The economy of the North-East region of Brazil based on the 2011 regional input-output matrix

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Abstract

This paper seeks to determine the leading sectors of the economy of the North-East region of Brazil based on input-output matrix methodology and the economic structure of 2011. For that purpose, the regional input-output matrix was updated from 2004 to 2011 and, subsequently, the Rasmussen-Hirschman linkage indices, field of influence and pure linkage indices were calculated, along with the type I and II multipliers of production, employment and income. The results confirm the importance of the textile and chemical sectors, along with those related to the oil industry, and show that the production of intermediate goods is one of the characteristics of the North-East region's economy.

Keywords

Economic conditions, economic development, regional development, industrial production, employment, income, input-output analysis, Brazil

JEL classification

R10, R11, R13

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I. Introduction

In the 1970s, efforts to decentralize the Brazilian economy through public investment in infrastructure (roads, ports, energy, etc.) and in strategic industrial sectors picked up pace, including under the Second National Development Plan (1975–1979) (Government of Brazil, 1970).[1] As a result of these initiatives, large production complexes were established in the North-East[2] from 1970–1984 (Galindo, 1997).

The decentralization process appears to be ongoing, as the South-East region's share in the value of industrial transformation fell from 69.3% in 1996 to 61.6% in 2004, while that of the North-East region increased from 4.3% to 10.1% (BCB, 2006). This underscores the economic growth of the North-East in spite of the heterogeneous characteristics of this process, in which some dynamic areas of regional development coexist with entire areas that are stagnant and lacking in production modernization.

The input-output matrix has often been employed in the design or analysis of public policies. Its widespread use is justified by its capacity to predict the potential effects of a shock in the final demand of a certain sector, both on the sector itself and on the rest of the economy.

Thus, it allows policymakers to stimulate sectors considered key —i.e., those in which a final demand shock spreads most strongly to the rest of the economy, both upstream (backward) and downstream (forward) in the production chain— and to identify and clear production bottlenecks.

Against this backdrop, as noted by Tosta, Lirio and Silveira (2004), input-output models have contributed to a wide range of economic works and analyses, as they facilitate the evaluation of the impact of production changes in a specific sector on different sectors.

However, works on the economy of the North-East based on this methodology remain scarce. In one of these studies, Guilhoto and others (2012) present a more theoretical and methodological approach and build a regional input-output table (base year 2004), calculating the main indicators and also presenting data by State. Drawing on the work of Guilhoto and others (2012), Ribeiro and others (2013) analysed Suape (an industrial port complex located in the State of Pernambuco) and the potential economic effects of the construction of the Abreu e Lima refinery, which they considered the core of the industry driving development.

The input-output matrix was also used by Morrone (2017) to examine the basic economic structure of Rio Grande do Sul in 2008 and to estimate the impact of the increase in the tax on the circulation of goods and services (ICMS) on final demand and economic activity in the State. The study showed the negative effect of the measure, which limited the possibilities for regional development.

Montoya, Finamore and Pasqual (2012) also used the input-output matrix to analyse the sources of growth and structural change in the economy of Rio Grande do Sul from 1998–2003. The matrix reflects the reduction and resumption of economic growth.

Similarly, Ribeiro and Leite (2012) conducted an analysis focused on States and built an input-output matrix for the State of Sergipe, using the RAS method for the construction of regional matrices.[3] According to the authors, the Sergipe economy faced problems relating to the supply of inputs in sectors crucial to the State's development because, in addition to sectoral concentration and limited international integration, there were few key sectors to stimulate local growth.

[1] See Lessa (1977), Delgado (1985) and Fishlow (1986) for more details on the Second National Development Plan (1975–1979) and the Brazilian economic context of that period.

[2] Notably, the petrochemical complex in Camaçari, Bahia; the integrated petrochemical complex in Sergipe; the chlorochemical and rock salt complex in Alagoas; the sugar and alcohol complex on the eastern coast of Pernambuco and Alagoas; agroindustry within the irrigated perimeter of the São Francisco River where it runs through Pernambuco and Bahia; the port industry of Suape, in Pernambuco; the chemical and metallurgical industry of Rio Grande do Norte; the textile and garment industry in Ceará; the mineral and metallurgical industry in Maranhão; and oil production along the North-East coast (Galindo, 1997).

[3] See Miller (1998, p. 89) for more details on the RAS method.

Considering regional vicissitudes, the aim of this work is to determine the sectors that currently play a leading role in the economy of the North-East region of Brazil based on input-output matrix methodology and the economic structure of 2011, and to raise important points to guide public policies targeting the region's development. For that purpose, the regional input-output matrix was updated from 2004 to 2011 and, subsequently, the Rasmussen-Hirschman linkage indices,[4] field of influence[5] and pure linkage indices[6] were calculated, along with the type I and II multipliers of production, employment and income.[7]

In order to better understand the instruments used, the second section presents a brief theoretical foundation for the input-output model. The third section examines the methodology used in this work, while section four identifies the main economic sectors of the North-East region, and is followed by final considerations.

II. Theoretical foundation

According to Miller and Blair (2009), an input-output model consists of a system of linear equations, each of which describes the distribution of a sector's products throughout the economy. Its basic objective is to analyse the interdependence of economic sectors. Guilhoto and others (2012) compare the input-output model proposed by Leontief (1966) with an "economic snapshot" of the economy itself, which can show how sectors are linked or, in other words, identify the sectors that demand products and services and those that supply them.

Input-output tables are often used to represent this interdependence, which is systematized in table 1.

Table 1
Leontief input-output matrix for two sectors

Sectors		Purchases *(j)*								Gross production value
		Intermediate demand			Final demand					
		Sector 1	Sector 2	Subtotal	C	I	G	E	Subtotal	
Sales *(i)*	Sector 1	Z_{11}	Z_{12}	$\sum_{j=1}^{2} z_{ij}$	C_1	I_1	G_1	E_1	Y_1	X_1
	Sector 2	Z_{21}	Z_{22}	$\sum_{j=1}^{2} z_{2j}$	C_2	I_2	G_2	E_2	Y_2	X_2
Subtotal		$\sum_{i=1}^{2} z_{i1}$	$\sum_{i=1}^{2} z_{i2}$	$\sum_{i,j=1}^{2} z_{ij}$	$\sum_{i=1}^{2} C_i$	$\sum_{i=1}^{2} I_i$	$\sum_{i=1}^{2} G_i$	$\sum_{i=1}^{2} E_i$	$\sum_{i=1}^{2} Y_i$	$\sum_{i=1}^{2} X_i$
Imports		M_1	M_2	$\sum_{i=1}^{2} M_j$						
Net indirect taxes		T_1	T_2	$\sum_{i=1}^{2} T_j$						
Value added		VA_1	VA_2	$\sum_{i=1}^{2} VA_j$						
Gross production value		X_1	X_2	$\sum_{i=1}^{2} X_j$						

Source: Prepared by the authors on the basis of J. J. M. Guilhoto, *Análise de insumo-produto: teoria, fundamentos e aplicações*, São Paulo, School of Economics, Management and Accounting, University of São Paulo (FEA/USP), 2007.

