Structural Change in the Automotive Industry and its Regional Impacts: The Case of Brazil

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Abstract

From the late 1980s onward, the Brazilian automotive industry has undergone significant change as it has embraced trade liberalization and growing inward FDI. Using an inter-regional input-output model, this paper analyses the evolution of the industry from a spatial perspective. It is shown that new investment has resulted in a more dispersed locational framework for the industry. However, not all the benefits of new investment are garnered by the recipient regions. The paper poses a number of policy questions which center on the issue of inter-regional dependence.

1. Introduction

Over the past two decades the automotive industry worldwide has been undergoing a profound structural transformation. Driven by declining barriers to trade and investment, an acceleration in the pace of technical change and rising pressure for consolidation, the locational characteristics of the industry have radically altered. In particular, the spread of global production chains[5] and a blurring of the boundary between components suppliers and assemblers have given rise to increasing internationalization of the production process. To a great extent, it is no longer appropriate to talk in terms of national, vertically integrated automotive industries. Instead, it has become increasingly

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common to observe a dispersion of discrete elements of the production chain across national frontiers. This process has perhaps been most elaborately developed in the case of Western Europe and North America where regional trade arrangements have facilitated the tariff-free intra-regional movement of components as well as finished vehicles.

The automotive industry in Latin America, like its counterparts elsewhere, has not proved immune to these global developments. In particular, the past decade has witnessed the rapid integration of the automotive industries of South America's two largest economies, Argentina and Brazil. With the creation of Mercosul[6], and the signing of a series of bi-lateral accords, trade in automotive products between Argentina and Brazil has been extensively – though far from totally – liberalized. Partly as a result, from the mid-1990s onwards both countries – but most especially Brazil – have experienced a surge in new investment directed at the automotive sector. In the case of Brazil, the expansion of capacity has also been spurred on by generally healthy growth in domestic demand, itself largely the product of a successful stabilization plan. In addition to these attractive features, a number of automotive producers have been drawn to Brazil by a range of generous fiscal incentives, often originating at sub-national levels of government.

While it is commonly accepted that Brazil's automotive sector is now larger and more "internationalized" than at any time in its history, there have been few attempts to assess formally the implications this has had for the domestic pattern of industrial location and, by extension the impact on regional development. Over the next few pages,

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[5] For a comprehensive discussion of this phenomenon see Gereffi (1993).

[6] A customs union founded by the Treaty of Asunción in 1991 which embraces Argentina, Brazil, Uruguay and Paraguay.

this chapter aims to address this somewhat overlooked issue by adopting the following approach. After a brief review of the main recent sectoral and policy developments, an attempt is made to characterize the locational evolution of the Brazilian automotive sector over the past decade. Having established the nature of these locational changes, the paper then goes on to evaluate their implications for the pattern of regional development within Brazil. In order to achieve this objective, an interregional input-output model is elaborated and then tested to assess the recent impact of locational change on such variables as regional income levels and employment. Finally, the tractability of these results is discussed before the possible policy implications are reviewed.

2. Structural Change in the Automotive Industry: International Trends

As suggested in the introduction, the international automotive industry has entered a radically new phase in its development. Up until twenty years ago, the development of the industry had been characterized by a curious paradox. While the bulk of global assembly was in the hands of a relatively select group of multinational corporations (MNCs), production activity itself was strongly national rather than global in orientation. Thus, while the major automotive manufacturers owned subsidiaries across North America, Europe, Latin America, Africa and Asia, the subsidiaries frequently had no connection with one another beyond drawing on the same pool of multinational capital and technological expertise.[7]

While assembly activity for the most part took take place within the national market to be supplied, the supply chains underpinning such assembly activity also tended

to be domestic, rather than international in character. Although a number of multi-national components suppliers existed, their production activities too, tended to be located in the countries for which output was destined. However, by no means all of the components sector was in the hands of MNCs. Instead, a significant portion of component supplies tended to be obtained from domestically owned enterprises in the country of assembly. Taking all of these considerations into account, it becomes obvious that any characterization of the automotive sector as "international" prior to the 1980s would need serious qualification.

Since the beginning of the 1980s, however, the evolution of the automotive sector worldwide has embarked on a distinctively new phase in which the concept of the national has become increasingly subsumed by that of the global. Over this period, both developed and less developed economies have significantly lowered barriers to trade and investment, opening up national automotive markets as never before to imports and permitting the entry of new producers. These developments have had the effect of inducing far greater competitive pressures upon automotive producers in whichever national market they operate. However, by the same token, both trade and investment liberalization have granted both incumbent producers and new entrants unparalleled opportunities to gain competitive advantage by shipping both finished products and components across frontiers. This process has been lent particular force in the case of Western Europe and North America where, respectively, the deepening of the European Union (EU) and the emergence of the North American Free Trade Area (NAFTA) have allowed much greater integration of the production process across national boundaries.

[7] SeeJenkins (1987) for an interesting discussion of these issues.

