The Economic Impacts, National and Regional, of the 2008-2011 Brazilian Federal Government's Pluriannual Plan[1]

(Preliminary Version – Work in Progress)

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ABSTRACT: The Brazilian federal government has a constitutional requirement to set out four year plans encompassing detailed public expenditure programs and targets (the Pluriannual Plan, or PPA). We investigate the sectoral, regional and national economic consequences of the latest PPA. Our modeling encompasses much detail. Firstly, we use a large-scale multi-regional CGE model of Brazil. The model is both bottom-up and top-down: bottom-up for Brazil's 27 states, and top-down for Brazil's 5507 municipalities. Despite the high level of regional disaggregation, the level of sectoral disaggregation is also high, at 36 sectors. Secondly, we model the PPA in detail, considering each of the 9 sets of expenditure programs under the 2008-11 plan. We find that the PPA can have strong impacts in some poor states, and contribute to a decrease regional inequality in both the short run and long run.

1. Introduction

This article aims to simulate the impacts of the 2008-2011 Brazilian Federal Government Investment Plan (PPA). The PPA consists of over 250 projects valued at around $R 57.8 billions, or about 2.9 per cent of GDP. This is the next four-year plan to be implemented, which is an institutional requirement encompassing detailed public expenditure programs and targets. We investigate the sectoral, regional and national economic consequences of the coming PPA. To simulate these investment projects we use a multi-regional computable general equilibrium model. It follows the theoretical structure of the TERM model, an acronym for *The Enormous Regional Model* (Horridge, Madden and Wittwer, 2005), calibrated for information on the Brazilian economy. TERM is a multi-regional computable general equilibrium model of the Johansen type.

[1] The model and databases described in this paper were developed at Cedeplar-UFMG (Brazil) within a projected managed by the ***Centro de Gestão e Estudos Estratégicos*** (CGEE, Brazil, *www.cgee.org.br*). Results in this paper reflect authors' opinion.

To make modelling these projects tractable, we aggregate them within 10 like groups:

1) Petroleum and gas extraction
2) Refining
3) Biofuels
4) Water
5) Sewer
6) Housing
7) Electricity
8) Roads
9) Other transportation
10) Communications

We were advised by a number of experts in the government and private sectors of the value and type of PPA-related investment. The investments were allocated among states using the available information, if it was not provided by the original source. We report policy-induced (see below) project- and region- specific PPA investments in Table 1. However, rather than report dollar values, we report each investment as a share of regional (and in the last row, national) GDP. This shows the size and importance of each investment in each region, and facilitates interpretation of results in Section 4. Projects in the PPA budget include spending by both the private and public sector, consistant with the Plurianual Plan 2008-11 (federal government) and the PAC (Plano de Aceleração Economica). Petroleum and Gas (column 1), Refining (column 2), Biofuels (column 3) and Communications (column 10) are private investments that the government expects will follow (or will be encouraged by) public investments. Much of the Petroleum and Gas and Refining investments are by Petrobras, a largely state-owned company. Communications are the investments intended by the private sector in the service[S1]. Investments in Water and Sewer (columns 4 and 5) largely relate to improving water supply and distribution and sewerage infrastructure in poorer regions.[S2] Housing (column 6) comprises investments on building popular houses and also financing middle class buildings. Electricity (column 7) consists of investment in power facilities and distribution. Roads (column 8) is investments in road infrastructure (e.g. new roads, duplication and bridges)[S3]. Other Transports (column 9) is investment in ports, airports and railroads.

Public and private investments in these groups were collected from the federal government and other public sources. Investment budgets reported in the PPA do not necessarily distinguish between baseline (business-as-usual) and policy-induced changes in investment. For our modeling, we wish only to investigate the effects of PPA-related investment that is new, or above basecase. To identify a base-line, we took historical information to separate the business-as-usual investment from the investment projected by the government and private sector[S4].[2] The difference is the investment intended by the government in order to accelerate the Brazilian growth (GDP growth rate was only 3.36% per year from 2003 to 2006, the first Lula government).

Brazilian investment is around 16.42% of GDP (2006 estimate by IBGE). We estimate the above-baseline component of the PPA budget to be 2.93% of GDP (Table 1). This is consistent with the Brazilian government's aim of increasing the investment rate to 20% of GDP.

[2] Trend regressions were used to evaluate the proposed investment and the correspondent usual level.

We note that the regional allocation of the PPA budget does not follow state shares in GDP (Table 2, Figure 1). The biggest state, Sao Paulo, has 32% of Brazillian GDP, but is set to receive only 16% of the PPA investment budget. In contrast, Rondonia, with only 0.54% of GDP, receives 3.84% of total PPA investment. This is a substantial boost to Rondonia's economic activity, with projected PPA investments representing 18.91 per cent of its regional GDP (Gross State Product, GSP). The same situation applies in Tocantins and Espirito Santo. These regions are expected to be the beneficiaries of some sizeable investments: in Rondonia, two power plants at Madeira River; in Tocantins, a power plant at Tocantins river; and in Espirito Santo, investment in Petroleum and gas extraction by Petrobras.

In the next section the multi-regional CGE model used to project national and regional impacts of these investments is described.

2. Multi-Regional Computable General Equilibrium Model

The multi-regional computable general equilibrium model used in this work follows the theoretical structure of the TERM model, an acronym for *The Enormous Regional Model* (Horridge, Madden and Wittwer, 2005), calibrated for information on the Brazilian economy. TERM is a multi-regional computable general equilibrium model of the Johansen type, in which the mathematical structure is represented by a set of linearized equations and exact solutions of the underlying levels equations are obtained in the form of deviations from an initial solution. There are other works on the Brazilian economy in the same modeling tradition, such as Guilhoto (1995), Haddad (1999, 2004), Haddad and Domingues (2001), Domingues (2002), Ferreira Filho and Horridge (2006) and Haddad and Hewings (2005). The TERM model derives from the continuous development of the ORANI model (Dixon, Parmenter, Sutton *et al.*, 1982) and of its generic version, ORANI-G (Horridge, 2000).

TERM is a multi-regional "bottom-up" model, in which the national results are aggregations of regional results. The model allows for simulating policies that generate impacts on specific prices in the regions, as well as for modeling multi-regional factor mobility (between regions or sectors). Another important and specific characteristic of TERM is its ability to deal with regionally differentiated transportation and commercialization margins. This specificity allows policies designed to improve transportation infrastructure, for example, to be thoroughly specified. The model implemented in this paper for the case of Brazil will be named TERM-Cedeplar, due to the specific database for the Brazilian economy and some modifications in its theoretical structure. In order to ease the understanding of the model, we kept the notation of the variables, equations and database, according with the version of the computational code available at *www.monash.edu.au/policy/term.htm*.

