	0	-6.863	-3.589	-2.930	-2.603
NE_t	drift	1	-1.794	-3.589	-2.930	-2.603
NE_t	drift and tendency	4	-3.094	-4.199	-3.524	-3.193
ΔNE_t	Drift	0	-4.991	-3.589	-2.930	-2.603

Source: Elaborated by authors base don database descript in section XX.

- Means the rejection of null hypothesis of nonstationariety for a siginificance level of 1%.
- Means the rejection of null hypothesis of nonstationariety for a siginificance level of 5%.

Table 2 shows the co-integration tests for the endogenous variables C and Y. We implement the Johansen and Engle and Granger tests. The second is based on an Augmented Dickey and Fuller test in the resides. Both tests rejected, at 5% significance level, the null hypothesis of co-integration. Someone can think that this kind of result in unexpected because we have the idea of a co-integration between consumption and income. We can explain the results base on the idea that during the 45 years (1960-2005) we present technological changes, consumption preferences, etc. Those changes can cause an impact in the long run relationship between C and Y.

Table 2: Cointegration tests between the variables, consumption and GDP.

Johansen				
Test Hypothesis: constant in the co-integration equation				
Eingevalue	Maximum Likelihood	Critical values		Nº of ECs* in the Null Hyp
		5%	1%	
0,131	6,36	15,41	20,04	0
0,004	0,18	3,76	6,65	máx. 1
Engle-Granger				
Level regression: C = 81365650 + 0,554Y				
ADF resides test				
nº de lags	t statistic	Critical values		
		1%	5%	10%
0	-1,764	-3,585	-2,928	-2,602

Source: Elaborated by authors based on database descript in section XX.
*EC = co-integration equation

Due the non existence of co-integration between C and Y we will estimate the econometric model by a VAR. The results are presented at Table 3. The maximum lag used at VAR model was one. This choice was based on the information criterion (AIC and SC). For consumption equation we included three dummy variables. D81, D87 and D88. Those dummies are for capture de high decrease in the consumption that occurred in 1981, 1987 and 1988. The 1981 dummy represents the beginning of a restrictive policy adopted by the policymakers and the dummies for 1987 and 1988 represent a bubble at consumption that happened after two plans for stabilization (Cruzado at 1986 and Bresser at 1987). For the income equation we put three dummies also. For the years 1981, 1988 and 1990. The first and the third dummy are to represent the effects of hyperinflation and the restrictive shock due to de Collor Plan.

Table 3. VAR model

Variables	D(CO)	D(Y)
D(CO(-1))	-	-
D(Y(-1))	0.239561	0.436533
	(1.76554)	(2.69595)
C	13770509	30456370
	(5289264)	(6311912)
	(2.60348)	(4.82522)
D81	-1.11E+08	-1.12E+08
	(-4.29503)	(-3.64359)
D87	-92504264	-
	(-3.49149)	-
D88	-74987282	-57432708
	(-2.75445)	(-1.76783)
D90	-	-1.12E+08
	-	(-3.69195)
R-squared	0.516682	0.464344
Adj. R-squared	0.438306	0.377481
Akaike AIC	-806.6412	-814.4186
Schwarz SC	-806.3573	-814.1348

Source: Elaborated by the authors
Number of observations: 44
t-statistics in parenthesis.

We construct two alternative scenarios for the exogenous variables. Those scenarios are presented at Table 4. Based on those scenarios, we made annual forecasts for 2006-2010 using the VAR model presented at Table 3. The VAR model does not incorporate the exogenous variables G, I and Ex although, they are determinant of Y as showed by the equation (1). Thus, in order to calculate the forecasts for endogenous variables we used only the equation for consumption variation (Table 3). The forecasts for income were made using the following identity:

$$\Delta Y_t = \Delta C_t + \Delta G_t + \Delta I_t + \Delta E_{Xt} \tag{14}$$

The first scenario called expansionist represents a more dynamic pattern for the Brazilian economy. All the variables present an increasing trajectory after 2007. The second scenario, that represents a contraction for the Brazilian economy is characterized by a lower degree of growth to government consumption, exports and imports and a decrease in the investment for 2007 and 2008. For the 2009 and 2010 year we forecast stagnation. The 2006 in both scenarios is constructed in the same way. We used information from IBGE to construct those behaviors for the basic year.