[4] See Rasmussen (1956) and Hirschman (1958).

[5] See Mendes, Pereira and Teixeira (2011).

[6] See Guilhoto and others (1994).

[7] See Miller and Blair (2009).

Where z_{ij} is the supply of inputs from sector i to sector j; C_i is the supply of sector i earmarked for private final consumption; I_i is the supply of sector i allocated to private investment; G_i is the supply of sector i set aside for the government (consumption and investment); E_i is the supply of sector i earmarked for exports to the rest of the world; Y_i represents the total final demand met by sector i ($C_i + I_i + G_i + E_i$); X_i represents the gross production value of sector i (or total supply of i); M_j represents the imports of sector j; T_j represents the total net indirect taxes collected by sector j; VA_j is the total gross value added of sector j; and C_j is the total production cost of sector j.

Table 1 is used to obtain the production equation through equation (1):

$$X_i = \sum_{j=1}^{2} z_{ij} + Y_i \tag{1}$$

Considering the assumptions of the Leontief model contained in Miller and Blair (2009), namely: (i) fixed relationships between a sector's inputs and its output and (ii) constant returns to scale, and the technical coefficient of production, also called the input-output coefficient or direct input coefficient, we obtain through equation (2):

$$a_{ij} = \frac{z_{ij}}{x_j} \tag{2}$$

where a_{ij} is the technical coefficient that indicates the quantity of inputs of sector i necessary for the production of one unit of final output in sector j.

Applying (2) to (1) and generalizing to n sectors, we obtain equation (3):

$$X_i = \sum_{j=1}^{n} a_{ij} x_j + Y_i \tag{3}$$

In matrix form, equation (3) can be written as (4):

$$X = AX + Y \tag{4}$$

Since final demand is exogenous, it follows that:

$$X - AX = Y \tag{5.A}$$

or, too:

$$\left(I - A\right)^{-1} Y = X \tag{5.B}$$

where the term $(I - A)^{-1}$, also called matrix B, corresponds to the matrix of direct and indirect coefficients, or the Leontief matrix. The dimension of this matrix is $n \times n$, where n indicates the number of sectors considered, whose elements can be represented by b_{ij}.

On the basis of the national model, Miller and Blair (2009) proposed a regional model, as shown in table 2.

Table 2
Intersectoral and interregional flow of goods

			Purchasing sectors			
			Region L		Region M	
			1	2	1	2
Selling sectors	Region L	1	z_{11}^{LL}	z_{12}^{LL}	z_{11}^{LM}	z_{12}^{LM}
		2	z_{21}^{LL}	z_{22}^{LL}	z_{21}^{LM}	z_{22}^{LM}
	Region M	1	z_{11}^{ML}	z_{12}^{ML}	z_{11}^{MM}	z_{12}^{MM}
		2	z_{21}^{ML}	z_{22}^{ML}	z_{21}^{MM}	z_{22}^{MM}

Source: Prepared by the authors on the basis of E. R. Miller and P. D. Blair, *Input-Output Analysis: Foundations and Extensions*, Cambridge, Cambridge University Press, 2009.

Bear in mind the hypothetical intersectoral and interregional flow of goods to regions L and M, both with two sectors, in which z_{ij}^{LL} is the monetary flow from sector i to sector j in region L; z_{ij}^{MM} is the monetary flow from sector i to sector j in region M; z_{ij}^{LM} is the monetary flow from sector i in region L to sector j in region M; and z_{ij}^{ML} is the monetary flow from sector i in region M to sector j in region L.

III. Methodology

The methodology used in this article is based on the input-output matrix, with productive linkages between activities and the determination of key economic sectors, specifically evaluated through Rasmussen-Hirschman indices, fields of influence and pure linkage indices, in addition to production, employment and income multipliers, which are described below.

1. Rasmussen-Hirschman linkage index

The linkage index developed by Rasmussen (1956) and Hirschman (1958) makes it possible to determine the economic sectors which reflect the strongest linkages and which, therefore, can be considered key sectors.[8]

Estimation starts with matrix B, i.e., the Leontief inverse matrix, described in equation (5.B). According to Guilhoto and others (2012), the Rasmussen-Hirschman linkage index can be found using equations (6) and (7):

$$U_j = \frac{B_{*j}/n}{B^*} \tag{6}$$

$$U_i = \frac{B_{i*}/n}{B^*} \tag{7}$$

where U_j is the backward linkage index and U_i corresponds to the forward linkage index; B is the Leontief inverse matrix; B^* is the average of all the elements of B; B_{*j} and B_{i*}, correspond, respectively, to the sum of each column and each row of B; and n is the number of economic sectors. The backward linkage index indicates the extent to which one sector demands inputs from the other sectors, while the forward linkage index indicates the extent to which the outputs of one sector are demanded by other sectors.

[8] See Hewings and others (1989) for a discussion of key economic sectors.

According to Haddad (1989), index values above unity may denote key sectors, which are strongly linked with upstream and downstream sectors in the production chain. However, Guilhoto and others (2012) note that the application of the Rasmussen-Hirschman linkage index methodology makes it difficult to determine the coefficients that, when modified, produce a greater impact on the system as a whole. The analysis of the field of influence was developed to fill this gap.

2. Field of influence

According to Mendes, Pereira and Teixeira (2011), the field of influence approach describes the way in which changes in direct coefficients are distributed throughout the economic system as a whole and makes it possible to determine the relationships between the most important sectors in the production process. Thus, the field of influence shows the extent to which each sector links backward and forward to all the other economic sectors.

To arrive at that result, we use a matrix of direct coefficients $A = |\alpha_{ij}|$, defining the matrix of incremental variations in direct coefficients of input $E = |\varepsilon_{ij}|$. The corresponding Leontief matrices are given by equation (8):

$$B = \left[I - A\right]^{-1} = \left| b_{ij} \right| \tag{8}$$

and by equation (9):

$$B(\varepsilon) = \left[I - A - \varepsilon\right]^{-1} = \left| b_{ij}(\varepsilon) \right| \tag{9}$$

If the variation is small and only occurs in a direct coefficient, we obtain:

$$\varepsilon_{ij} = \begin{cases} \varepsilon, & i = i_1,\ j = j_1 \\ 0, & i \neq i_1,\ j \neq j_1 \end{cases} \tag{10}$$

The field of influence of this variation can be approximated using the expression (11):

$$F(\varepsilon_{ij}) = \frac{\left[B(\varepsilon_{ij}) - B\right]}{\varepsilon_{ij}} \tag{11}$$

where $F(\varepsilon_{ij})$ is a matrix (n x n) of the field of influence of coefficient α_{ij}.