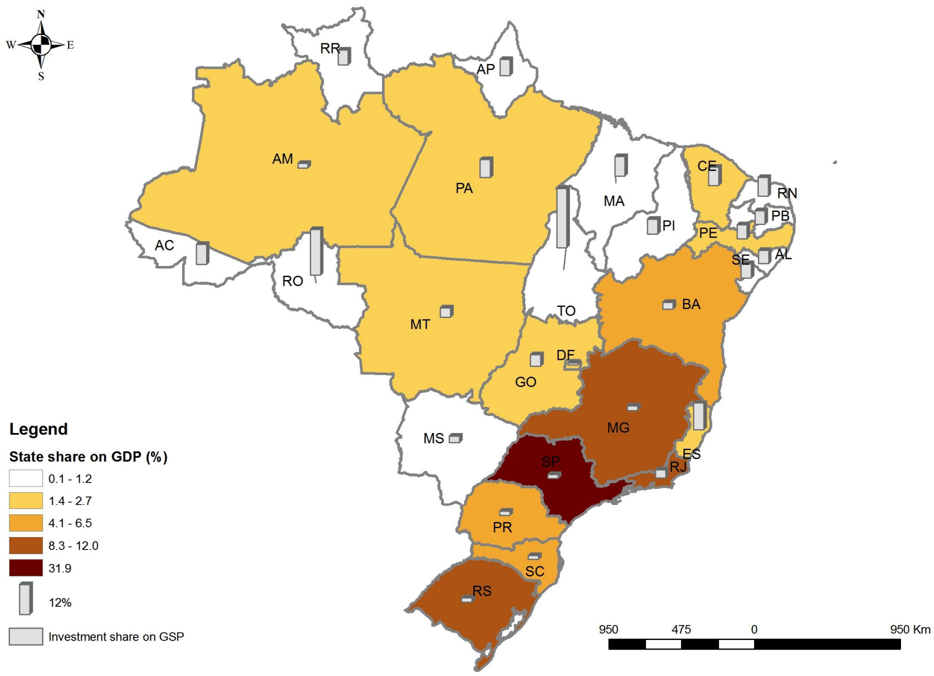
Table 1. Pluriannual Plan Investment by year, 2008 to 2011 (Gross State Product %)

Macro-region		State	Petroleum and Gas	Refining	Biofuels	Water	Sewer	Housing	Eletricity	Roads	Other Transports	Comunica tions	Total
North	RO	Rondonia	-	-	-	0.02	0.58	0.54	17.21	-	0.05	0.51	18.91
	AC	Acre	-	-	-	0.07	0.83	0.86	1.80	4.04	0.16	0.65	8.41
	AM	Amazonas	-	-	0.01	0.01	0.37	0.56	0.21	0.48	0.02	0.27	1.92
	RR	Roraima	-	-	-	0.20	1.29	1.04	2.85	-	0.36	0.51	6.24
	PA	Para	-	-	0.01	0.01	0.47	1.10	3.38	1.59	0.40	0.52	7.47
	AP	Amapa	-	-	-	0.39	0.71	0.40	1.59	2.71	0.43	0.52	6.74
	TO	Tocantins	-	-	-	1.26	1.37	1.49	13.38	-	6.34	0.80	24.63
Northeast	MA	Maranhao	0.08	-	-	1.01	0.80	2.97	2.19	-	0.36	0.67	8.08
	PI	Piaui	0.15	-	0.24	1.43	0.74	1.73	1.10	-	0.06	0.85	6.29
	CE	Ceara	1.82	0.52	0.06	1.53	0.53	1.12	0.10	-	1.28	0.74	7.71
	RN	Rio Grande do Norte	2.39	-	-	2.57	0.43	0.81	0.28	0.69	0.10	0.68	7.94
	PB	Paraiba	0.08	-	0.05	2.62	0.44	0.86	0.08	0.79	0.03	0.67	5.63
	PE	Pernambuco	0.11	1.37	-	1.04	0.34	0.77	0.89	0.22	0.42	0.60	5.76
	AL	Alagoas	-	-	-	1.92	0.52	0.96	0.57	0.89	-	0.78	5.65
	SE	Sergipe	2.69	-	-	0.83	0.42	0.66	0.10	0.80	-	0.50	5.99
	BA	Bahia	0.14	0.20	0.03	0.28	0.36	0.68	0.22	0.31	0.14	0.49	2.86
Southeast	MG	Minas Gerais	0.07	0.10	0.11	0.10	0.30	0.36	0.18	0.28	0.00	0.49	2.00
	ES	Espirito Santo	9.26	-	-	0.02	0.27	0.32	0.02	0.31	0.47	0.42	11.09
	RJ	Rio de Janeiro	1.43	0.71	-	0.01	0.20	0.23	0.24	0.08	0.09	0.38	3.36
	SP	São Paulo	0.34	0.12	0.07	0.00	0.20	0.23	0.04	0.05	0.08	0.35	1.48
South	PR	Parana	-	0.15	0.03	0.01	0.32	0.24	0.36	0.03	0.16	0.38	1.68
	SC	Santa Catarina	0.05	-	-	0.03	0.32	0.22	0.42	0.20	0.14	0.37	1.74
	RS	Rio grande do Sul	-	0.12	-	0.01	0.24	0.22	0.40	0.29	0.11	0.34	1.73
Center West	MS	Mato Grosso do Sul	-	-	0.66	0.03	0.41	0.35	0.75	0.02	0.01	0.45	2.68
	MT	Mato Grosso	-	-	0.08	0.01	0.36	0.37	1.07	1.13	0.52	0.43	3.96
	GO	Goias	-	0.59	0.52	0.07	0.58	0.46	1.22	0.04	0.68	0.60	4.77
	DF	Distrito Federal	-	-	-	0.00	0.18	0.25	-	-	0.08	0.38	0.89
Brazil			0.55	0.22	0.06	0.17	0.29	0.38	0.46	0.20	0.17	0.42	2.93

Table 2. Investments and Gross State Product

State		State share on GDP	Investments share	Investment (% GSP)
RO	Rondonia	0.54	3.46	18.91
AC	Acre	0.17	0.49	8.41
AM	Amazonas	1.84	1.21	1.92
RR	Roraima	0.11	0.23	6.24
PA	Para	1.89	4.83	7.47
AP	Amapa	0.19	0.44	6.74
TO	Tocantins	0.27	2.26	24.63
MA	Maranhao	0.88	2.44	8.08
PI	Piaui	0.46	1.00	6.29
CE	Ceara	1.84	4.84	7.71
RN	Rio Grande do Norte	0.86	2.34	7.94
PB	Paraiba	0.86	1.66	5.63
PE	Pernambuco	2.70	5.32	5.76
AL	Alagoas	0.67	1.29	5.65
SE	Sergipe	0.74	1.52	5.99
BA	Bahia	4.69	4.58	2.86
MG	Minas Gerais	9.31	6.35	2.00
ES	Espirito Santo	1.90	7.21	11.09
RJ	Rio de Janeiro	12.04	13.84	3.36
SP	São Paulo	31.89	16.08	1.48
PR	Parana	6.46	3.72	1.68
SC	Santa Catarina	4.06	2.42	1.74
RS	Rio Grande do Sul	8.27	4.88	1.73
MS	Mato Grosso do Sul	1.21	1.10	2.68
MT	Mato Grosso	1.43	1.93	3.96
GO	Goias	2.35	3.83	4.77
DF	Distrito Federal	2.35	0.72	0.89
	Brazil	100.00	100.00	2.93

Figure 1. Gross State Product and Investments



One of the main features of the TERM-Cedeplar model, in comparison with the regional models based on the Monash-MRF (Adams, Horridge e Parmenter, 2000), is its computational capacity to work with a large number of regions and sectors starting from a simpler database. This feature derives from the compact structure of the database and from simplifying hypotheses in modeling multi-regional trade. The model assumes that all the users – say, of industrial goods – in a particular region, purchase from the various regions in fixed proportions. Therefore, the need of data on the origin of goods by specific uses in the destination is eliminated, as well as the need of this information in the database. This is a typical hypothesis in CGE models for international trade, such as GTAP (Hertel, 1997). This specification of the database can be an advantage of the TERM-Cedeplar model in terms of implementation, given the information restrictions on regional flows of goods. For the case of Brazil, for instance, there are interstate trade tables by sectors [Vasconcelos and Oliveira (2006)], but the information on destination by use in the buying regions is not available. That is, the tables register the total aggregate flows (for all uses in the destination) of goods and services among Brazilian states. This information is enough to calibrate a multi-regional model such as TERM-Cedeplar. Aditional details about TERM database construction can be found in Horridge, Madden and Wittwer (2005) and Domingues, Viana e Oliveira (2007) for the Brazilian model.

In the next subsection, some features of the theoretical structure of the model are discussed.