Thus, to a great extent, at least in the case of Europe and North America, it seems increasingly anachronistic to talk in terms of national automotive sectors.

In tandem with this regionalization if not globalization of the automotive industry, two other imperatives have been affecting its developments over the past 20 years. In first place, it is possible to observe a far-reaching shift in technological strategy, which has at its core the objective of creating global vehicle platforms upon which local market variants can be produced. With much of automotive assemblers' considerable research and development expenditure being concentrated on the design of the engine, transmission and floor pan layout, it is obvious that such costs (as well as unit production costs) can be defrayed more effectively, the greater the number of units produced using a given platform. In addition, it is equally clear that unit R+D (if not production) costs will tend to fall the fewer the numbers of platform type in use.

Accompanying the global standardization of platforms, it is also possible to observe a concurrent shift in the relation between assemblers and their suppliers. To an increasing extent, the major automotive assemblers have been altering their production strategies, aiming to reduce the complexity of the final assembly process and lower their working capital requirements. The result of these developments has been to enhance the role of component suppliers, obliging them to produce more elaborate sub-assemblies and to deliver these to assembly plants on a just in time basis. At the same time, given the increasingly stringent demands of markets around the world, assemblers have been demanding ever-higher standards of quality from their suppliers. Consequently, unprecedented competitive demands have been placed on components suppliers, demands that many traditional single-country based enterprises have been unable to meet. As a consequence, a growing trend within the international automotive industry has been for

assemblers to forge global preferred supplier agreements with major multinational components manufacturers such as Lear, TRW and Robert Bosch.

In sum, therefore, as the automotive industry enters its second century of operation, its structural characteristics are changing as rapidly as the technology it embodies. As international production chains supplant their domestic counterparts and components manufacturing becomes dominated by MNCs, automotive manufacturing is at last on the road to becoming a genuinely global undertaking. Under these circumstances, one might well expect profound changes in the locational characteristics of the industry with attendant implications for patterns of regional development. As will be made clear, the experience of Brazil provides ample evidence that this has in fact been the case.

3. Structural Change in the Automotive Industry: Policy Developments in the 1990s and the Brazilian Experience

Prior to 1990, the Brazilian automotive sector was one of the world's most heavily protected, being surrounded by stringent tariff and non-tariff barriers which applied to both components and assembled vehicles. This protective regime represented the ultimate evolution of almost four decades of official attempts to foster the development of the sector through a policy of import substitution industrialization (ISI). In general terms, the application of ISI policies proved initially highly successful in bringing about the expansion and modernization of Brazil's nascent automotive industry (Shapiro 1994; Addis 1999). However, by the 1980s it had become increasingly clear that the policies of protection that had once guided the sector's development so effectively were now directly associated with mounting inefficiency, poor quality, technological

backwardness and low export intensity. With the accession to power of President Fernando Collor de Melo in 1990, policy makers embarked on an ambitious program of trade liberalization, which had as its prime objective the rapid insertion of Brazil into the international economy (Amann, 2000). The impacts of this dramatic shift in policy on levels of protection enjoyed by the automotive sector were profound. As Table 1 indicates, over the first four years of the trade liberalization program, average tariff levels applying to finished vehicles and autoparts fell by 40%. More significantly still, the trade reforms of 1990 abolished quantitative restrictions on imports. For a number of years these had effectively barred imports of finished vehicles rendering the heavy tariffs redundant.

Table 1: The Evolution of Brazilian Import Tariffs on Automotive Sector Products, 1990-2000 (%)

	1990	*1994*	*1995 (February)*	*1995 (March)*	*1996-1999*	*2000*
Finished Vehicles	45	20	32	70	70-35*	35
Autoparts	30	18	18	18	2.4-9.6	14-18

*Manufacturers with assembly facilities in Brazil qualified for the 35% tariff. All other importers were required to pay the 70% tariff

Source: Santos & Gonçalves, 2001, p. 209

However, by the beginning of 1995 a combination of accelerating domestic demand and a strengthening exchange rate had led to a substantial surge in automotive imports, particularly of assembled passenger cars. With this surge in imports strongly contributing towards a sharp deterioration in the trade balance, the authorities elected to partially reverse their policy of trade liberalization, raising tariffs on finished vehicles from 32% to 70%. However, by 1996 with concern over the trade deficit abating, the tariff increase was partially rescinded with a new tariff of 35% established applying to

imports of vehicles by manufacturers with production facilities in Brazil (Bonelli *et al*., 1997).

The launch of the Brazilian trade liberalization program in the early 1990s coincided with another highly significant development: negotiations for the creation of a regional free trade area embracing Brazil, Argentina, Uruguay and Paraguay. This free trade area, known as Mercosul, formally came into being on 1st January 1995 and should have ushered in completely free trade in automotive products between its members. However, the Argentineans, fearing that their automotive industry would not be able to withstand unrestrained competition from its Brazilian counterpart, set in train negotiations to create a managed trade regime in which quantitative measures would continue to play a role. With the negotiations concluded, towards the end of 1995, the first automotive accord came into force providing for qualified free trade in automotive products between South America's two largest economies.