To determine the coefficients with the greatest field of influence, it is necessary to associate a value with each matrix $F(\varepsilon_{ij})$. Thus,

$$S_{ij} = \sum_{k=1}^{n} \sum_{l=1}^{n} \left[f_{kl}(\varepsilon_{ij}) \right]^2 \tag{12}$$

where S_{ij} is the value associated with matrix $F(\varepsilon_{ij})$. Therefore, the direct coefficients with the highest values of S_{ij} will be those with the greatest field of influence within the economy as a whole.

3. Pure linkage indices

According to Mendes, Pereira and Teixeira (2011), pure linkage indices —which complement the analysis of the input-output matrix— determine the behaviour of the production structure, considering the level of production of each sector and allowing the measurement of interactions between sectors in terms of production value. Also known as the GHS index,[9] it was proposed by Guilhoto and others (1994) with the objective of isolating the effects of each sector on the economic system as a whole.

Therefore, considering the matrix of direct input coefficients, A (based on 5.B), which represents an input-output system for a given sector j, and the rest of the economy, we obtain:

$$A = \begin{bmatrix} A_{jj} & A_{jr} \\ A_{rj} & A_{rr} \end{bmatrix} \tag{13}$$

where A_{jj} and A_{rr} are square matrices of direct inputs of sector j and the rest of the economy, respectively; and A_{jr} and A_{rj} are rectangular matrices showing, respectively, the direct inputs purchased by sector j from the rest of the economy and the direct inputs purchased by the rest of the economy from sector j. Based on the following Leontief inverse matrix:

$$B = \left(I - A\right)^{-1} = \begin{bmatrix} B_{jj} & B_{jr} \\ B_{rj} & B_{rr} \end{bmatrix} = \begin{bmatrix} \Delta_{jj} & 0 \\ 0 & \Delta_{rr} \end{bmatrix} \begin{bmatrix} \Delta_j & 0 \\ 0 & \Delta_r \end{bmatrix} \begin{bmatrix} I & A_{jr}\Delta_r \\ A_{rj}\Delta_j & I \end{bmatrix} \tag{14}$$

the elements are defined as:

$$\Delta_j = \left(I - A_{jj}\right)^{-1} \tag{15}$$

$$\Delta_r = \left(I - A_{rr}\right)^{-1} \tag{16}$$

$$\Delta_{jj} = \left(I - \Delta_j A_{jr} \Delta_r A_{rj}\right)^{-1} \tag{17}$$

$$\Delta_{rr} = \left(I - \Delta r A r j \Delta_j A_{jr}\right)^{-1} \tag{18}$$

Thus, from (14), it is possible to determine the production process within the economy and derive a set of multipliers or linkages represented by the matrices. By combining (15) and (5.B), it is possible to derive a set of indices that can be used both to rank sectors according to their importance in the production value generated, and to determine the production process within the economy.

From (14) and (5.B), it follows that:

$$\begin{bmatrix} X_j \\ X_r \end{bmatrix} = \begin{bmatrix} \Delta_{jj} & 0 \\ 0 & \Delta_{rr} \end{bmatrix} \begin{bmatrix} \Delta_j & 0 \\ 0 & \Delta_r \end{bmatrix} \begin{bmatrix} I & A_{jr}\Delta_r \\ A_{rj}\Delta_j & I \end{bmatrix} \begin{bmatrix} Y_j \\ Y_r \end{bmatrix} \tag{19}$$

from which it is possible to derive the definitions of the pure backward linkage index (PBL) and the pure forward linkage index (PFL), given respectively by (20) and (21):

[9] In honour of its creators, Guilhoto, Hewings and Sonis.

$$PBL = \Delta_r A_{rj} \Delta_j Y_j \tag{20}$$

$$PFL = \Delta_j A_{jr} \Delta_r Y_r \tag{21}$$

The PBL provides the pure impact of the value of total output of sector j on the rest of the economy, while the PFL provides the pure impact of the value of total output of the rest of the economy on sector j. As both are in current values, we can proceed as in equation (22):

$$PTL = PBL + PFL \tag{22}$$

The values of the indices are normalised by the average value of the economic sectors, which allows a comparison, over time, in economies experiencing inflation or changes in the monetary standard. According to Nunes and others (2012), a sector is considered key —from the perspective of normalized pure linkage indices— when the values of the normalized pure total linkage indices (PTL) exceed unity ($PTL > 1$).

4. Multipliers

As noted by Tosta, Lirio and Silveira (2012), production, employment and income multipliers are often used to quantify the effects of exogenous changes on selected economic activities and can be classified into type I and type II multipliers. The fundamental difference between these two types is that the second model considers households' consumption, as well as their respective remuneration, endogenously.

Basically, Miller and Blair (2009) define employment and income multipliers as the increase in employment or wages, respectively, given a shock to final demand, which can be represented mathematically by the expression (23):

$$m(h)_j = \sum_{i=1}^{n} \alpha_{n+1} \cdot b_{ij} \tag{23}$$

where $m(h)_j$ is the employment (or income) multiplier for sector j; α_{n+1} is the ratio of the number of persons employed in the sector (or value added to the economy) to the sector's output; and b_{ij} is the element in row i and column j of the Leontief inverse matrix.

As defined by Miller and Blair (2009), the output multiplier for a specific sector is the total value of production in all economic sectors required to satisfy one additional monetary unit of final demand for the output of that sector. Mathematically, it can be expressed as:

$$m(o)_j = \sum_{i=1}^{n} b_{ij} \tag{24}$$

where $m(o)_j$ is the output multiplier for sector j; and b_{ij} is the element in row i and column j of the Leontief inverse matrix.

Type II multipliers can be found algebraically by means of the equations presented in (23) and (24). However, the Leontief inverse matrix is based on a matrix of technical coefficients in which households are endogenous to the model. Schematically, considering an economy with only two sectors, the matrix A is given by:

$$A = \begin{bmatrix} X_{11}/X_1 & X_{12}/X_2 & C_1/U \\ X_{21}/X_1 & X_{22}/X_2 & C_2/U \\ VA_1/X_1 & VA_2/X_2 & 0 \end{bmatrix} \quad (25)$$

where X_{ij} is the output of sector i to serve sector j; X_j is the total output of sector j; C_i is the private consumption of sector i; U is the sum of private consumption; and VA_j is the total gross value added of sector j.

As type II multipliers consider households endogenously, they tend to minimize the problem of underestimation posed by type I multipliers.