Mechanism of composition of the regional demands by origin

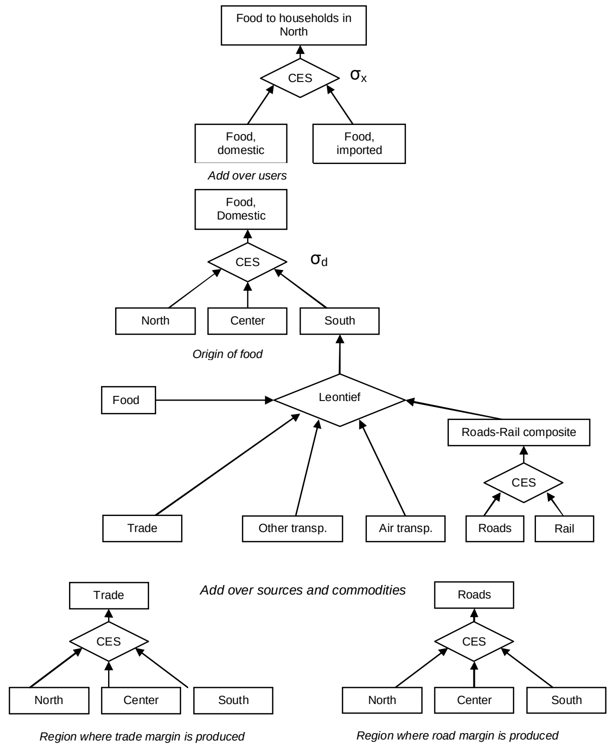
Figure 1 illustrates the details of the system of composition of the demands by origin in the TERM-Cedeplar model. Although this figure represents the food demand composition of families from ”North”, the same diagram applies to other goods and uses in the model, both for sectors or final users. Figure 1 is segmented in four levels, top to bottom. In the first level (I) the families choose between domestic and imported (from other countries) food, and this choice is described by a CES specification (Armington's Hypothesis). Demands are related to the specific purchase values by use. The elasticity of substitution between the domestic and imported input is σ_x. This parameter is usually specific for each good but common by use and by region, even though different estimates can also be used. Demands for domestic goods in a region are aggregated (for all uses) in order to determine the total value. The use matrix is valued in terms of "deliver" prices – which include the basic values and the margin values, and exclude the taxes for specific uses.

The next level (II) refers to the origin of the domestic composed good among the various regions. A matrix shows how this composed good is divided between the *r* originating regions. Again, a CES specification controls this allocation, with elasticity σ_d. The CES specification implies that regions with falling relative production costs increase their market share in the destination region of that good. The substitution mechanism is based upon deliver prices, including trade and transportation margins. Therefore, even when production prices are fixed, changes in transportation costs affect the regional market shares. Note that variables at this level do not have a subscript by use – the decision is made taking into account all the uses (as if wholesale stores, and not final users, decided the origin of the food imported from other regions).

Level III shows how food from South delivered in North is composed by basic values and by margins of trade, road and railway transportation, and others. The participation of each component in the deliver price is given by a Leontief-type function, with fixed proportions. Therefore we eliminate the possibility of substitution between trade margins and various transportation margins. The share of each margin in the deliver price is a given by combination between origin, destination, good and source. For example, the share of transportation costs in the deliver price is expected to be high for transactions between two distant regions, and also in the case of goods with significant participation of transportation costs in its price.

The final part of the substitution hierarchy (V) indicates how margins on food from South to North can be produced in different regions. The figure shows the originating mechanism for road transportation margins, but it also applies to the other modes. It is expected that such margins will be evenly distributed between origin (South) and destination (North), or between intermediary regions in the case of transactions between distant regions. The same mechanism regarding the origin of the flows is applied to imported goods. In this case, however, its origin is traced back to the port of entry, and not the originating region (which is the external market).

Figure 2. Demand composition mechanism in the TERM-Cedeplar model



Sectoral Production Tecnology

Each regional sector can produce more than one good, using domestic and imported inputs, labor and capital. This option may become tractable with the use of separability hypotheses, which reduce the need for parameters. Thus the generic production function of a given sector is composed of two blocks, the first one regarding the composition of the sectoral production, and the other one related to the utilization of the inputs. These blocks are connected by the level of sectoral activity.

Households

There is a set of representative families in each region, who consume domestic goods (from different regions in the national economy) and imported goods. The families' demand specification is based on a combined system of preferences CES/Klein-Rubin. The demand equations are derived from a utility maximization problem, whose solution follows hierarchized steps. At the first level there is a CES substitution between domestic and imported goods. At the next level there is a Klein-Rubin aggregation of the composed goods; thus the utility derived from consumption is maximized according to this utility function. Such specification leads to the linear expenditure system (LES), in which the participation of expenditures above the subsistence level for each good represents a constant share of total subsistence expenditure for each family.

Investment Demand

"Investors" are a category of use of final demand, responsible for the production of new capital units (gross fixed capital formation). They choose the inputs to be used in the process of capital formation through a process of cost minimization subject to a hierarchized technology structure. This technology is similar to the production technology, but with some adaptations. As in the production technology, the capital goods is produced using domestic and imported inputs. At the first level, a CES function is used in the combination of domestic and imported goods. At the second level, an aggregate of the set of intermediate composed inputs is formed by combination in fixed proportions (Leontief), which defines the level of capital production in the sector. No primary factor is directly used as input in capital formation.

There are three possible model configurations for comparative statics exercises, which assume different hypotheses about investment behavior. The alternative to be chosen in the simulation will depend on the characteristics of the experiment, such as time frame (short or long-run) and capital mobility.

The use of the model for comparative statics implies that there is no fixed relation between capital and investment, this relation being chosen according to specific simulation requirements. For instance, in typical long-run comparative statics simulations, it is assumed that the growth rates of investment and capital are identical (see Peter, Horridge, Meagher *et al*., 1996).

Exports Demand, government and inventories

In a model where the Rest of the World is exogenous, the usual hypothesis is to define negatively sloped demand curves on the very prices of world markets. In the TERM-Cedeplar, a vector of elasticities (different by product, but not by region of origin) represents the external demand response to changes in the FOB prices of exports. Shifting terms for prices and export demand allow for shocks on the demand curves.

The export demand functions represent the outflow of composed goods that leave the country through a given region (port). Since the same specification of demand composition by origin applies to exports, the model can capture transportation costs of, for instance, goods from Minas Gerais being exported via the port of Vitoria (Espirito Santo). This particular characteristic of the model allows to distinguish the region producing the exported good from its point (region) of export. It is worth noting that this kind of information (volume of state exports leaving the country through a specific port of exit) is available for Brazil, in SECEX (Secretary of Foreign Trade), and it was used for calibrating the model.

The demand from the regional government in the model represents the sum of demands from the three levels of administration (federal, state, and municipal). Government's demand is not explicitly modeled, and it can follow either the regional income or an exogenous scenario. The model has shifting terms which allow for variations in specific components of government demand (by good or by region), accommodating specific expenditures associated with different macroeconomic scenarios. Finally, the change in inventories is linked to the level of production of the regional sector.

Labor Markets

The model does not have a theory of labor supply. There are two options for the operationalization of the model: i) exogenous employment (fixed or with variations given by historical demographic characteristics) with wages adjusting endogenously to equilibrate the regional labor market; ii) fixed real (or nominal) wage, and employment determined by the demand side in the labor market. The operationalizing options of the model allow for alternative functioning rules for the labor market: i) exogenous national employment (fixed or with variations given by historical demographic characteristics) with migration adjusting endogenously to equilibrate the labor market or impacts in relative wages; ii) fixed real (or nominal) wage and employment being determined by the demand side in each region's labor market (absence of migration).