Under the terms of the accord, automotive products could be traded free of tariffs between Brazil and Argentina provided that neither country ran an automotive product trade deficit or surplus with the other. The agreement also set out the tariffs, which would be applied to imports from outside Mercosul. In the case of Brazil, it was agreed that a tariff of 35% would apply, although, as noted above, a tariff of 70% would be imposed on vehicles whose manufacturers had no production facilities in Brazil. By the end of 2000, a new version of the automotive accord had come into being. This agreement, while retaining the 35% tariff for non-Mercosul vehicle imports, allows for limited free Argentinean-Brazilian trade in automotive products even in the event that such trade is imbalanced.

To sum up, over the 1990s, despite the existence of a bi-lateral managed trade accord with Argentina and the persistence relatively high tariffs there is no question but that Brazil did substantially liberalize trade in automotive products. A particular feature of the trade liberalization process has been its emphasis on the creation of a regional, as opposed to a purely national market for vehicles and their components. This, taken together with strong regional growth in the early to mid-1990s provided conditions that proved highly attractive to foreign investors. As a result, the Brazilian automotive industry has recently experienced a surge in investment not seen since its foundation in the 1950s. Responding to this promising development, substantial competition has emerged between different localities in Brazil to act as recipients for this investment. Taken together with regional integration, and increasing competitive pressure on producers, a radical evolution in locational patterns within the sector has resulted. It is to this issue that the paper now turns.

4. Changes in the Locational Characteristics of the Brazilian Automotive Sector and the Role of Local Incentives

Large-scale vehicle assembly in Brazil began at the end of the 1950s with the establishment of assembly plants by Volkswagen, Toyota, Ford (for passenger cars and light commercial vehicles), Mercedes-Benz (for trucks and buses) and General Motors (for all vehicle types). As in the early days of mass production in the United States, the initial growth of the automotive industry in Brazil was characterized by a high degree of geographical concentration. Of the assembly facilities mentioned above, all lay within the confines of metropolitan São Paulo with the industrial suburb of São Caetano do Sul alone playing host to no fewer than four plants. Accompanying the expansion of

automotive assembly came rapid growth in the components sector. Once again, the development of this sector proved initially highly geographically concentrated with the vast bulk of capacity being located in São Caetano do Sul and the neighbouring suburbs of Santo André and Diadema.

In similar fashion to the United States, as time progressed and the industry matured, a process of geographical dispersion became evident. The origins of this development can be traced to the early 1970s when Ford and Volkswagen, attracted by the fiscal incentives on offer, extended their activities beyond the immediate vicinity of metropolitan São Paulo into the upstate region of Vale do Paraíba. General Motors, too, opted to locate a portion of capacity away from São Paulo City, choosing São José dos Campos for its new engine plant. More significantly still, in 1977 Fiat established a major assembly facility well away from São Paulo, in Betim in the heart of Minas Gerais state. Despite these important locational decisions, however, the Brazilian automotive sector still remained largely centered on São Paulo city right through the late 1970s and into the 1980s.

Since the beginning of the 1990s, the centrifugal forces underpinning geographical dispersion in the industry have become far stronger. As noted in the previous section, technological change and alterations in the policy environment over the past ten years or so have proved increasingly conducive to the location of production facilities away from traditional industrial centers. In first place, the lowering of trade barriers, while by no means as dramatic as for other industrial sectors, has nonetheless placed heightened competitive pressure on both automotive assemblers and components manufacturers.

Against this background, enterprises have become preoccupied with tackling the cost base and improving flexibility of response to changing market demands. Not surprisingly, therefore, the attractions of locating away from São Paulo city with its relatively high labor costs and levels of unionization have proved compelling. At the same time, the advent of Mercosul and the signing of automotive trade accords with Argentina have opened up new markets to the South. Aside from providing an enhanced export outlet for finished vehicles, the accords specifically promote the use of Argentinean components in Brazilian vehicles and vice-versa. As a consequence, the opportunities presented by locating both assembly and components production closer to Brazil's southern borders have become far more enticing than was the case previously.

Perhaps of greatest significance in determining new locational patterns in the Brazilian automotive industry has been the role of state and municipal government incentives. While the development of Mercosul and strong growth in the domestic market have proven key determinants of the wave of new investments in the sector since 1990, the importance of provision of tax breaks, grants, infrastructure and other measures by sub-national governments should not be under-estimated. As Tables 2 and 3 are not alone in suggesting, states and municipalities outside the traditional heartland of the Brazilian automotive industry have proven by far the most aggressive in offering prospective investors generous incentives. In a number of instances, the scale of these incentives has been such as to outweigh substantially the otherwise obvious locational disadvantages of particular sites.[8]

[8] The most noteworthy example here being Ford´s decision to invest in Bahia, a coastal state several hundred kilometres north of major concentrations of markets and suppliers.