5. Updating of the input-output matrix

The starting point for building the input-output matrix for the North-East region and the rest of Brazil in 2011 was similar to that proposed by Guilhoto and others (2012) for 2004. This matrix includes 12 areas, namely: the States within the jurisdiction of the Superintendency for the Development of the North-East (SUDENE) (Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Sergipe, and parts of Espírito Santo and Minas Gerais) and the rest of Brazil. First, the matrix of technical coefficients (Matrix A) was determined for 2004, by dividing intermediate consumption by the respective gross production value. This was used to obtain the Leontief inverse matrix (Matrix $B = (I\text{-}A)^{-1}$), of dimension 1,332 x 1,332.

The system of national accounts of the Brazilian Institute of Geography and Statistics (IBGE, 2014) was used to measure the variation of regional value added for the North-East States from 2004–2011. The ratio between the volume of gross value added in 2004 and that of 2011 was considered, taking into account the 111 sectors and activities listed in table 3.

Table 3
Brazil: selected activities and sectors of the input-output matrix of the North-East region, 2011

Sector or activity		Sector or activity	
1	Maize	57	Metallurgy of non-ferrous metals
2	Sugar cane	58	Metal products, except machinery and equipment
3	Soybean	59	Agricultural machinery and tools
4	Fruit growing	60	Machinery and equipment for oil exploration and extraction
5	Other crops	61	Other machinery and equipment
6	Forestry	62	Household appliances
7	Vegetable production	63	Office machinery and computer equipment
8	Cattle	64	Electrical machinery, equipment and materials
9	Other animals	65	Electronic and communications equipment
10	Pigs	66	Medical and hospital measuring and optical equipment and instruments
11	Poultry	67	Cars, vans and utility vehicles
12	Fish	68	Trucks and buses
13	Oil and other	69	Motor vehicle parts and accessories
14	Natural gas	70	Other transport equipment
15	Services related to oil and gas extraction	71	Furniture industry
16	Iron ore	72	Miscellaneous industries
17	Other products of the extractive industry	73	Electricity production
18	Slaughter of cattle	74	Electricity distribution
19	Slaughter of pigs and other animals	75	Piped gas
20	Slaughter of poultry	76	Water and sewerage
21	Vegetable oil production	77	Urban cleaning services

Table 3 (concluded)

Sector or activity		Sector or activity	
22	Dairy industry	78	Construction
23	Processing of other vegetable products	79	Wholesale trade
24	Poultry feed	80	Fuel retail trade
25	Sugar production	81	Vehicles, parts and accessories retail trade
26	Coffee industry	82	Supermarkets
27	Other food products	83	Other retail trade
28	Beverages	84	Cargo transport by road
29	Tobacco products	85	Cargo transport by air
30	Textiles	86	Cargo transport by rail
31	Clothing and accessories	87	Cargo transport by water
32	Leather goods and footwear	88	Cargo transport by pipeline
33	Wood products, except furniture	89	Ancillary cargo transport activities
34	Production of cellulose and mechanical pulp	90	Passenger transport by road
35	Production of paper, cardboard and paper products	91	Passenger transport by air
36	Newspapers, magazines, records	92	Passenger transport by rail
37	Oil and coke refining	93	Passenger transport by water
38	Alcohol	94	Ancillary passenger transport activities
39	Other chemical elements	95	Postal services
40	Fertilizers	96	Mobile telephone services
41	Manufacturing of basic petrochemical products	97	Fixed-line telephone services
42	Manufacturing of intermediate products for resins and fibres	98	Other information services
43	Manufacturing of other organic chemical products	99	Financial intermediation and insurance
44	Manufacturing of resins and elastomers	100	Real estate and rental services
45	Manufacturing of artificial and synthetic fibres, wires and cables	101	Maintenance and repair services
46	Pharmacy and veterinary services	102	Accommodation services
47	Pesticides	103	Food services
48	Perfume, hygiene and cleaning products	104	Business services
49	Paints, varnishes, enamels and lacquers	105	Private education
50	Miscellaneous chemical products and preparations	106	Private health care
51	Rubber industry	107	Other services
52	Plastic items	108	Public education
53	Cement	109	Public health care
54	Manufacturing of glass and glass products	110	Public security
55	Other non-metallic mineral products	111	Other public administration and social security services
56	Manufacturing of steel and steel products		

Source: Prepared by the authors on the basis of official information.

The final demand items for 2011were estimated by calculating the product of 2004 final demand and the respective value added growth ratios. The sum of these items generated a column vector (1,332x1), which represented final demand for 2011. Multiplying the Leontief inverse matrix (matrix B) by that vector gives the gross production value for 2011, which is also a column vector (1,332x1).

The intermediate consumption matrix for 2011 (dimension 1,332x1,332) was obtained by taking the matrix of technical coefficients (matrix A) and multiplying it by the gross production value. Next, the column vector of gross production value was transposed, giving rise to the row vector of dimension 1x1,332 from which the sum of each column of intermediate consumption was subtracted, which determined the value added to production for 2011. The same proportion recorded in 2004 was used to update the values relating to taxes and to disaggregate the value added items.

To determine the item "employed personnel", the annual variation of employed personnel was measured for each sector or activity from 2003–2008 (most recent year for which data were available), and used to estimate figures for the year 2011.

After updating the input-output matrix, the 12 areas were aggregated into only 2 areas, the first one including the 9 States of the North-East region and the second one integrating Minas Gerais and Espírito Santo into the rest of Brazil.[10]

IV. Results and analysis

1. Rasmussen-Hirschman linkage indices

Table 4 shows eight sectors with strong linkages, both upstream (backward) and downstream (forward) in the production chain, namely: oil and other (13), textiles (30), oil and coke refining (37), fertilizers (40), manufacturing of basic petrochemical products (41), manufacturing of resins and elastomers (44), manufacturing of steel and steel products (56), and metal products (except machinery and equipment) (58). With the exception of the second sector, all the sectors and activities listed belong to the intermediate goods industry, which means they reflect strong linkages. Thus, according to Prado (1981) and Guilhoto and others (1994), these sectors and activities can be considered key to the North-East region's economy in 2011 and strategic to the formulation of sectoral policies.