In the standard "short-run" configuration, all the wages are indexed to the price index of final demand in the region, or they are indexed to a national price index. In the usual "long-run" configuration, national employment is exogenous, implying an endogenous response of average wages, with fixed sectoral and regional wage differentials. Thus, there is inter-sectoral and regional labor mobility.

Market equilibrium, demand for margins and buying prices

The model works with market equilibrium equations for all the goods locally consumed, both domestic and imported. The buying prices for each of the use groups (producers, investors, families, exporters, and government) are given by the sum of basic values, sales taxes (direct and indirect) and margins (trade and transportation). Sales taxes are treated as *ad valorem* taxes on the basic flows. There is market equilibrium for all the goods, both domestic and imported, as well as in the factor (capital and labor) markets in each region. Demands for margins (trade and transportation) are proportional to the flows of goods to which the margins are related.

TERM-Cedeplar is a CGE model for Brazil which implements the possibility of intermodality (substitution of transportation margins). In the current version, there is a possibility of substitution between road and railway transportation margins. The substitution between the road modal and the railway modal follows the CES specification, as in the substitution between domestic and imported goods. Thus, a decrease in railway transportation prices in relation to road transportation leads to a substitution in the margin toward the cheapest modal.

Database and parameters

The model's core database presents two sets of representative matrices of the use of goods in each state (USE), of the trade flows (TRADE) and of trade margins (TRADEMAR). USE represents the relations of use of goods (domestic and imported) for 40 users in each of the 27 Brazilian states: 36 sectors and 4 final users (families, investment, exports, government). The set TRADE represents the trade flows between states for each of the 36 goods in the model, in both origins (domestic and imported). In this set, the domestic origin-destination flow of a given good represents the monetary flow between two states, for all the uses in the state of origin, including exports.

A large set of primary information was used to build these two datasets. The primary data come from the complete accounts of the 2003 national input-output table Guilhoto and Sesso Filho (2005)[Guilhoto and Sesso Filho (2005)]. The primary information for the construction of the trade matrices is the data on interstate trade from 1999 published by Vasconcelos and Oliveira (2006). These data had to be adjusted so that all the states were represented in the matrices (the original datum do not present information for 5 states) and it could reflect the 2003 base year (see Magalhães and Domingues, 2007).

A distinction of the TERM-Cedeplar model is the specification of 4 transportation margins, which capture the main transportation modals: road, railway, airway, and others (basically, ductway and hydroway). The model specification allow for substitution between transportation modals, which is a significant development in transportation modeling using general equilibrium models. Furthermore, the margins can be produced by the respective modal sectors both in the state of origin and in the destination, which is closer to economic reality (usually, CGE models consider margins being produced at the region of origin). The calibration of transportation margins was made according to information from the interstate trade flows matrices, described above, and specific data on freight and intermodal uses for Brazil.

The final database also contains a further, sub-regional, disaggregation into 5507 municipalities. For example, there are 854 municipalities in Minas Gerais. The only additional subregional data consists of a 36*5507 matrix showing how sectoral output is divided among municipalities. This allows for a useful system of "top-down" modelling – which is not too computationally costly. [3]

3. Simulations

We assume the investment is spread evenly over four years (2008-2011). Hence the annual investment budget is depicted in Table 1. The investments were deflated by the national price index. We model a construction phase and a benefit phase. The construction phase is modelled under a short-run comparative static closure. The benefit phase is modelled under a long-run comparative static closure.

We adopt traditional short-run factor market closures. Capital and land, by regional industry, are exogenous. This fixes land and capital supply at the national, regional, and industrial levels. Regional employment is endogenous at given regional real consumer wages. Household nominal consumption at the regional level moves with household nominal labour income.

3.1 Petroleum, Gas Extraction and Biofuels

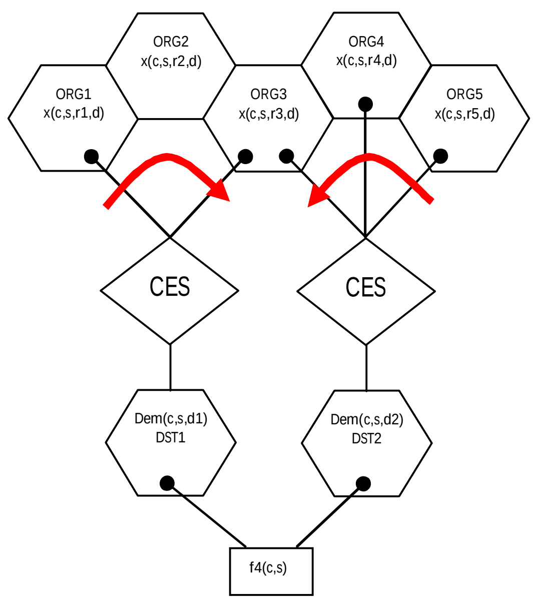
We will describe the simulation for Petroleum and Gas in detail. Our simulation of the Biofuels and Refining follow the same pattern, but for different sectors in the model.

The PPA investment spending is assumed to boost investment in the model's *Petroleum and gas extraction* sector in selected regions (see Table 1). Consistent with us having already removed from the PPA budget any amounts that we considered "baseline" or "business-as-usual", we allow the project to increase short-run national investment relative to what it would otherwise have been. We assume that the project will be financed through reduced private consumption,either via higher savings or higher direct taxation. An alternative is financing via reduced public consumption. However, in our view, complete financing via reduced public consumption creates two issues. Firstly, public consumption is very labour intensive. Under our short-run factor market closure (see above) the negative impact on real GDP of reduced public consumption is greater than the positive effect of increased real investment. Hence project financing through reduced public spending causes short-run real GDP to fall. Secondly, if some proportion of the reduced public spending is viewed as reduced spending on other capital projects, then the foregone benefits from these projects should be modelled in the long-run. This would complicate the modelling of the long-run. For these reasons, we prefer tax (that is, private consumption) financing.

[3] For example, there is no explicit modelling of trade within states. Even it were possible to build a fully detailed database with 5507 regions, such a huge and detailed model would take days or weeks to solve.

Implementing the long-run benefit shock for the petroleum and gas extraction project is somewhat complex. The long-run effects were estimate by isolated simulations in each state. Lets take the Rio de Janeiro investment as an example. We assume a rate of return of 16% on the project investment. Deflated to the size of the 2003 Brazilian economy using our deflation factor, we expect this investment to generate returns to land and capital. To bring forth these benefits, we require an expansion in demand for Rio de Janeiro *Petroleum and gas extraction* sufficient to draw this amount in capital and land rentals into the sector at exogenous land rental rates and exogenous capital rates of return. We assume that the source of demand is foreign. However TERM presents a complication in this regard. As Figure 3 describes, individual regions do not face export demand schedules related to output from their own region. Rather, export demands faced by a given region enter that region's total demand pool independently of the regional commodity sourcing decision. For example, in Figure, 3, an increase in foreign demand for commodity (c,s) from region DST1 causes region DST1 to lift its demand for (c,s) from regions ORG1 through to ORG3. This could present a problem if our new petroleum and gas plant is located in region ORG3 and region DST1 sources non-trivial quantities of petroleum and gas from regions ORG1 and ORG2. In this case, we could calibrate the export demand shock to reflect the demand for the new project's output, but the demand stimulus would be spread among many regions. We overcome this problem by simultaneously lifting foreign demand for petroleum and gas, and twisting each region's sourcing requirements towards the region in which the new plant is operating (ORG 3 in Figure 3).

Figure 3. Combination export demand shock and sourcing twist



With this closure in place, expansion in the output of *Petroleum and gas extraction* in Rio de Janeiro (achieved via an exogenous expansion in the sector's land and capital supply) will be accommodated at (exogenous rates of return and largely given land prices) by an accommodating twist in *Petroleum and gas extraction* sourcing requirements towards Rio de Janeiro.