Table 2. Federal Government Regional Incentives Explicitly Permitted under the 1997 Special Automotive Regime

	North, North East and Center-West	*South and South East*
Fiscal Incentives	100% reduction in tariffs on capital good imports 90% reduction in tariffs on other imported inputs Up to 50% reduction in tariffs on finished vehicles imported by manufacturer Industrial products tax exemption on capital goods; 45% reduction on other inputs Maritime transport tax exempted on all imported inputs Financial transactions tax exempted on exchange rate operations Corporation tax exempted on profits Corporation tax credit on employer payroll tax contributions	90% reduction in tariffs on capital good imports 55% reduction in tariffs on other imported inputs (this fell to 40% in 1998 and 1999). Up to 50% reduction in tariffs on finished vehicles imported by manufacturer
Local Content Requirement for Receipt of Incentives	For vehicles possessing 3 or more wheels: 50%. For motorcycles and scooters : 60%	For enterprises with production capacity already in existence: 60% For enterprises establishing production capacity for the first time: 50%, rising to 60% after 3 years
Special restrictions	No more than 30% of total imports may be in the form of capital goods if the 100% tariff reduction on the latter items is to apply. In addition the tariff concession on capital goods imports requires that for every Real spent on imported capital goods, R$1.50 must be spent on Domestically produced equipment; for all tariff concessions, total expenditure on imported inputs and finished products may not exceed 2/3 of the total value of exports	The tariff concession on capital goods imports requires that for every Real spent on imported capital goods, R$1.50 must be spent on domestically produced equipment. Total purchases of imported inputs may not exceed purchases of domestically produced inputs; total imports cannot exceed 2/3 of the total value of exports

Source: Folha de São Paulo, 4/6/97

Table 3: State and Municipal Government Incentives Granted to Automobile Assemblers: Two Case Studies

Incentive	*The State of Minas Gerais and Mercedes Benz*	*The State of Paraná and Renault*
Land Donated by State/Municipality	28 million square meters	Purchase of 5 million square meters funded though not donated by the state government
Infrastructure provided	Drainage, road access, vehicle testing roads, electricity connection	Electricity substation and connection (with 25% electricity tariff reduction), railhead and spur, water supply, exclusive berth at Paranaguá docks
Capital participation by state/municipal government	None	40% equivalent to R$300m financed by COPEL (a power utility) share sales and credits from the now extinct BADEP (Paraná State Bank)
Credit granted	R$112m in fixed and working capital finance facilities repayable at a 3.5% annual real rate of interest. Repayment holidays apply to tranches of the borrowing ranging from 12 to 30 months	Value not disclosed but terms are generous (10 year and no interest) according to company balance sheets
Deferment of state sales tax (ICMS) payments	Deferred payment allowed and financed by state-provided credit facilities	Deferment of 48 months granted. The real rate of interest to be charged on the balance due is equivalent to 0%
Tax exemptions granted	None disclosed	None disclosed
State government guarantees for credit facilities provided	R$101.9m in CEMIG (a power utility) shares; a R$3.1m bond	None disclosed

Source: Cavalcanti & Prado, 1998, p.132-5

Taking all of the above factors together, it is hardly surprising that the geographical spread of the Brazilian automotive industry has altered radically over the past few years. As Table 4 attests, besides the state of São Paulo, major assembly facilities now operate in the states of Rio de Janeiro, Minas Gerais, Paraná, Rio Grande do Sul, Goiás and Bahia. Whereas at the beginning of the 1970s, 100% of vehicles were assembled in São Paulo, by the beginning of this decade the state was responsible for just under 50% of total national output (ANFAVEA, 2000). By contrast, automotive assembly

plants in Minas Gerais and Rio de Janeiro states, non-existent in the early 1970s, now account for around 30% of all vehicles produced in Brazil.

Table 4. Location of Major Production Facilities in the Brazilian Automotive Sector

State	*City*	*Company*	*Product*
São Paulo	São Bernardo do Campo	Ford	Cars, light commercials
		Karmann-Ghia	Tools, welding and assembly of modules and complete bodies, vehicle assembly
		Land Rover	Light commercials
		Mercedes-Benz	Trucks, bus chassis, engines
		Scania	Trucks, bus, industrial and marine engines
		Toyota	Light commercials
		Volkswagen	Cars, light commercials
	São Paulo	Ford	Light commercials, trucks
	Taubaté	Ford	Components, engines, transmissions
		Volkswagen	Cars
	São Caetano do Sul	General Motors	Cars
	Mogi das Cruzes	General Motors	Stamped Components
		Toyota	Wheel tractors
	Sumaré	Honda	Cars
	Campinas	Mercedes-Benz	Bus platforms
	Indaiatuba	Toyota	Cars
	São Carlos	Volkswagen	Engines
	Pederneiras	Volvo	Articuled trucks, loaders motorgraders
Minas Gerais	Betim	Fiat	Cars, light commercials, Engines
	Juiz de Fora	Mercedes-Benz	Cars
	Pouso Alegre	JPX	Light commercials
	Sete Lagoas	Fiat/Iveco	Light commercials, trucks and engines
Rio de Janeiro	Porto Real	Peugeot Citroën	Cars
	Resende	Volkswagen	Trucks, bus
Paraná	Campo Largo	Chrysler	Light commercials
		Chrysler/BMW	Engines
	Curitiba	Volvo	Trucks, truck cabins, bus chassis, engines
	São José dos Pinhais	Renault	Cars, engines
		Volkswagen/AUDI	Cars
Rio G. do Sul	Caxias do Sul	Agrale	Trucks, bus chassis, component manufacturing
	Gravataí	General Motors	Trucks
Goiás	Catalão	MMC	Light commercials
Bahia	Camaçari	Ford	Not available