Table 4
North-East region of Brazil: Rasmussen-Hirschman linkage indices for 111 selected sectors, 2011

Sector	Forward	Backward	Sector	Forward	Backward	Sector	Forward	Backward	Sector	Forward	Backward
1	0.72354	0.82314	29	0.53872	1.13799	57	0.76379	1.05482	85	0.66087	1.13846
2	1.01153	0.70596	30	1.08843	1.08328	58	1.01705	1.03178	86	0.61709	0.97824
3	0.77160	0.70299	31	0.55268	1.04472	59	0.55290	1.13785	87	0.76187	0.99129
4	0.67836	0.71155	32	0.61421	1.21382	60	0.54061	1.11377	88	0.70264	1.10395
5	1.21008	0.77743	33	0.71347	1.03333	61	0.63537	1.11008	89	1.02975	0.91238
6	0.70688	0.83189	34	0.58320	1.11122	62	0.53675	1.13188	90	0.65240	0.90732
7	0.63879	0.69577	35	0.81300	1.05756	63	0.55504	1.13211	91	0.63151	1.10386
8	1.05394	0.85847	36	0.68633	0.96709	64	0.79273	1.08242	92	0.53382	0.89684
9	0.57570	0.88255	37	2.34460	1.23225	65	0.66517	1.20464	93	0.52896	0.87796
10	0.74281	1.00538	38	0.60660	0.94458	66	0.56500	0.90767	94	0.62746	0.78737
11	0.97111	0.91979	39	0.96093	1.16268	67	0.55683	1.32781	95	0.70868	0.78479
12	0.53958	0.93099	40	1.23459	1.18894	68	0.53936	1.30662	96	0.97496	0.87398
13	1.02749	1.01047	41	1.10412	1.14821	69	0.88599	1.18658	97	1.05959	0.87310
14	0.90663	1.01397	42	0.98196	1.28876	70	0.67221	1.19708	98	1.10018	0.82491
15	0.57316	0.77573	43	0.82138	1.21740	71	0.55676	1.03816	99	2.27300	0.83964
16	0.53174	0.93498	44	1.41930	1.22334	72	0.57476	1.05912	100	1.02986	0.56296
17	0.83825	0.95853	45	0.59717	1.11244	73	1.13878	0.64641	101	0.82337	0.71133
18	0.61142	1.21165	46	0.56599	0.97388	74	1.61589	0.84980	102	0.54363	0.85866
19	0.56294	1.28510	47	0.87593	1.18945	75	0.91970	1.05248	103	0.68086	0.98353
20	0.56295	1.23139	48	0.62772	1.08760	76	0.66747	0.69770	104	2.63910	0.77858
21	0.67299	1.30239	49	0.60998	1.21366	77	0.60692	0.82046	105	0.58584	0.83967
22	0.58696	1.28826	50	0.68712	1.17829	78	0.77135	0.90079	106	0.57086	0.91791
23	0.54419	1.17096	51	0.63465	1.12974	79	3.15717	0.69120	107	0.78992	0.80256
24	0.66304	1.23598	52	0.61817	1.20879	80	0.69760	0.67856	108	0.53063	0.67256
25	0.70647	1.02986	53	0.62865	0.94440	81	0.66004	0.73072	109	0.52677	0.82817
26	0.59904	1.29563	54	0.56697	1.00374	82	0.55883	0.71953	110	0.53168	0.82946
27	0.77187	1.27484	55	0.65966	1.04157	83	0.57337	0.69741	111	0.68703	0.78170
28	0.72714	1.11985	56	1.03698	1.07267	84	1.86853	0.93173			

Source: Prepared by the authors on the basis of official information.
Notes: The sectors are listed in table 3. The highlighted sectors reflect a backward or forward Rasmussen-Hirschman index greater than unity.

[10] Microsoft® Excel® 2013 and MATLAB® R2010a software were used to estimate the matrices, coefficients and multipliers.

Despite the importance of the petrochemical industry in the value of industrial transformation in the North-East region (highlighted by the linkage indices), Wanderley (2008) states that its growth did not translate into proportional development in some industries that would naturally benefit from the strong forward linkages in the chemical industry. In some industries —such as pharmaceuticals, perfumery and plastics, among others— there was no significant increase. This performance indicates that the raw materials of the chemical industry were not used in the North-East, probably owing to the lack of an incentive programme for the development of the sectors that use these raw materials, which would favour the linkages of the chemical industry in the region. The results of the observation of the field of influence, presented below, reflect this.

2. Field of influence

As a complement to the examination of the Rasmussen-Hirschman linkage indices, the analysis of the field of influence shows the notable performance of key sectors with respect to the other sectors analysed, as shown in annex table A1.1.

The observation of the field of influence of the North-East region's economy in 2011 validates the condition confirmed by the Rasmussen-Hirschman backward and forward linkage indices.

Thus, the evaluation of the field of influence reveals that the oil and other sector (13) demands products and services from sectors such as other transport equipment (70) and cargo transport by pipeline (88), indicating the importance of transport providers for the oil industry.

There are many linkages relating to the textile sector (30), characterised by the demand for inputs from sectors linked to agricultural activities (20, 21, 22, 25 and 26) and the purchase of their output, among others, by the wholesale trade sector (79). According to Garcia (2010), the configuration of local production systems is a fairly common feature of the textile, clothing and footwear industries in the North-East region. Given the simplicity of the technical base of these sectors and the ample opportunities for product segmentation, there is a strong incentive for the emergence and existence of a vast array of small specialized businesses. Moreover, the geographic concentration of businesses allows producers to enjoy the benefits deriving from business agglomerates and the interactions between them.

Another important sector, oil and coke refining (37), demands inputs and services from sectors such as cargo transport by pipeline (88) and financial intermediation and insurance (99), while it has backward linkages with sectors such as textiles (30), electronic and communications equipment (65) and fertilizers (40).

The manufacturing of resins and elastomers (44) has backward linkages with sectors such as oil and coke refining (37), cargo transport by pipeline (88) and financial intermediation and insurance (99), and provides outputs to the following sectors: textiles (30), electronic and communications equipment (65) and wood products, except furniture (33).

The aforementioned linkages reinforce the importance of the sectors considered key according to the Rasmussen-Hirschman linkage index. They also indicate basically the same dominant industries upstream and downstream in the production chain of the North-East region's economy, and underscore the importance of financial services, transport and logistics and the manufacturing of electronic and communications equipment.

3. Pure linkage indices

When evaluating the economy of the North-East region from the perspective of normalized pure linkage indices, or GHS indices, five sectors and activities reflect a total coefficient (*PTL*) greater than unity, namely: oil and coke refining (37); construction (78); financial intermediation and insurance (99); business services (104) and other public administration and social security services (111) (see table 5).