Under a standard long-run closure, regional industry investment is indexed to regional industry capital stocks. National investment is endogenous, being the sum of regional industry investment. This closure, at least as it relates to the *Petroleum and gas extraction* sector in Rio de Janeiro, is not suitable for the long-run benefit simulation. This is because the exogenous increase in capital supply to the sector is very large. Hence, under the standard investment closure, aggregate investment would increase sharply, crowding out consumption. We do not believe this story. To avoid this outcome, we deactivate indexation of investment to capital for the Rio de Janeiro *Petroleum and gas extraction*sector.

The remaining features of our closure define a standard long-run environment. Capital stocks in all regional industries (other than *Petroleum and gas extraction* in Rio de Janeiro) are in elastic supply at exogenous rates of return. National employment is exogenous and the national real wage is endogenous. National investment is endogenous, and is calculated as the sum of regional industry investments. Investment/capital ratios for all regional industries (other than *Petroleum and gas extraction* in Rio de Janeiro) are exogenous. Labour is free to move between regions, subject to upward-sloping regional wage curves. The balance of trade is exogenous, with national private and public consumption endogenous.

3.2 Infra-structure projects (Water, Sewer, Electricity, Roads, Other Transports)

Each infrastructure investment (Table 1) is spread across all Brazilian regions. Each region's project (Water, Sewer, Electricity, Roads, Other Transports) is assumed to generate an annual benefit equal to 12.9%[S5] of the value of investment. We express the benefit as an improvement in each region's long run primary factor productivity. In each region, we weight the distribution of the gains towards specific sectors. For example, roads and transports to the transport sector, water and sewer to water and sewer sectors, electricity to the electricity sector). The model does not contain, for example, an industry representing the provision of road services by road, sewer, water, electricity and other transports infrastructure. Hence there is no pre-existing "infrastructure investment" activity. We anticipate that the investments will be intensive in civil construction. Capital formation for the model's Ownership of Dwellings sector is intensive in civil construction. Hence we use investment in Ownership of Dwellings as a proxy for investment in the infrastructure construction programs. This allows us to correctly model the commodity composition of the new investment. It also ensures that the national and regional macro accounts are correct, since the model will correctly add the new investments to these macro aggregates.

Like the petroleum and gas extraction investment, we provide two project financing options (private consumption and public spending). As in the above simulations, we have used the first one). Lets take the roads projects as an example. The roads projects are assumed to generate an annual return of 12.9%.[S6] We express the return in each region as an improvement in regional primary factor productivity. We assume that the Road transport sector stands to gain most from the roads projects, so we weight the distribution of each region's primary factor productivity gain towards this sector.

3.3 Housing

Most regions are beneficiaries of this expenditure program. We view the housing as public housing, directed at providing dwellings to people ill-serviced by the private dwellings market. We model a construction phase and a benefit phase. The construction phase is modelled under a short-run comparative static closure. The benefit phase is modelled under a long-run comparative static closure. We simulate the construction phase of the housing program by lifting investment in regional *Dwellings* industries. We have added to the model equations to automate the housing program finance shocks.

Capital and land, by regional industry, are exogenous. Regional employment is endogenous at given regional real consumer wages. Household nominal consumption at the regional level moves with household nominal labour income, subject to project financing requirements as discussed above.

We deliver the project investment long run shock increasing the capital stock in the regional dwelling sector, taking into account an estimate of each state capital stock in the sector and investment value.

4. Simulation Results

4.1 Macroeconomic impacts

The macroeconomic impacts of all investments are presented in Table 3, and allow us to elucidate the different short-run and long-run hypothesis adopted in the simulations. In the short run, these investments represent an additional 15.04% of annual growth of aggregate investment in the economy. Such growth is in some degree financed by the marginal reduction in families' consumption and in foreign trade balance (since imports increase more than exports)[S7]. The final result for the economy as a whole is the additional increase in annual employment (1.79%) and GDP (0.92%).

The long-run effects of investments are positive for the national economy (Table 4). Annual long-run real GDP is 2.85 per cent higher than what it would otherwise have been. This reflects the benefits of the PPA investments. Recall that we deliver these benefits via two routes: higher productivity (water, sewerage infrastucture, housing, electricity, roads and transportation) and higher land and capital supply (petroleum and gas, refining, biofuels and housing). The rise in real wages is due to the positive impact of productivity growth and additional land and capital supply, which contributes to real income growth and families' consumption growth.

Table 3. Short-run construction and financing impacts (% change, typical year)

	Investments										
	Petroleum and Gas	Refining	Biofuels	Water	Sewer	Housing	Eletricity	Roads	Other Transports	Comunic.	Total
Real private consumption	-0.61	-0.25	-0.07	-0.09	-0.30	-0.16	-0.55	-0.17	-0.20	-0.51	-2.90
Real investment	3.09	1.25	0.33	0.62	1.63	1.08	2.57	1.15	0.95	2.36	15.04
Real foreign exports	0.22	0.09	0.02	0.00	0.06	-0.01	0.24	-0.01	0.10	0.25	0.96
Real foreign imports	0.45	0.18	0.05	0.06	0.21	0.12	0.37	0.13	0.16	0.39	2.12
Real GDP	0.18	0.07	0.02	0.05	0.10	0.08	0.14	0.09	0.05	0.12	0.92
Employment	0.36	0.14	0.04	0.10	0.21	0.18	0.25	0.19	0.09	0.23	1.79
CPI	1.63	1.71	0.85	-0.05	-0.11	-0.32	-0.21	-0.08	-0.07	-0.18	3.15
GDP deflator	-0.29	-0.11	-0.03	0.12	0.03	0.22	-0.39	0.23	-0.21	-0.53	-0.97

Table 4. Long-run impacts
(% change, typical year of operation)

	Investments										
	Petroleum and Gas	Refining	Biofuels	Water	Sewer	Housing	Eletricity	Roads	Other Transports	Comunic.	Total
Real private consumption	0.53	0.47	0.10	0.09	0.25	0.08	0.42	0.23	0.15	0.47	2.79
Real investment	0.52	0.75	0.23	0.08	0.24	0.03	0.40	0.23	0.14	0.42	3.03
Real public consumption	0.53	0.47	0.10	0.09	0.25	0.08	0.42	0.23	0.15	0.47	2.79
Real foreign exports	1.45	2.00	0.67	0.04	0.15	0.01	0.25	0.14	0.09	0.26	5.06
Real foreign imports	1.72	2.44	0.83	0.03	0.12	-0.01	0.20	0.11	0.07	0.20	5.72
Real GDP	0.54	0.52	0.13	0.09	0.25	0.07	0.42	0.23	0.15	0.46	2.85
Real wage	1.01	0.98	0.31	0.17	0.48	0.42	0.82	0.42	0.27	0.64	5.51
Capital stock	1.16	1.19	0.26	0.05	0.16	0.18	0.27	0.17	0.09	0.32	3.86

4.2 Regional impacts

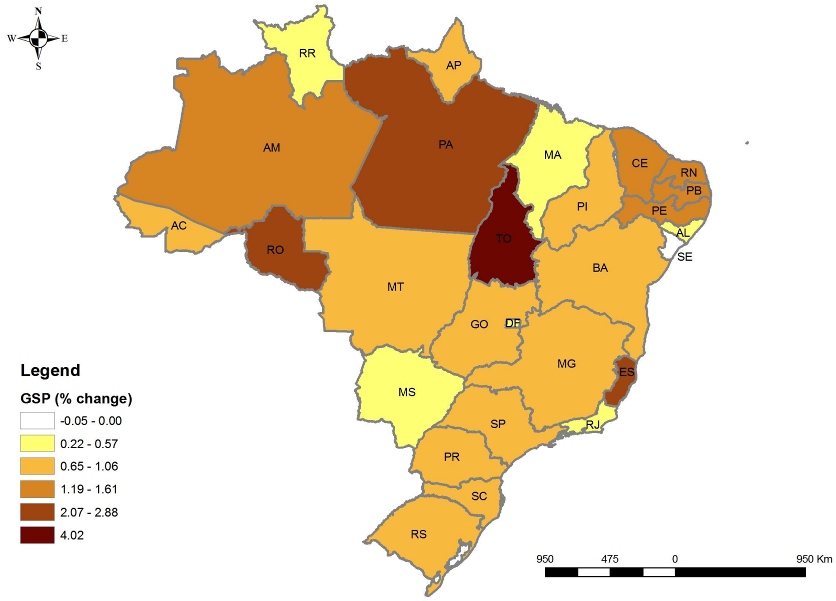
Table 5 and Figure 4 show regional short run construction and financing impacts. Tocantins, Rondonia, Para and Espirito Santo are the most benefited states. It´s clear from Table 6 how real private consumption is financing the investments. Bigger investments increases (like in Tocantins, Rondonia and Espirito Santo) cause regional trade deficits.