Source: ANFAVEA – Statistical Yearbook of the Brazilian Automotive Industry (2000)

Although the production of automotive components remains concentrated in São Paulo state[9], the past few years have nevertheless witnessed a process of geographical dispersion similar in direction if not in scale to that affecting the assembly sector. As Table 5 reveals, between 1991 and 2001, both in terms of employees and numbers of enterprises there was a marked tendency towards the movement of component manufacturing outside its traditional heartland of metropolitan São Paulo. Of particular significance, over this ten-year period the percentage of enterprises and employees engaged in component production in states other than São Paulo rose from 9.3% to 20.9% and 10.6% to 29.4% respectively.[10]

Table 5. Percentage Distribution by Location of Enterprises and Employees in the Automotive Components Sector (1991-2001)

	Enterprises		*Employees*	
	1991	*2001*	*1991*	*2001*
City of São Paulo	38.9	24.6	30.2	13.0
ABCD Industrial Suburbs*	18.4	16.6	15.8	13.4
Other districts of Greater São Paulo city	16.2	16.8	19.9	15.6
São Paulo state**	17.2	21.1	23.5	28.6
Other states	9.3	20.9	10.6	29.4

* Namely Santo André; São Bernardo do Campo; São Caetano do Sul and Diadema. These suburbs form the industrial core of the greater São Paulo city metropolitan area.
** i.e. São Paulo State excluding the greater São Paulo city metropolitan area.
Source: Sindipeças (2002)

[9] Some 80% of auto components plants are currently located in the state
[10] In absolute terms, for São Paulo State, the number of enterprises rose from 506 to 573 between 1991 and 2002 while over the same period number of employees fell from 255,600 to 170,000.

Naturally, this tendency towards geographical dispersion of production activity in the components sector should not be viewed in isolation from the emergence of new locational patterns in the assembly sector. As new assembly facilities were established away from the greater São Paulo city area, increasingly components manufacturers[11] found it necessary to locate close to their customers. At the same time, as in the case of the assembly industry, the components industry found itself able to benefit from attractive fiscal incentives on offer often tied into just-in-time relationships with their clients in locations away from its traditional center of production.

In the next section, we use an interregional input-output model for the Brazilian economy for purposes of regional impact assessment. The model is to be used to capture the role of interindustrial and interregional relations in the economic development process through the evaluation of the regional impact of the new investments in the automobile industry. The use of this modeling approach is very relevant to the Brazilian case. Its ability to handle detail at a disaggregated level is useful for the analysis of the evolution of Brazil's productive structure.

5. Assessing the Regional Impacts of Fiscal Incentives in the Automobile Sector in Brazil

We start by describing the model used to analyze the regional effects of new investments in the automobile industry. The general equilibrium nature of economic interdependence and the fact that the policy impacts in various regional markets differ are

[11] Whom are frequently tied into just-in-time relationships with their clients

considered in the results of the model. Attention is directed to two main issues: a) the differential impacts in the construction and the operation phases, and b) the differential impacts of investments originating in different regions.

As the simulations try to mimic a "typical investment project", we have selected as our case study the investments undertaken by Mercedes Benz in the State of Minas Gerais. In this chapter we intend to use the project parameters to simulate different arbitrary locations for the plant, rather than evaluate more properly the impacts of the Mercedes Benz itself. Readers interested in the specific impacts of the latter project in Juiz de Fora are directed to the chapter by Perobelli *et al*.

5.1. Theoretical Background

The intersectoral flows in a given economy can be represented by the following system:

$$X = AX + Y \tag{1}$$

where X is a (*nx1*) vector with the value of the total production in each sector, Y is a (*nx1*) vector with values for the final demand, and A is a (*nxn*) matrix with the technical coefficients of production. In this model, the final demand vector can be treated as exogenous to the system, such that the level of total production can be determined by the final demand, i.e.,

$$X = BY \tag{2}$$

$$B = (I - A)^{-1} \tag{3}$$

where B is a (*nxn*) matrix of the Leontief inverse.