Table 5
North-East region of Brazil: normalized forward (*PFL*), backward (*PBL*) and total (*PTL*) GHS indices for 111 selected sectors, 2011

Sector	*PFL*	*PBL*	*PTL*	Sector	*PFL*	*PBL*	*PTL*	Sector	*PFL*	*PBL*	*PTL*
1	0.1216	0.0710	0.0963	38	0.0886	0.0880	0.0883	75	0.2025	0.2763	0.2395
2	0.3527	0.0282	0.1901	39	0.3190	0.0597	0.1891	76	0.1784	0.1254	0.1518
3	0.2023	0.0609	0.1315	40	0.4681	0.1198	0.2936	77	0.0920	0.0561	0.0740
4	0.1224	0.0932	0.1078	41	0.4975	0.1015	0.2991	78	0.5148	3.2660	1.8932
5	0.4748	0.1844	0.3293	42	0.3734	0.1500	0.2615	79	1.3992	0.3721	0.8846
6	0.0857	0.0371	0.0613	43	0.2231	0.1011	0.1619	80	0.3940	0.0887	0.2411
7	0.0526	0.0120	0.0322	44	0.7285	0.3449	0.5363	81	0.1266	0.2286	0.1777
8	0.3478	0.1511	0.2493	45	0.0241	0.0195	0.0218	82	0.0172	0.3828	0.2004
9	0.0171	0.0034	0.0102	46	0.0288	0.0344	0.0316	83	0.0281	0.4883	0.2587
10	0.0663	0.0470	0.0566	47	0.2327	0.0539	0.1431	84	0.7078	0.0406	0.3735
11	0.1845	0.1249	0.1546	48	0.0866	0.1250	0.1058	85	0.0382	0.0383	0.0383
12	0.0152	0.0265	0.0209	49	0.1123	0.0240	0.0680	86	0.0288	-0.0155	0.0066
13	0.6904	0.0417	0.3654	50	0.0800	0.0330	0.0564	87	0.1173	0.2710	0.1943
14	0.3607	-0.0750	0.1424	51	0.0514	0.0163	0.0338	88	0.0275	0.0079	0.0177
15	0.0384	0.0026	0.0204	52	0.0262	0.0031	0.0146	89	0.2630	0.0321	0.1473
16	0.0007	0.0010	0.0009	53	0.2433	-0.0009	0.1210	90	0.1304	0.8949	0.5134
17	0.2787	0.0596	0.1689	54	0.0400	0.0072	0.0236	91	0.1132	0.0202	0.0666
18	0.0982	0.3946	0.2467	55	0.3140	0.0346	0.1740	92	0.0064	0.0206	0.0135
19	0.0112	0.0403	0.0258	56	0.2843	0.2005	0.2423	93	0.0022	0.0012	0.0017
20	0.0099	0.0817	0.0459	57	0.1678	0.2089	0.1884	94	0.0640	0.0238	0.0438
21	0.1066	0.3323	0.2197	58	0.2985	0.1618	0.2301	95	0.1362	0.0081	0.0720
22	0.0233	0.0747	0.0490	59	0.0047	0.0129	0.0088	96	0.4568	0.0641	0.2601
23	0.0141	0.0503	0.0322	60	0.0008	0.0010	0.0009	97	0.4932	0.1960	0.3443
24	0.1411	0.2858	0.2136	61	0.0380	0.0960	0.0671	98	0.5755	-0.0036	0.2854
25	0.0958	0.2941	0.1951	62	0.0022	0.0306	0.0164	99	1.7043	0.3481	1.0248
26	0.0323	0.0856	0.0590	63	0.0140	0.1125	0.0633	100	0.4912	0.1938	0.3422
27	0.2345	0.6963	0.4659	64	0.1186	0.0644	0.0914	101	0.1964	0.0613	0.1287
28	0.2815	0.4787	0.3803	65	0.0101	0.0241	0.0171	102	0.0303	0.1361	0.0833
29	0.0001	0.0243	0.0122	66	0.0071	0.0204	0.0137	103	0.2442	0.9961	0.6209
30	0.4939	0.3259	0.4097	67	0.0039	0.8466	0.4261	104	2.1540	0.0491	1.0995
31	0.0372	0.3856	0.2117	68	0.0014	0.0362	0.0188	105	0.0747	0.4932	0.2844
32	0.0251	0.6542	0.3403	69	0.0931	0.0268	0.0598	106	0.0393	1.0400	0.5406
33	0.0458	0.0104	0.0281	70	0.0035	0.0316	0.0176	107	0.2527	1.0419	0.6481
34	0.0454	0.1020	0.0738	71	0.0254	0.1832	0.1044	108	0.0039	0.7653	0.3854
35	0.1041	0.0337	0.0688	72	0.0546	0.0479	0.0513	109	0.0001	1.2929	0.6478
36	0.1430	0.0507	0.0968	73	0.6315	-0.0273	0.3014	110	0.0052	0.3788	0.1923
37	1.3422	0.7978	1.0694	74	0.7904	0.5608	0.6754	111	0.1209	3.9736	2.0512

Source: Prepared by the authors on the basis of official information.
Notes: The sectors are listed in table 3. The highlighted sectors reflect a GHS index greater than unity.

Among the key sectors determined according to the Rasmussen-Hirschman criterion, only oil and coke refining (37) is also noteworthy according to the GHS methodology. In addition, the financial intermediation and insurance sector, which already stood out as an important service provider, now emerges as a key sector when examining the field of influence. This indicates that these sectors were important to the North-East economy in 2011.

Some sectors not highlighted by the Rasmussen-Hirschman methodology appear as key sectors according to the methodology of pure linkage indices, for example other public administration and social security services (111), as also shown by Mendes and others (2011) when analysing the economy of Minas Gerais.

4. Multipliers

The results obtained with the multiplier method, shown below, demonstrate the effects on employment, wages and production of a change in final demand in each selected sector or activity. Since the effects are propagated along the entire chain, backwards and forwards with respect to the target sector, industries with stronger linkages tend to present the highest multipliers. See annex tables A1.1 and A2.1, which contain type I and II multipliers, respectively.

With respect to type I multipliers, oil and coke refining reflects the highest employment multiplier (98.19) and the second highest wage multiplier (10.84), indicating the dynamism of this sector. Thus, for every increase of 1 million reais in final demand in this sector, there is an expectation of an increase or maintenance of 98.19 direct and indirect jobs and there is a tendency for wages in the economy to respond positively by 10.84 times in relation to the value of the initial shock. This result is consistent with that obtained by Nunes, Capucho and Parré (2012) when analysing the Brazilian economy, taking 2008 as the base year. Other sectors, linked to the energy industry as well, also generated significant results in terms of employment growth, as in the case of the piped gas sector (80.04) and the oil and other sector (38.79).

When considering the output multiplier, each increase of 1 million reais in final demand in the cars, vans and utility vehicles sector should result in an increase of 2.52 times that value in the total economic output, similar to that found by Guilhoto and others (2012) when analysing the economy of the North-East region in 2004. Other sectors, such as vegetable oil production (2.47), the coffee industry (2.46), the dairy industry (2.45) and the slaughter of pigs and other animals (2.44), are all part of agribusinesses which, in general, respond well to sectoral demand stimuli in terms of increased production.

In the case of type II multipliers, which differ from type I multipliers by making the "household spending" sector endogenous, changes are observed in the magnitude of the multiplier values, as well as in the ranking of the selected sectors or activities, which may lead to suggestions for formulating more targeted and effective public policies.

According to the results obtained with the type II multiplier, the oil and coke refining sector continues to present the highest employment multiplier (118.60) and is the third largest wage multiplier (12.06). In other words, for every increase of 1 million reais in the final demand of this sector, there is an expectation of an increase or maintenance of 118.60 direct, indirect and induced jobs and a tendency for wages in the economy to increase 12.06 times in relation to the value of the initial shock.