Table 5. Regional short-run construction and financing impacts (GSP % change, typical year)

	State	Total	Petroleum and Gas	Refining	Biofuels	Water	Sewer	Housing	Eletricity	Roads	Other Transports	Comunic.
RO	Rondonia	2.88	0.01	0.01	0.01	0.00	0.13	0.14	2.34	0.14	0.02	0.07
AC	Acre	0.66	-0.04	-0.02	0.00	-0.01	0.02	0.06	0.00	0.69	-0.01	-0.02
AM	Amazonas	1.57	0.17	0.07	0.02	0.08	0.16	0.26	0.29	0.25	0.07	0.19
RR	Roraima	0.21	-0.07	-0.03	-0.01	0.02	0.02	0.13	0.20	-0.01	-0.01	-0.03
PA	Para	2.07	0.10	0.04	0.01	0.03	0.12	0.27	0.60	0.69	0.07	0.12
AP	Amapa	0.79	0.14	0.06	0.01	0.03	0.07	0.03	0.11	0.14	0.05	0.12
TO	Tocantins	4.02	0.22	0.14	0.07	0.06	0.28	0.45	1.95	0.19	0.45	0.19
MA	Maranhao	0.43	0.02	0.01	0.00	0.11	0.03	0.18	0.06	0.02	0.00	0.01
PI	Piaui	0.92	0.00	-0.01	0.04	0.22	0.06	0.40	0.15	0.03	0.00	0.04
CE	Ceara	1.61	0.35	0.09	0.01	0.55	0.11	0.29	0.01	0.05	0.08	0.07
RN	Rio Grande d	1.37	0.28	0.03	0.01	0.55	0.07	0.12	0.06	0.17	0.02	0.07
PB	Paraiba	1.24	-0.01	-0.01	0.01	0.80	0.05	0.14	-0.01	0.26	-0.01	0.02
PE	Pernambuco	1.19	0.04	0.22	0.00	0.37	0.08	0.18	0.10	0.15	0.02	0.03
AL	Alagoas	0.54	-0.01	0.00	0.00	0.11	0.03	0.13	0.02	0.24	-0.01	0.03
SE	Sergipe	-0.05	0.06	-0.03	-0.01	0.03	-0.02	0.02	-0.07	0.08	-0.03	-0.07
BA	Bahia	0.65	0.08	0.04	0.01	0.03	0.09	0.16	0.03	0.16	0.01	0.04
MG	Minas Gerais	0.87	0.14	0.07	0.03	0.02	0.14	0.10	0.08	0.15	0.03	0.11
ES	Espirito Santo	2.40	1.83	0.03	0.00	0.02	0.10	0.09	0.03	0.16	0.05	0.08
RJ	Rio de Janeiro	0.57	0.23	0.11	0.00	0.00	0.07	0.04	0.04	0.03	0.01	0.04
SP	São Paulo	0.84	0.19	0.07	0.02	0.02	0.12	0.06	0.11	0.04	0.06	0.16
PR	Parana	0.72	0.09	0.07	0.02	0.00	0.12	0.07	0.12	0.03	0.06	0.14
SC	Santa Catarin	1.06	0.16	0.06	0.02	0.01	0.14	0.06	0.20	0.10	0.09	0.21
RS	Rio Grande d	0.86	0.11	0.07	0.01	0.02	0.11	0.05	0.15	0.12	0.07	0.16
MS	Mato Grosso	0.39	0.00	0.00	0.11	0.00	0.06	0.06	0.10	0.01	0.00	0.03
MT	Mato Grosso	0.65	0.02	0.01	0.01	0.00	0.05	0.05	0.15	0.28	0.03	0.04
GO	Goias	0.74	0.02	0.10	0.09	0.02	0.10	0.11	0.18	0.04	0.05	0.04
DF	Distrito Feder	0.38	0.07	0.03	0.01	0.02	0.05	0.04	0.05	0.04	0.02	0.05
	Total	0.92	0.18	0.07	0.02	0.05	0.10	0.08	0.14	0.09	0.05	0.12

GSP: Gross State Product (regional GDP)

Figure 4. Regional short-run construction and financing impacts (% change, typical year)



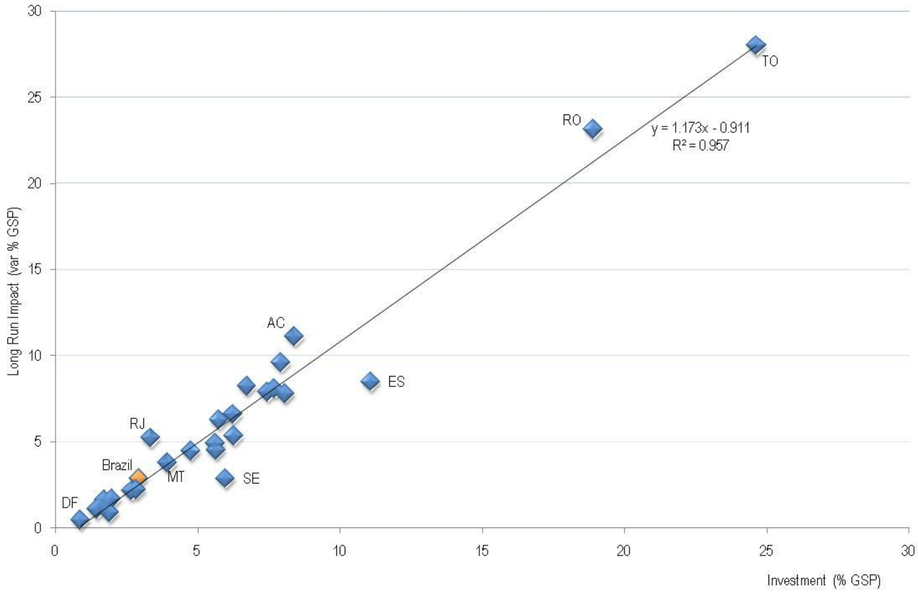
GSP: Gross State Product (regional GDP)

Table 6. Regional short-run construction and financing impacts (% change, typical year)