According to Miller & Blair (1985), an interregional model for two regions L and M, can have its coefficients matrix represented in matricial terms as:

$$A = \begin{bmatrix} A^{LL} & A^{LM} \\ A^{ML} & A^{MM} \end{bmatrix} \quad (4)$$

The vectors X^L and X^M will constitute the total production vector, X

$$X = \begin{bmatrix} X^L \\ X^M \end{bmatrix} \quad (5)$$

The final demand vector, Y will be composed of the vectors Y^L and Y^M

$$Y = \begin{bmatrix} Y^L \\ Y^M \end{bmatrix} \quad (6)$$

As so, the system presented by equation (2) can then be used to represent an interregional system, in this way, it is possible to evaluate the impact of the final demand over total production, and from there, over employment, imports, wages, etc., for each one of the regions considered in the model.

Multipliers

From the multiplier results it is possible to measure the direct and indirect effects of a change in the final demand over production, income, tax, employment, etc. (see Miller and Blair, 1985).

From the Leontief inverse matrix (B) defined above one has that the production multiplier of type I for each economic sector is given by:

$$P_j = \sum_{i=1}^{n} b_{ij}$$
$$j = 1,\ldots,n \quad (7)$$

where P_j is the production multiplier for sector j and b_{ij} is an element of matrix B.

Using the structure of derivation elaborated below for the employment multipliers, all the other multipliers in the economy can be derived.

The first step is to estimate the coefficients of employment, given by

$$w_j = \frac{e_j}{x_j} \tag{8}$$

where w_j is the coefficient of employment in sector j, e_j is the total employment in sector j, and x_j is the level of production in sector j.

The total employment of type I (E_j), generated in sector j is given by

$$E_j = \sum_{i=1}^{n} w_i b_{ij} \tag{9}$$

where b_{ij} is an element of matrix B described above.

5.2. Hypotheses for the Simulations

In order to grasp the differential effects associated to different locations of such a "typical project", we will consider six different macro-regional locations for the investment, namely North, Northeast, São Paulo State, Rest of Southeast and South. An interregional input-output model, based on data for 1999 (Guilhoto et al., 2002), will serve as the basis for our simulations. Based on the information provided by the Mercedes Benz project, the project was divided into two phases: a) the first one is the construction phase, in which the Mercedes Benz production plant is implemented; and b) the second one is the operational phase, when the the Mercedez Bens Classe A is produced by the automobile plant.

In the construction phase, the total investment assumed is of R$ 700 millions, of which 59% is spent in Machinery, and 30% in Civil Construction, and the remaining value is distributed to the other economic sectors according to their respective shares in the standard unit of investment embedded in the input-output coefficients. In this phase, MB will also buys investment goods from the region to which it is located and from the other regions, how much it buys from its region and from the other regions will depend on the capacity of the regions to produce capital goods.

In the operational phase, its is assumed that: a) MB will produce, annually, 12 thousand Classe A 160 Classic Mechanic at an average price of R$ 30 thousands, resulting on a total sale of R$ 360 millions to the final demand; b) 79.1% of the autoparts are produced in São Paulo; c) autoparts represent around 17% of the total cost of production; d) the production technology of the automotive sector for the Northeast is made equal to the one for Brazil as a whole; and e) when changing the productive structure, it is assumed that a given region buys inputs from itself and from the other regions, according to the capacity of the regions to produce these kinds of goods.

5.3. Results

Tables 6a and 6b present the results, respectively, for the value added and employment effects in the construction phase, when the plant is located in each one of the six regions being considered in the model. It is clear from the results presented, that when the direct and indirect effects are taken into consideration, the region that benefits the most in the process is the state of São Paulo. This benefit however, is not uniform and will depend where the plant is located.

In the construction phase, if the plant is located in the Northeast, Central West, or Rest of the Southeast region, between 43% to 48% of the value added, and between 25% to 33% of the employment generated in the process goes to the state of São Paulo. If the plant is located in the North region, São Paulo gets 32% of the value added and 22% of the employment. But, if the location is in the South region, the share of São Paulo decreases to 14% in the value added and 13% in the employment. This gives an indication of the high level of the dependence that the other regions have on São Paulo, as a supplier of capital goods.

For the operation phase, the results for value added and employment are presented into tables 7a and 7b. In this phase, the impacts in the region where the plant is installed are greater than in the construction phase, fact that can be explained in part by the high concentration of the capital goods industry in the state of São Paulo, and in part by the fact that when a new automobile plant is installed, it brings together a series of satellites industries. However, the results show that between 17% to 23% of the value added, and 13% to 26% of the employment generated stays in the State of São Paulo.

In both phases it also stands out that: a) after São Paulo, the South region is the one that depends less on the other regions; and b) the South and rest of Southeast regions also play an important role as a suppliers to the other regions, which is not the case of the North, Northeast and Central West regions.

The differences in the results are, of course, accounted by the regional differences and the hypothesis that the productive structure of the regions are given. Naturally, as the case of Fiat in Minas Gerais has shown, after some time, it is possible that the satellites industries of the automotive complex will move towards the main industry.