In the oil and other sector, there is an increase of 48.09 jobs, and the value of production in relation to the shock doubles. Another sector linked to the oil industry, natural gas, also responds significantly to the increase in demand, generating 35.84 additional direct, indirect and induced jobs and more than tripling the value of the shock in relation to wages.

Bearing in mind that the non-metallic mineral extraction and refining sites and chemical complexes are generally located in limited areas of the North-East region, these results appear to reflect, according to Lima and Simões (2010), the strengthening of heterogeneity within the region itself, where stagnant areas of selective and limited modernization (when it exists), coexist with dynamic areas where the production structure is quite modern and contributes significantly to the performance of the region as a whole.[11]

[11] As a mitigating counterpoint to this situation, it can be deduced that a significant movement of "employment insourcing" is under way in the North-East region. According to BCB data (2006), while 45.9% of the industry's jobs were carried out in the region in 1996, this figure had already risen to 51.6% in 2004.

In general, sectors with significant inputs downstream in the production chain are rising as a result of the changes in the economy of the North-East region since the implementation of the Second National Development Plan (1975–1979). According to Lima and Simões (2010), this reflects a trend towards greater complementarity between the industrial segments of the North-East and the rest of the country, especially the South-East region, despite the relocation of industries producing durable consumer goods to the North-East, especially to Bahia. In addition, the search for extra-regional consumer markets has reaffirmed the position of the North-East as a supplier of inputs for the other regions of the country, reflecting its special role in the interregional division of industrial labour in Brazil.

V. Final considerations

The analysis of the results obtained from the application of different methodologies to examine the input-output matrix has shown the importance of traditional sectors in the economy of the North-East region. Worthy of note are the textile industry and the sectors promoted within the framework of the Second National Development Plan (1975–1979), such as the chemical, resin and elastomer, and oil sectors.

It has also underscored the importance, albeit incipient, of sectors such as electronic and communications equipment, and pointed out that most of these sectors rely heavily on logistics systems and financial services.

Given the linkages in several sectors, it was confirmed that the economy of the North-East is still based, in part, on the organization established by the development policies of the 1970s and 1980s. The region remains a hub supplying intermediate goods to industries in other regions of the country, despite the recent relocation of some durable consumer goods industries to some States in the North-East. Consequently, the region's development is not an autonomous process and depends on the rest of the country.

However, for the integration of production to be effective, it must be based on planning that includes physical transport and logistics infrastructure that interconnects the different regions, as well as national projects that include energy generation and distribution, data transmission capacity and, above all, quality education.

Thus, the action of State and municipal governments is very important to close still wide gaps between regions, through tax incentives and structural improvements that also allow the decentralization of production and direct it to the North-East region, which is sometimes forgotten and lacks more thriving production sectors.

Those responsible for formulating public policy should pay more attention to incentives for the rural sector, given that activities relating to the growing of sugar cane and other crops and raising livestock reflect strong forward linkages.

Agro-industrial activities also reflect strong backward linkages that enhance value added, helping to support the inhabitants of rural areas and to improve their well-being thanks to the combination of the multiplier effects of employment and wages.

The textile sector, which in the past played a dominant role in the economy of some States in the North-East region, also represents a potential source of regional dynamism, given its strong influence upstream and downstream in the production chain. This justifies the need for stimulation through targeted public policies.

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Annex A1

Type I production, employment and income multipliers in the North-East region, 2011

Table A1.1

North-East region of Brazil: type I production, employment and income multipliers, 2011

Sector	Type I multipliers			Sector	Type I multipliers			Sector	Type I multipliers		
	Employment	Income	Production		Employment	Income	Production		Employment	Income	Production
1	1.0610	1.2306	1.5629	38	20.1414	3.8610	1.7934	75	80.0401	10.7379	1.9983
2	1.0152	1.0814	1.3404	39	10.4201	3.6488	2.2075	76	1.9771	1.2401	1.3247
3	1.3704	1.6294	1.3347	40	9.2598	3.3028	2.2574	77	1.3147	1.2304	1.5578
4	1.0153	1.1703	1.3510	41	7.4355	2.7333	2.1801	78	1.3303	1.8623	1.7103
5	1.1324	1.5127	1.4761	42	6.9810	15.4360	2.4469	79	1.3066	1.1933	1.3123
6	1.1931	1.4597	1.5795	43	6.3801	5.8975	2.3114	80	1.2635	1.1641	1.2884
7	1.0890	1.1988	1.3210	44	18.9709	3.9483	2.3227	81	1.1721	1.2354	1.3874
8	1.1212	1.3583	1.6299	45	2.7822	2.3543	2.1121	82	1.1487	1.2193	1.3661
9	1.0599	1.4378	1.6757	46	3.4064	1.8521	1.8491	83	1.0673	1.1894	1.3241
10	1.8175	1.8438	1.9089	47	19.7539	4.5913	2.2584	84	1.4524	1.8784	1.7690
11	1.1983	1.5198	1.7464	48	4.0184	2.0827	2.0650	85	10.7877	3.8855	2.1615
12	1.0662	1.3687	1.7676	49	7.9493	2.3100	2.3043	86	1.8228	1.4757	1.8573
13	38.7929	2.6379	1.9185	50	2.9262	2.3720	2.2372	87	3.6958	2.1877	1.8821
14	29.3068	3.0267	1.9252	51	5.0258	2.1699	2.1450	88	2.5914	2.5286	2.0960
15	2.4112	1.2021	1.4728	52	1.9191	1.8454	2.2951	89	1.4143	1.3997	1.7323
16	8.9887	3.6018	1.7752	53	8.8002	2.2286	1.7931	90	1.2403	1.3733	1.7227
17	1.5695	1.7090	1.8199	54	2.5234	2.0642	1.9058	91	6.6024	2.1911	2.0959
18	29.7316	5.0114	2.3005	55	1.4927	1.7492	1.9776	92	1.7023	1.2517	1.7028
19	13.4425	3.8766	2.4400	56	7.2917	2.9059	2.0366	93	1.9280	1.3035	1.6669
20	14.5036	4.1864	2.3380	57	2.8568	2.7634	2.0027	94	1.3505	1.2514	1.4950
21	20.3202	7.3520	2.4728	58	1.7774	1.9088	1.9590	95	1.3098	1.1664	1.4900
22	7.3290	3.8428	2.4460	59	2.7529	2.1207	2.1604	96	1.4637	2.0419	1.6594
23	8.0674	3.3269	2.2232	60	1.5288	1.7546	2.1147	97	2.3643	2.4961	1.6577
24	7.4981	2.9379	2.3467	61	2.0609	2.0218	2.1077	98	1.6343	1.4870	1.5662
25	12.3703	3.1589	1.9554	62	2.3880	2.2009	2.1491	99	3.2768	1.5778	1.5942
26	10.5345	3.6901	2.4600	63	6.1804	2.5824	2.1495	100	3.9215	1.5765	1.0689
27	3.9344	3.0116	2.4205	64	2.9882	1.7897	2.0551	101	1.2768	1.1945	1.3506
28	6.6452	2.5066	2.1262	65	4.6439	3.8798	2.2872	102	2.4056	1.2308	1.6303
29	13.3877	2.9401	2.1607	66	1.4977	1.6080	1.7233	103	1.3821	1.7169	1.8674
30	1.8717	2.3792	2.0568	67	12.1553	3.4727	2.5211	104	1.2100	1.3152	1.4783
31	1.2523	1.7580	1.9836	68	7.2150	4.2123	2.4808	105	1.3341	1.2027	1.5942
32	2.2513	2.1879	2.3046	69	3.0403	2.1045	2.2529	106	1.4245	1.4321	1.7428
33	1.8550	1.8151	1.9619	70	3.4722	2.3190	2.2728	107	1.0770	1.1660	1.5238
34	28.9656	4.5228	2.1098	71	1.8252	2.1092	1.9711	108	1.1564	1.0619	1.2770
35	2.9515	1.8823	2.0079	72	1.6153	2.1821	2.0109	109	1.7604	1.2256	1.5724
36	1.7622	1.5742	1.8362	73	7.3128	1.8755	1.2273	110	1.8203	1.2825	1.5749
37	98.1900	10.8380	2.3396	74	4.8449	1.9481	1.6135	111	1.4923	1.1939	1.4842