State		Real private consumption	Real investment	Real interstate exports	Real interstate imports	Real foreign exports	Real foreign imports
RO	Rondonia	-2.3	116.4	-2.6	11.2	1.9	-0.4
AC	Acre	-4.6	42.3	-1.6	1.7	0.9	2.5
AM	Amazonas	-2.1	13.2	2.9	1.7	0.0	3.5
RR	Roraima	-4.6	29.0	0.1	1.4	2.1	0.5
PA	Para	-2.2	42.9	0.4	3.9	0.2	0.8
AP	Amapa	-3.9	35.4	2.2	1.9	1.8	0.2
TO	Tocantins	-1.1	145.2	-0.7	11.3	12.0	-1.9
MA	Maranhao	-4.4	34.3	0.6	2.0	-0.1	-0.3
PI	Piaui	-3.8	24.6	0.5	1.2	13.6	-2.7
CE	Ceara	-3.0	42.5	-0.5	4.1	1.9	-0.1
RN	Rio Grande do Norte	-3.4	41.1	0.6	3.7	3.4	-0.3
PB	Paraiba	-4.0	29.0	-0.1	1.3	3.1	-4.3
PE	Pernambuco	-3.4	30.6	0.3	3.2	1.7	-1.6
AL	Alagoas	-4.2	19.1	-0.7	0.3	3.2	-5.1
SE	Sergipe	-5.1	28.8	-0.1	2.0	3.1	-4.0
BA	Bahia	-3.3	13.1	0.9	1.4	1.2	-0.9
MG	Minas Gerais	-2.6	12.0	1.2	1.2	2.9	-3.5
ES	Espirito Santo	-2.4	72.8	-0.5	4.7	-0.1	1.9
RJ	Rio de Janeiro	-3.4	16.2	0.7	1.7	0.6	0.4
SP	São Paulo	-2.6	7.4	2.1	0.0	0.9	3.3
PR	Parana	-2.6	9.9	1.2	0.9	2.0	2.1
SC	Santa Catarina	-2.3	9.7	3.0	0.6	0.2	8.6
RS	Rio Grande do Sul	-2.7	9.1	2.2	0.8	1.3	2.2
MS	Mato Grosso do Sul	-3.8	13.6	0.7	0.4	1.0	1.0
MT	Mato Grosso	-3.7	19.2	0.5	1.5	2.4	-2.5
GO	Goias	-3.1	24.3	0.2	2.8	2.6	-3.1
DF	Distrito Federal	-4.1	1.0	1.3	-1.9	4.8	-7.8
	Brazil	-2.9	15.0	-	-	1.0	2.1

Figure 5 and Table 7 show regional long run impacts. State impacts follow the size of the investments (Figure 5). Tocantins (TO), Rondonia (RO) and Espirito Santo (ES) are the most benefited states. Eletricity investments are the biggest impacts on Rondonia and Tocantins. In the case where investments are concentrated in one region (Water in the Northeastern states), the model predicts a capital flow from other regions to the Northeastern states, causing a negative impact in the rest of Brazil (Table 7).

Figure 5. Investments and long-run impacts



GSP: Gross State Product (regional GDP)

Table 7. Regional long-run construction and financing impacts (GSP % change, typical year)

	State	Total	Petroleum and Gas	Refining	Biofuels	Water	Sewer	Housing	Eletricity	Roads	Other Transports	Comunications
RO	Rondonia	23.13	0.09	0.09	0.11	-0.09	0.57	0.13	21.66	0.07	-0.03	0.54
AC	Acre	11.12	0.26	0.24	0.10	-0.01	1.05	0.27	2.76	5.54	0.20	0.72
AM	Amazonas	0.90	-0.50	0.14	0.03	-0.12	0.31	0.18	0.12	0.65	-0.07	0.17
RR	Roraima	6.60	0.08	0.09	0.07	-0.03	1.50	0.37	3.63	0.01	0.35	0.53
PA	Para	7.90	-0.01	-0.02	0.03	-0.04	0.45	0.44	4.05	1.97	0.44	0.60
AP	Amapa	8.25	0.07	0.04	0.01	0.51	0.91	0.14	2.05	3.44	0.56	0.52
TO	Tocantins	27.99	0.06	0.10	0.09	-0.12	1.51	0.51	17.41	-0.17	7.66	0.94
MA	Maranhao	7.79	0.16	0.11	0.02	1.10	0.95	1.42	2.86	-0.02	0.46	0.73
PI	Piaui	5.36	0.71	-0.07	0.31	0.52	0.84	0.76	1.28	-0.06	0.12	0.95
CE	Ceara	8.10	1.87	0.67	0.15	1.58	0.64	0.52	0.03	0.00	1.69	0.95
RN	Rio Grande do Norte	9.61	2.12	0.44	0.02	3.88	0.53	0.29	0.26	1.05	0.17	0.85
PB	Paraiba	4.91	0.17	-0.35	0.10	2.90	0.37	0.31	-0.26	0.88	0.01	0.78
PE	Pernambuco	6.29	0.44	1.40	0.09	1.13	0.36	0.29	0.95	0.41	0.47	0.75
AL	Alagoas	4.52	0.24	0.00	0.10	0.45	0.53	0.38	0.70	1.12	0.01	0.98
SE	Sergipe	2.89	-0.85	1.30	-0.02	0.28	0.41	0.22	0.00	1.03	-0.04	0.56
BA	Bahia	2.22	-1.11	1.44	0.14	0.01	0.35	0.24	0.07	0.40	0.10	0.59
MG	Minas Gerais	1.71	0.27	0.16	0.01	0.00	0.26	0.06	0.03	0.40	-0.09	0.61
ES	Espirito Santo	8.50	6.97	0.17	0.01	-0.06	0.20	0.05	-0.19	0.34	0.53	0.48
RJ	Rio de Janeiro	5.24	2.47	1.95	-0.01	-0.08	0.16	0.00	0.27	0.01	0.06	0.42
SP	São Paulo	1.10	0.34	0.32	0.14	-0.06	0.13	0.01	-0.14	-0.03	0.03	0.35
PR	Parana	1.36	0.18	0.03	0.22	-0.06	0.26	0.01	0.23	-0.07	0.12	0.43
SC	Santa Catarina	1.37	0.00	0.07	0.12	-0.05	0.27	-0.01	0.26	0.18	0.09	0.44
RS	Rio Grande do Sul	1.64	0.13	0.12	0.20	-0.04	0.18	-0.01	0.34	0.29	0.08	0.36
MS	Mato Grosso do Sul	2.16	0.06	0.11	0.97	-0.09	0.32	0.03	0.55	-0.15	-0.09	0.44
MT	Mato Grosso	3.78	0.02	0.15	0.21	-0.10	0.29	0.04	1.07	1.19	0.49	0.43
GO	Goias	4.47	0.13	0.67	0.10	-0.05	0.60	0.10	1.45	-0.03	0.78	0.73
DF	Distrito Federal	0.49	0.09	0.07	0.03	-0.11	0.11	-0.02	0.03	-0.09	0.09	0.28
	Brazil	2.85	0.54	0.52	0.13	0.09	0.25	0.07	0.42	0.23	0.15	0.46

GSP: Gross State Product (regional GDP)