The results of the application of the econometric model at Table 3 in each one of the scenarios pointed earlier are the forecasts for the endogenous variables C and Y for the period 2006-2010 presented at Table 4. At the expansionist scenario, the consumption grows to R$ 1.51 trillions in 2010. At the same scenario the income grows to R$ 2.59 trillions in 2010

Table 4.Future Scenarios

Scenarios/Variables	Endogenous										Endogenous	
	Var. (%)					R$ billions de 2004					R$ billions de 2004	
	G*	I	E_X	M	NE	G*	I	X	M	NE	C	Y
Expansionist												
2006	7.6%	4.3%	4.7%	9.4%	-3.0%	412,913	382,269	301,644	195,972	105,673	1,110,923	2,011,778
2007	5.0%	5.0%	4.0%	4.5%	3.1%	433,559	401,383	313,710	204,790	108,920	1,165,044	2,108,905
2008	5.0%	5.0%	3.0%	3.5%	2.1%	455,237	421,452	323,121	211,958	111,163	1,245,901	2,233,753
2009	5.0%	5.0%	3.0%	3.5%	2.0%	477,999	442,524	332,815	219,377	113,438	1,359,899	2,393,861
2010	5.0%	5.0%	2.0%	2.5%	1.0%	501,899	464,650	339,471	224,861	114,610	1,514,977	2,596,137
Damped												
2006	7.6%	4.3%	4.7%	9.4%	-3.0%	412,913	382,269	301,644	195,972	105,673	1,110,923	2,011,778
2007	5.0%	-5.0%	4.0%	5.0%	2.1%	433,559	363,156	313,710	205,770	107,940	1,165,044	2,069,699
2008	5.0%	-5.0%	2.0%	2.5%	1.0%	455,237	344,998	319,984	210,914	109,070	1,245,901	2,155,206
2009	0.0%	0.0%	0.0%	0.0%	0.0%	455,237	344,998	319,984	210,914	109,070	1,359,899	2,269,204
2010	0.0%	0.0%	0.0%	0.0%	0.0%	455,237	344,998	319,984	210,914	109,070	1,514,977	2,424,282

Source: Elaborated by the authors

5.2 Input-output analysis: sector results

The two scenarios for the exogenous variables and its forecasts constructed by the VAR analysis for the endogenous variables (last two columns at Table 4) were used as inputs for the IP part of the EC+IP model. Due to the nonexistence of co-integration between C and Y the IP version used to implement the sectoral forecasts for energy use was the open model (see section three). We compute annual forecasts for each type of energy consumption by sector for the period 2006 to 2010. The results for the expansionist scenario are presented at Tables 5A to 5E and the results for the damped scenario are presented at Tables 6A to 6E.

5.2.1 Natural Gas Consumption

The results at Tables 5A and 6A show that:

a) Chemicals, other sector, transportation and steel are the sectors that present the highest natural gas consumption both for the expansionist and contraction scenario;
b) Food and Beverages, mining, textiles, trade and services and nonferrous metals are sectors that present a medium natural gas consumption for the both scenarios;
c) Nonmetallic minerals, public administration and agriculture are sectors that present the lowest natural gas consumption for the both scenarios.

5.2.2 Other renewable sources of energy consumption

The results at Tables 5B and 6B show that:

a) Food and Beverages, transportation, paper products and printing, steel and agriculture are the sectors that present the highest other renewable sources of energy consumption for the both scenarios;
b) Nonmetallic minerals, chemicals, trade and services and textiles are sectors that present a medium other renewable sources of energy consumption for the both scenarios;
c) Mining, public administration and nonferrous metals are sectors that present the lowest other renewable sources of energy.

5.2.3 Electricity

The results at Tables 5C and 6C show that:

a) Trade and services, other sectors, nonferrous metals, food and beverages, chemicals and public administration are the sectors that present the highest electricity consumption for the both scenarios;
b) Agriculture, steel, paper products and printing and textiles are the sectors that present the medium electricity consumption for the both scenarios;
c) Mining, nonmetallic metals and transportation are the sectors that present the lowest electricity consumption for the both scenarios.