Source: Prepared by the authors on the basis of official information.
Note: The sectors are listed in table 3.

Annex A2

Type II production, employment and income multipliers in the North-East region, 2011

Table A2.1
North-East region of Brazil: type II production, employment and income multipliers, 2011

Sector	Type II multipliers			Sector	Type II multipliers			Sector	Type II multipliers		
	Employment	Income	Production		Employment	Income	Production		Employment	Income	Production
1	1.1031	1.4281	1.8964	38	20.7981	4.2940	2.0138	75	96.0721	12.0887	2.1168
2	1.0380	1.2069	1.7198	39	12.9557	4.0598	2.3331	76	2.6151	1.3628	1.4687
3	2.0700	2.6087	1.6598	40	11.6067	3.6677	2.3968	77	1.5437	1.3517	1.8023
4	1.0372	1.4159	1.6968	41	9.2919	3.0377	2.3013	78	1.4981	2.1696	1.9193
5	1.2197	2.0039	1.7925	42	8.3087	17.2399	2.5509	79	1.6144	1.3684	1.5929
6	1.2858	1.8181	1.8985	43	7.6214	6.5786	2.4228	80	1.5483	1.3281	1.5782
7	1.1493	1.4810	1.6802	44	23.7181	4.3913	2.4276	81	1.3091	1.4066	1.6692
8	1.1884	1.6499	2.0388	45	3.3501	2.6098	2.2356	82	1.2652	1.3857	1.6540
9	1.0829	1.7474	2.0666	46	4.1063	2.0511	2.0332	83	1.1190	1.3558	1.6105
10	2.0871	2.3044	2.2885	47	23.1338	5.1088	2.3870	84	1.6580	2.2064	1.9986
11	1.2572	1.8485	2.1454	48	4.7394	2.3201	2.2419	85	14.3167	4.5096	2.3513
12	1.0877	1.5989	2.1533	49	9.9259	2.5665	2.4716	86	2.2710	1.6352	2.1122
13	48.0909	2.9363	2.0709	50	3.4319	2.6365	2.3951	87	4.9078	2.5741	2.0924
14	35.8448	3.3757	2.0681	51	5.9869	2.4216	2.3004	88	3.1631	2.9275	2.3414
15	3.4865	1.3211	1.7277	52	2.2801	2.0379	2.4691	89	1.6870	1.5853	1.9922
16	10.7869	4.0221	1.8721	53	11.1774	2.4754	1.9165	90	1.3962	1.5533	1.9823
17	1.7934	1.9048	1.9892	54	3.0424	2.3055	2.0688	91	8.9529	2.4878	2.3055
18	32.0626	5.8864	2.5955	55	1.6735	1.9417	2.1633	92	2.3063	1.3778	2.0225
19	14.8433	4.5699	2.7225	56	9.1601	3.2282	2.1518	93	2.6736	1.4745	1.9247
20	15.4027	4.9165	2.6401	57	3.4338	3.0664	2.1190	94	1.6547	1.4224	1.7842
21	25.1616	9.2273	2.7217	58	2.1457	2.1389	2.1160	95	1.5923	1.2845	1.7606
22	7.9000	4.4391	2.7384	59	3.4318	2.3473	2.3305	96	1.5941	2.3183	1.8260
23	8.5199	3.8530	2.4861	60	1.7645	1.9375	2.3115	97	2.7690	2.8616	1.8098
24	8.3630	3.4324	2.5930	61	2.4770	2.2389	2.2771	98	1.9188	1.6591	1.7876
25	12.8413	3.5054	2.1962	62	2.8603	2.4351	2.3177	99	4.2172	1.7431	1.7812
26	11.6323	4.3496	2.7230	63	7.8418	2.8664	2.3170	100	5.0929	1.8217	1.0949
27	4.3260	3.4869	2.6616	64	3.8362	1.9764	2.2404	101	1.8652	1.4305	1.7033
28	7.3866	2.8288	2.3561	65	5.5107	4.3179	2.4430	102	3.1556	1.3716	1.9602
29	14.8288	3.4461	2.3885	66	1.7524	1.7939	1.9051	103	1.4869	1.9871	2.1509
30	2.0364	2.7289	2.2506	67	15.3430	3.8560	2.7148	104	1.3612	1.4971	1.7556
31	1.3295	2.0627	2.2846	68	8.8601	4.6785	2.6583	105	1.5472	1.3285	1.9444
32	2.5449	2.4451	2.5416	69	3.7748	2.3253	2.4425	106	1.6282	1.6146	2.0546
33	2.0143	2.0349	2.1885	70	4.2979	2.5663	2.4561	107	1.1352	1.2927	1.8951
34	32.1407	5.2212	2.2836	71	2.0814	2.4000	2.1692	108	1.4260	1.1630	1.6985
35	3.5056	2.0891	2.1832	72	1.8450	2.4882	2.1976	109	2.1977	1.3474	1.9118
36	2.1069	1.7476	2.0505	73	8.9747	2.0736	1.2748	110	2.3155	1.4096	1.8322
37	118.5966	12.0601	2.4499	74	6.2108	2.1490	1.6845	111	1.8822	1.3104	1.7816

Source: Prepared by the authors on the basis of official information.
Note: The sectors are listed in table 3.