Table 6a. Projected Value Added Effects of New Regional Investments in the Automobile Sector: Construction Phase

			Percentage Distribution			
	N	*NE*	*CW*	*SP*	*RES*	*S*
North	47.21	2.63	2.74	1.58	2.16	0.91
Northeast	2.47	25.56	3.23	2.85	2.79	1.83
Center-west	1.41	1.06	20.05	1.08	1.17	1.12
São Paulo	31.69	43.01	43.12	80.48	48.06	14.12
Rest of Southeast	8.31	12.39	13.75	9.55	33.55	6.32
South	8.92	15.34	17.12	4.47	12.28	75.70
Total	100.00	100.00	100.00	100.00	100.00	100.00
			R$ Millions			
	N	*NE*	*CW*	*SP*	*RES*	*S*
North	271.75	15.38	15.91	9.11	12.59	5.47
Northeast	14.19	149.77	18.73	16.49	16.26	11.06
Center-west	8.10	6.24	116.37	6.22	6.85	6.80
São Paulo	182.39	252.01	250.29	465.42	280.41	85.38
Rest of Southeast	47.85	72.62	79.84	55.25	195.74	38.22
South	51.32	89.86	99.37	25.85	71.65	457.74
Total	575.61	585.87	580.52	578.33	583.50	604.66

Source: Research Results

Table 6b. Projected Employment Effects of New Regional Investments in the Automobile Sector: Construction Phase

			Percentage Distribution			
	N	*NE*	*CW*	*SP*	*RES*	*S*
North	52.41	2.87	3.03	2.71	3.00	1.38
Northeast	5.38	47.30	6.63	7.09	6.55	4.33
Center-west	4.15	2.34	36.19	2.29	3.48	2.17
São Paulo	21.69	24.97	27.31	70.70	33.26	13.32
Rest of Southeast	7.96	10.63	12.63	9.72	41.66	5.32
South	8.42	11.89	14.22	7.50	12.06	73.47
Total	100.00	100.00	100.00	100.00	100.00	100.00
			R$ Millions			
	N	*NE*	*CW*	*SP*	*RES*	*S*
North	9940	668	644	487	567	278
Northeast	1021	10999	1411	1276	1239	871
Center-west	787	543	7703	411	657	437
São Paulo	4113	5805	5812	12721	6287	2677
Rest of Southeast	1510	2472	2688	1749	7876	1069
South	1596	2764	3026	1350	2280	14768
Total	18967	23252	21284	17994	18906	20099

Source: Research Results

Table 7a. Projected Value Added Effects of New Regional Investments in the Automobile Sector: Operation Phase

			Percentage Distribution			
	N	*NE*	*CW*	*SP*	*RES*	*S*
North	64.96	1.09	1.11	1.63	1.74	0.98
Northeast	2.98	70.80	1.64	3.17	2.50	1.67
Center-west	1.60	0.66	67.32	1.28	1.25	1.04
São Paulo	19.54	17.35	18.47	78.14	22.84	17.65
Rest of Southeast	7.37	6.53	7.24	10.95	66.14	8.00
South	3.55	3.56	4.21	4.83	5.52	70.66
Total	100.00	100.00	100.00	100.00	100.00	100.00
			R$ Millions			
	N	*NE*	*CW*	*SP*	*RES*	*S*
North	154.39	2.66	2.71	3.70	4.39	2.55
Northeast	7.09	173.20	4.01	7.21	6.32	4.32
Center-west	3.80	1.60	164.40	2.92	3.15	2.69
São Paulo	46.44	42.45	45.11	177.77	57.66	45.75
Rest of Southeast	17.51	15.98	17.69	24.90	166.96	20.74
South	8.43	8.72	10.28	10.99	13.94	183.16
Total	237.65	244.62	244.20	227.49	252.42	259.21

Source: Research Results

Table 7b. Projected Employment Effects of New Regional Investments in the Automobile Sector: Operation Phase

			Percentage Distribution			
	N	*NE*	*CW*	*SP*	*RES*	*S*
North	60.87	1.21	1.20	3.58	2.73	1.44
Northeast	5.81	76.34	2.83	9.10	7.30	4.21
Center-west	3.21	1.00	71.62	2.78	2.98	1.85
São Paulo	19.05	13.05	14.54	65.49	26.18	17.70
Rest of Southeast	6.10	4.59	5.20	10.33	52.10	6.33
South	4.96	3.81	4.62	8.72	8.72	68.46
Total	100.00	100.00	100.00	100.00	100.00	100.00
			R$ Millions			
	N	*NE*	*CW*	*SP*	*RES*	*S*
North	4966	136	119	256	202	122
Northeast	474	8528	281	653	540	359
Center-west	262	111	7111	199	221	158
São Paulo	1554	1458	1443	4696	1940	1507
Rest of Southeast	498	512	516	740	3860	539
South	405	426	459	625	646	5828
Total	8159	11171	9929	7171	7409	8513

Source: Research Results

Final Remarks

In relation to the discussion above it is worth making a few additional points. In first place, the results and estimations so far presented constitute only a partial view of the enormous spatial changes currently affecting the Brazilian automotive sector. Specifically, the analysis only concerned itself with the Brazilian "mega regions" and the state of São Paulo, taking into account their productive interrelationships. From the point of view of a planning exercise at state level, an interstate model would probably be more suitable when estimating the effects of investment location within the state or the leakage of investment benefits to other regions of the country.