5.2.4 Other sources of energy

The results at Tables 5D and 6D show that:

a) Transportation, steel and chemicals are the sectors that present the highest other sources of energy consumption for the both scenarios;
b) Nonmetallic metals, other sectors, food and beverages, paper products and printing, nonferrous metals and mining present a medium other sources of energy consumption for the both scenarios;
c) Trade and services, textiles, public administration and agriculture present the lowest other sources of energy consumption for the both scenarios.

5.2.5 Diesel Oil

The results at Tables 5E and 6E show that:

a) Transportation, agriculture are the sectors that present the highest diesel oil consumption for the both scenarios;
b) Mining is the sector that present the medium consumption for the both scenarios;
c) Nonmetallic minerals, steel, nonferrous metals, paper products and printing, chemicals, textiles, food and beverages, trade and services, transportation, public administration and other sectors present the lowest diesel oil consumption for the both scenarios.

Table 5A. 2006-2010 Forecasts for the Natural Gas Consumption - Expansionist Scenario

Model/Sectors	Mil tep				
	2006	**2007**	**2008**	**2009**	**2010**
Opened					
Agriculture	-	-	-	-	-
Mining	165	173	184	199	220
Nonmetallic Minerals	13	13	14	15	17
Steel	332	348	369	396	431
Nonferrous metals	81	85	90	97	107
Paper products and printing	235	247	263	285	314
Chemicals	967	1.014	1.082	1.177	1.304
Textiles	136	143	152	166	184
Food and Beverages	201	211	225	245	271
Trade and Services	103	108	116	126	140
Transportation	354	371	396	431	478
Public Administration	6	7	7	7	8
Other Sectors	566	593	630	679	742
Total	**3.160**	**3.313**	**3.529**	**3.824**	**4.215**

Table 6A. 2006-2010 Forecasts for the Natural Gas Consumption - Contracionist Scenario

Model/Sectors	Mil tep				
	2006	**2007**	**2008**	**2009**	**2010**
Opened					
Agriculture	-	-	-	-	-
Mining	165	172	182	196	215
Nonmetallic Minerals	13	13	14	15	16
Steel	332	341	354	376	405
Nonferrous metals	81	83	87	93	101
Paper products and printing	235	245	260	280	308
Chemicals	967	1.008	1.071	1.161	1.283
Textiles	136	143	152	165	183
Food and Beverages	201	210	224	244	270
Trade and Services	103	108	115	125	138
Transportation	354	370	393	426	472
Public Administration	6	7	7	7	7
Other Sectors	566	576	596	635	687
Total	**3.160**	**3.276**	**3.455**	**3.722**	**4.086**

Table 5B. 2006-2010 Forecasts for Other Renewable Sources of Energy - Expansionist Scenario

Model/Sectors	Mil tep				
	2006	**2007**	**2008**	**2009**	**2010**
Opened					
Agriculture	1.105	1.159	1.237	1.346	1.493
Mining	-	-	-	-	-
Nonmetallic Minerals	118	124	132	142	156
Steel	1.597	1.673	1.773	1.904	2.071
Nonferrous metals	3	3	3	3	4
Paper products and printing	2.042	2.141	2.280	2.472	2.727
Chemicals	191	200	214	233	258
Textiles	58	61	65	71	79
Food and Beverages	8.710	9.131	9.747	10.607	11.768
Trade and Services	97	102	109	119	132
Transportation	3.782	3.966	4.233	4.604	5.104
Public Administration	-	-	-	-	-
Other Sectors	1.179	1.236	1.313	1.415	1.546
Total	**18.883**	**19.796**	**21.106**	**22.915**	**25.336**

Table 6B. 2006-2010 Forecasts for Other Renewable Sources of Energy - Contracionist Scenario

Model/Sectors	Mil tep				
	2006	**2007**	**2008**	**2009**	**2010**
Opened					
Agriculture	1.105	1.156	1.231	1.337	1.481
Mining	-	-	-	-	-
Nonmetallic Minerals	118	121	126	135	147
Steel	1.597	1.638	1.701	1.805	1.947
Nonferrous metals	3	3	3	3	4
Paper products and printing	2.042	2.128	2.256	2.431	2.670
Chemicals	191	199	212	229	254
Textiles	58	61	65	71	78
Food and Beverages	8.710	9.125	9.731	10.572	11.717
Trade and Services	97	102	108	118	130
Transportation	3.782	3.950	4.202	4.558	5.043
Public Administration	-	-	-	-	-
Other Sectors	1.179	1.201	1.243	1.323	1.431
Total	**18.883**	**19.685**	**20.877**	**22.582**	**24.901**