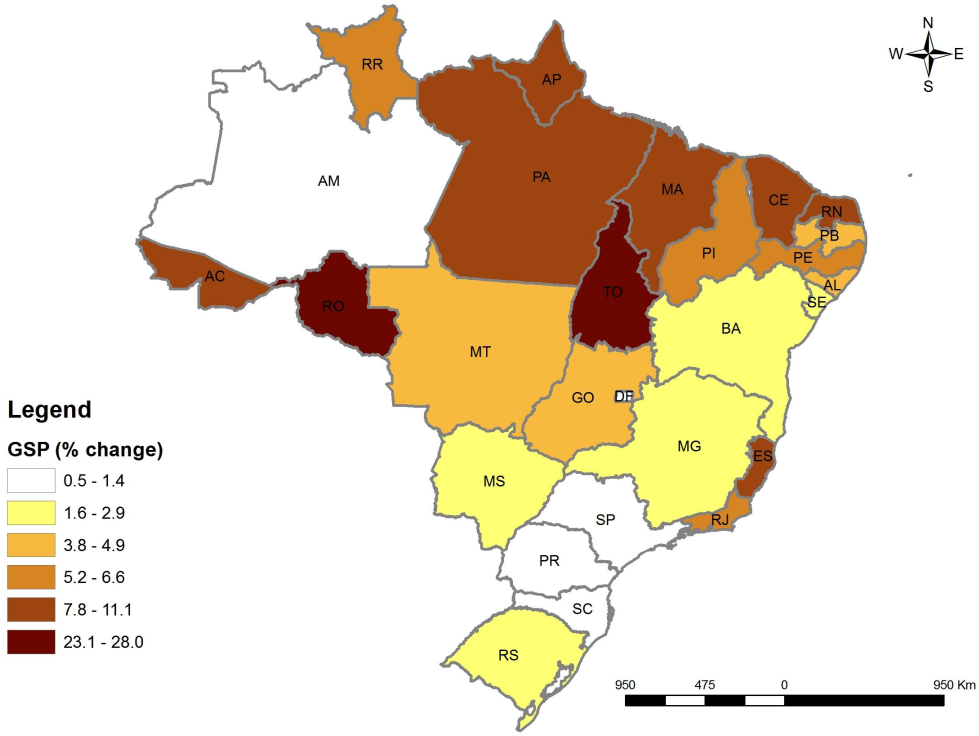
Table 8 breaks up state GDP results in its components (expenditure side). Consumption and investment grows in all states, but are more important in small states with huge investments (Rondonia and Tocantins). In those states, an inter-regional trade deficit also shows up, pointing out to important regional linkages to other states. Foreign imports also increases in each state (remember that the foreign trade in the results relates to the state of entry/exit of these flows and not the final destination of goods and services).

Table 8. Regional long-run impacts (% change, typical year of operations)

	State	Real private consumption	Real investment	Real interstate exports	Real interstate imports	Real foreign exports	Real foreign imports
RO	Rondônia	17.0	18.2	36.2	19.4	4.5	11.5
AC	Acre	12.1	13.1	34.9	11.5	34.6	8.7
AM	Amazonas	1.4	1.2	1.7	1.0	-1.6	4.1
RR	Roraima	6.2	6.5	7.5	4.9	2.9	8.1
PA	Para	7.2	6.8	7.1	3.0	-2.6	4.7
AP	Amapá	9.4	9.6	21.4	9.1	-1.0	10.8
TO	Tocantins	17.9	18.2	29.6	17.6	-19.8	15.1
MA	Maranhão	9.9	8.0	9.8	6.0	-0.8	6.9
PI	Piauí	7.1	5.8	6.4	6.5	-26.3	12.3
CE	Ceara	7.7	7.1	6.4	3.5	2.0	7.9
RN	Rio Grande do Norte	8.2	8.7	11.4	7.1	26.8	11.6
PB	Paraíba	5.7	5.1	4.4	4.2	-1.6	11.4
PE	Pernambuco	6.3	6.0	5.2	3.1	0.9	9.6
AL	Alagoas	5.5	4.9	5.2	4.8	3.7	9.1
SE	Sergipe	3.2	0.1	3.5	2.8	-3.7	9.3
BA	Bahia	3.0	2.2	1.2	6.0	24.0	7.1
MG	Minas Gerais	2.4	2.3	1.3	1.4	-6.1	9.9
ES	Espirito Santo	3.1	1.4	10.6	1.4	-2.2	5.8
RJ	Rio de Janeiro	3.6	5.5	2.6	4.2	24.3	7.4
SP	São Paulo	1.3	1.7	1.9	3.2	5.2	4.7
PR	Paraná	1.2	1.7	2.0	1.1	0.6	5.6
SC	Santa Catarina	1.5	2.0	1.9	0.8	-1.9	4.8
RS	Rio Grande do Sul	2.1	2.3	2.1	1.1	-0.9	4.5
MS	Mato Grosso do Sul	2.1	2.2	2.8	1.4	-1.2	7.3
MT	Mato Grosso	3.9	4.0	4.8	4.0	-3.5	9.0
GO	Goiás	4.2	4.0	6.5	5.2	-3.5	9.8
DF	Distrito Federal	1.5	2.7	0.0	1.7	-8.0	11.5
	Brazil	2.8	3.0	-	-	5.1	5.7

Figure 6 maps the regional long run impacts of all PPA investments. Rondonia (RO), Tocantins (TO) be the most benefited states, all in the North region. Amazonas (AM), although an important industrial district in the region (Manaus), is not much impacted. We should remember that Amazonas has a close relation to São Paulo (SP), selling and buying industrial goods, and Sao Paulo is not much impacted with the investments. Maranhão (MA), Ceará (CE) and Rio Grande do Norte (RN) are the most benefited in the Northeast. These results are due to housing investments, in Maranhão; Petroleum and Gas, Water and Other Transports investments, in Ceara and Rio Grande do Norte (see Table 7). In the Southeast, the big impact at Espirito Santo (ES) come from Petroleum and Gas investments, the same source of gains in Rio de Janeiro (RJ). Sao Paulo (SP), Parana (PR) and Santa Catarina (SC) are not much contemplated with investments, and in the long run its competitiveness, relatively to other regions, seems to decrease.

Figure 6. Regional long-run impacts (% change, typical year)



GSP: Gross State Product (regional GDP)

Finally, Table 9 compares the regional inequality (% change in the GINI index of per-capita income) and the national growth impacts in the long run. There is no visible trade-off between national growth and regional inequality. But there are some marked differences due to the spatial configuration of the projects. Petroleum and Gas are concentrated in the Southeast, so regional inequality increases. Electricity is very concentrated in the North (poorer states), so regional inequality decreases.

Table 9. Long-run impacts: regional inequality and growth

Investment	Regional inequality (GINI index % change)	Growth (GDP % change)
Petroleum and Gas	0.38	0.54
Refining	0.13	0.52
Biofuels	0.01	0.13
Water	-0.42	0.09
Sewer	-0.27	0.25
Housing	-0.07	0.07
Eletricity	-1.69	0.42
Roads	-0.44	0.23
Other Transports	-0.45	0.15
Comunications	-0.18	0.46

5. Final remarks

Simulation results point out to important issues regarding infrastructure investments. In general the short-run impacts tend to favor the most developed regional economies which are, proportionally, the less benefited regions by the investment portfolio. The strong interregional linkages of these regions are the important source of this inter-regional growth leakage. Such short-run results can be explained by the different forms which the impacts are absorbed by the national economy over time. In the short run the impacts measure the construction effects, when the projects are physically executed. The sectors directly affected are the suppliers of intermediate inputs and capital goods for the expansion of fixed capital, which compose the investment vectors of the projects.

It is expected that states which are specialized in these sectors will be the most beneficiaries. Except for the construction industry, which has a local base, the other sectors related to capital goods and intermediate industries are geographically concentrated and organized in national markets through interstate trade flows. Localized investment shocks result in inter-regional demands from these sectors, benefiting the inter-state export regions. The local base of the construction industry does not mean the absence of inter-regional spillovers, given by purchases from other regions of industrial intermediate inputs for construction, such as non-metallic minerals, metallurgic products and plastic materials. In sum, the short-run simulation shows that the inter-regional growth leakage coming from flowing effects predominate over the intra-regional absorption effects.

The long-run results show the other side of the time dynamics of the portfolio investment shocks. Regional increases in sectoral factor productivity and cost reductions, including transport costs, change the relative price system to the benefit of the backward regions receiving most of the additional investments. These investments bring about improvements in the backward region’s inter-regional competitiveness coming from income multiplier effects and forward and backward effects from inter-sectoral linkages within the regions. Therefore, it generates expansion in local production and decrease in imports from other regions and, consequently, it increases regional GDP. As the results show, the economic benefits from investments are strongly concentrated in the backward states where larger fractions of investment take place. This bias towards peripheral regions of the Brazilian 2008-2011 investment plan may result in positive effects for the regional income distribution in Brazil.

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