Table 5C. 2006-2010 Forecasts for Electricity - Expansionist Scenario

Model/Sectors	Mil tep				
	2006	**2007**	**2008**	**2009**	**2010**
Opened					
Agriculture	717	752	802	873	968
Mining	346	363	386	418	462
Nonmetallic Minerals	201	210	224	241	265
Steel	708	741	785	843	918
Nonferrous metals	1.124	1.178	1.252	1.350	1.479
Paper products and printing	605	634	676	732	808
Chemicals	1.004	1.053	1.124	1.222	1.355
Textiles	423	443	473	515	572
Food and Beverages	1.020	1.070	1.142	1.242	1.378
Trade and Services	2.817	2.954	3.154	3.433	3.809
Transportation	73	76	81	88	98
Public Administration	834	876	921	971	1.026
Other Sectors	1.397	1.466	1.557	1.677	1.832
Total	**11.268**	**11.815**	**12.577**	**13.608**	**14.968**

Table 6C. 2006-2010 Forecasts for Electricity - Contracionist Scenario

Model/Sectors	Mil tep				
	2006	**2007**	**2008**	**2009**	**2010**
Opened					
Agriculture	717	750	799	867	960
Mining	346	360	381	411	452
Nonmetallic Minerals	201	206	215	229	250
Steel	708	726	753	800	862
Nonferrous metals	1.124	1.154	1.203	1.286	1.398
Paper products and printing	605	631	668	720	791
Chemicals	1.004	1.047	1.112	1.206	1.333
Textiles	423	443	472	513	569
Food and Beverages	1.020	1.069	1.140	1.238	1.372
Trade and Services	2.817	2.946	3.139	3.408	3.775
Transportation	73	76	81	87	97
Public Administration	834	875	920	928	939
Other Sectors	1.397	1.424	1.473	1.568	1.697
Total	**11.268**	**11.706**	**12.357**	**13.263**	**14.495**

Table 5D. 2006-2010 Forecasts for Other Sources - Expansionist Scenario

Model/Sectors	Mil tep				
	2006	**2007**	**2008**	**2009**	**2010**
Opened					
Agriculture	111	117	124	135	150
Mining	713	747	796	862	951
Nonmetallic Minerals	1.466	1.537	1.634	1.764	1.933
Steel	4.037	4.229	4.481	4.812	5.235
Nonferrous metals	786	824	875	944	1.034
Paper products and printing	778	816	869	942	1.039
Chemicals	2.279	2.390	2.550	2.773	3.073
Textiles	164	172	183	200	222
Food and Beverages	783	821	877	954	1.058
Trade and Services	430	451	482	525	582
Transportation	11.941	12.521	13.364	14.537	16.115
Public Administration	223	234	246	259	274
Other Sectors	986	1.034	1.099	1.184	1.293
Total	**24.698**	**25.893**	**27.581**	**29.891**	**32.960**

Table 6D. 2006-2010 Forecasts for Other Sources - Contracionist Scenario

Model/Sectors	Mil tep				
	2006	**2007**	**2008**	**2009**	**2010**
Opened					
Agriculture	111	116	124	134	149
Mining	713	742	786	847	931
Nonmetallic Minerals	1.466	1.504	1.568	1.676	1.823
Steel	4.037	4.140	4.299	4.562	4.920
Nonferrous metals	786	807	841	899	978
Paper products and printing	778	811	860	927	1.018
Chemicals	2.279	2.376	2.523	2.735	3.024
Textiles	164	172	183	199	221
Food and Beverages	783	821	875	951	1.054
Trade and Services	430	450	480	521	577
Transportation	11.941	12.472	13.266	14.391	15.921
Public Administration	223	234	246	248	251
Other Sectors	986	1.005	1.040	1.107	1.198
Total	**24.698**	**25.649**	**27.089**	**29.197**	**32.064**

Table 5E. 2006-2010 Forecasts for Diesel Oil - Expansionist Scenario

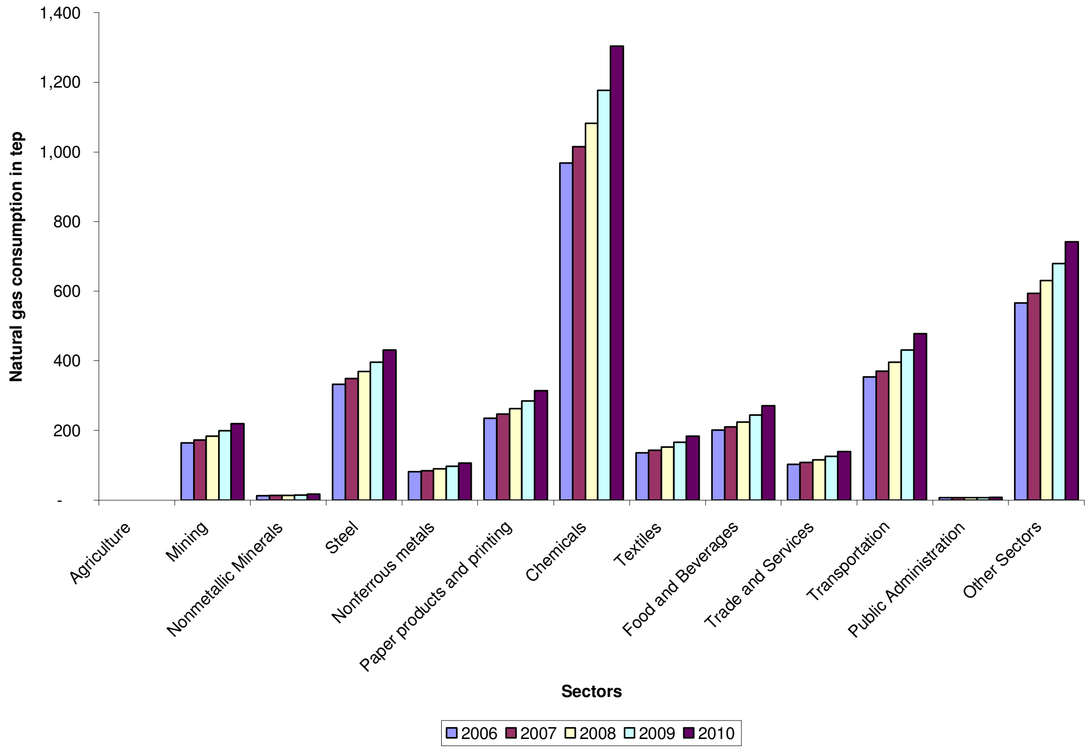
Model/Sectors	Mil tep				
	2006	**2007**	**2008**	**2009**	**2010**
Opened					
Agriculture	3.267	3.426	3.656	3.978	4.412
Mining	97	101	108	117	129
Nonmetallic Minerals	12	13	14	15	16
Steel	9	10	10	11	12
Nonferrous metals	-	-	-	-	-
Paper products and printing	18	19	20	22	24
Chemicals	53	56	60	65	72
Textiles	2	3	3	3	3
Food and Beverages	29	31	33	35	39
Trade and Services	44	46	49	54	60
Transportation	17.472	18.320	19.554	21.269	23.578
Public Administration	41	43	45	47	50
Other Sectors	68	71	75	81	89
Total	**21.113**	**22.137**	**23.627**	**25.699**	**28.486**

Table 6E. 2006-2010 Forecasts for Diesel Oil - Contracionist Scenario

Model/Sectors	Mil tep				
	2006	**2007**	**2008**	**2009**	**2010**
Opened					
Agriculture	3.267	3.418	3.640	3.952	4.377
Mining	97	101	107	115	126
Nonmetallic Minerals	12	13	13	14	15
Steel	9	10	10	11	11
Nonferrous metals	-	-	-	-	-
Paper products and printing	18	19	20	22	24
Chemicals	53	56	59	64	71
Textiles	2	3	3	3	3
Food and Beverages	29	31	33	35	39
Trade and Services	44	46	49	53	59
Transportation	17.472	18.248	19.409	21.055	23.294
Public Administration	41	43	45	45	46
Other Sectors	68	69	71	76	82
Total	**21.113**	**22.054**	**23.459**	**25.445**	**28.148**

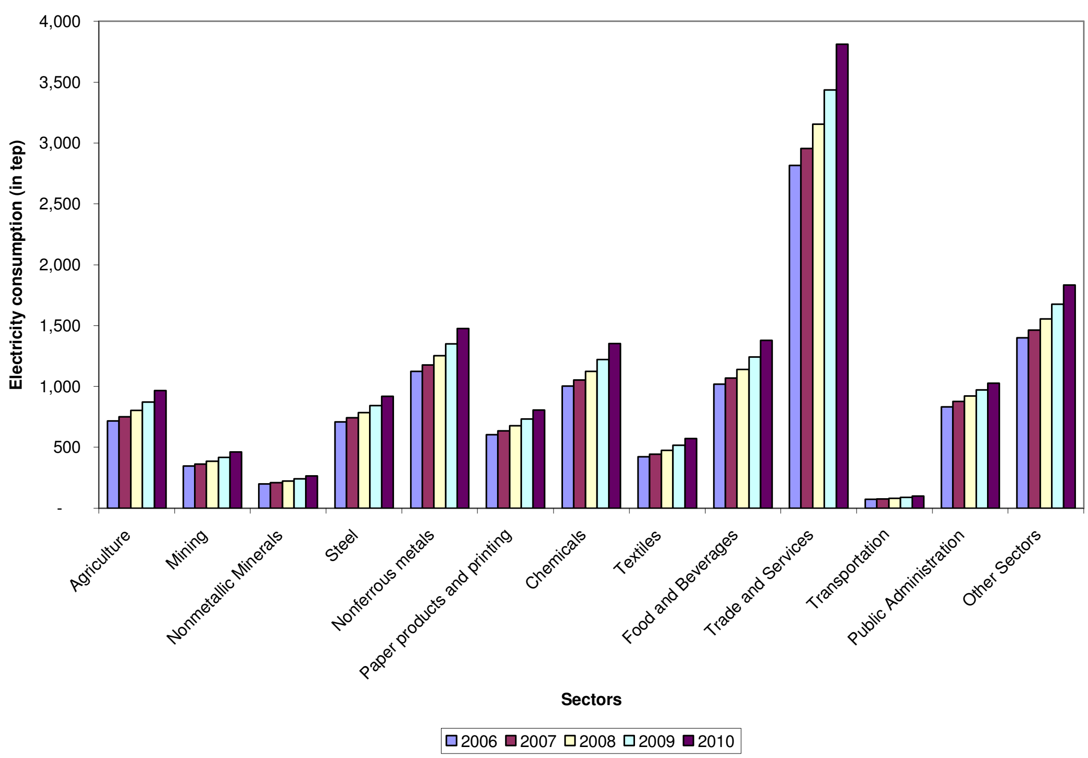
Figures 4 and 5 shows the behavior of natural gas and electricity consumption by sector and period. Those figures enable us to affirm that there is a growing perspective for all the consumption of natural gas and electricity for the majority of the sectors. For natural gas we can verify that Chemicals is the sector that presents the highest level of consumption. In terms of electricity it is possible to verify the importance of the Trade and Services sector. It is important to highlight the difference between the consumption in both sectors. In absolute terms the forecast for the consumption of natural gas is around 1,2 millions of tep and the forecast for the consumption of electricity is around 4,0 millions of tep.

Figure 3. Natural gas consumption: Forecasts (2006-2010)



Source: Elaborated by the authors based on the results from the model.

Figure 4. Electricity: Forecasts (2006-2010)



Source: Elaborated by the authors based on the results from the model.

Conclusions

The present paper shows a possible extension of the econometric input-output paper constructed by Mattos et al (2005). The model proposed and implemented in this paper enables us to have results for a five different types of energy projected until 2010. The field of EC+IO modeling is rapidly evolving on both empirical and theoretical fronts. Is this paper we used the approach of VAR and ECV models to link with the IO part. The integration of EC and IO models constituted an improvement in regional and impact analysis. There is a bunch of methodological characteristics that has to be investigated.

The results enable us to deal with the idea that the total requirement of energy in Brazil will increase. The natural gas is the source that put less pressure in that trajectory. On the other hand other sources of energy are the source that put the highest pressure in that trajectory.

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