Above and beyond this, such an exercise should also take into account the relationship between the income generating effects of investment and its impact on consumption. Haddad & Hewings (1999) show that such relationships are also important in the assessment of regional impacts of automotive investment since the income generated in and outside the region transforms itself into distinct patterns of consumption from region to region, a factor which induces new and region-specific rounds of expenditure in the economy[12]. A related point emerges in a study by Perobelli (1999) which highlighted several important regional impacts of investment, drawing on the case study of the Mercedes Benz plant in Juiz de Fora. Taking into account alternate locational configurations of second and third tier suppliers, Perobelli demonstrated that it was municipalities from the state of Rio de Janeiro which had most benefited from the investment despite the fact that it was the government of neighbouring Minas Gerais state

[12] Haddad, E.A. & Hewings, G.J.D. (1999) 'The short-run regional effects on new investments and technological upgrade in the Brazilian automotive industry: an interregional Computable General Equilibrium analysis', *Oxford Development Studies*, vol.27, no.3

had expended all the time, money and effort in attracting Mercedes Benz[13]. In other words, the state of Minas faced a sort of free rider problem as it failed to fully internalise the benefits of the new inward investment.

In second place, it is important to take into account technological considerations. One of the principal concerns of trades unions relates to the adoption of new capital-intensive technologies in the automotive sector. The experience of the recent wave of investment has been that the modernization of existing plants has been accompanied by reductions in the level of employment due to the less labour intensive production techniques embodied in the new capital stock. The implications of this are clearly of great significance in terms of regional income-generating effects. Interestingly, preliminary studies have shown that the multiplier effects of the automotive sector and productivity gains associated with technical progress more than compensate for the fall in employment from the perspective of the economy as a whole[14].

In third place, the results presented in this chapter constitute an essentially static view of the regional economies. Future studies must move beyond this, highlighting the differences in regional impacts over time. In our study, in the short run, the productive structure was taken as given and it was also assumed that there would be a failure to fully internalise the benefits of large investments in the peripheral regions. As was demonstrated, currently some 80% of autoparts suppliers in Brazil are located in the state of São Paulo leading to the supply chain being especially regionally concentrated. However, the recent experience of some automotive assemblers points to a more "optimistic" scenario in which suppliers are increasingly located in greater proximity to

[13] Perobelli, F.S. (1999) 'Uma Análise das potencialidades de desenvolvimento dos municípios da região de Juiz de Fora utilizando análise fatorial', *Relatório Final de Pesquisa*, NUPE-FEA, Universidade Federal de

the customer base. The effect of this, given the establishment of car plants in other parts of Brazil will be to encourage the development of a less regionally concentrated autoparts industry.

Evidence to support this conclusion is offered by the case of Fiat. When the enterprise originally commenced operations in Betim, Minas Gerais in 1976, most of its suppliers were concentrated in São Paulo state although, it should be stated, the overall level of domestic content was relatively low. With the passing of time, structural changes in the sector (outsourcing, just in time, automation etc.) created the conditions for an increasing proportion of production to take place in and around the Betim site itself. This tendency was strengthened further through the direct support of the state government. Thus, comparative advantages were progressively created allowing the entrenchment of a viable, integrated automotive sector in a region of the country where previously there had been none[15]. Today, Fiat and its suppliers represent one of the principal sources of state and municipal revenues in Minas Gerais.

In the current context of state government fiscal crisis, much criticism has been levelled at financial incentives to attract automakers. Often, but not always, this criticism has had little rational basis. The arguments against the provision of state support span a spectrum ranging from questions of efficiency to doubts surrounding the power of the automotive sector to propel regional development. As will be evident from the introduction, however, the current cycle of investment in Brazil forms part of a global process of automotive sector restructuring, one that involves new productive techniques

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Juiz de Fora. See also chapter in this volume

[14] Haddad & Hewings, op.cit

[15] In 1989, 26% of Fiat purchases stemmed from suppliers located in Minas Gerais. In 1999 the equivalent figure stood at 75% (Santos, A. & Pinhão, C., (1999) 'Pólos automotivos Brasileiros', *BNDES Setorial*, Rio de Janeiro, no. 10, pp. 173-200

and sales and marketing strategies. Against this background, it is only to be expected that regional governments would compete actively for a share of the resulting investment activity.

As has been demonstrated, there is a very real danger that the benefits of new inward investments will not be fully internalised by the states that seek to instigate them. In this regard, from a regional perspective, it is important that effective strategies are devised which minimize this risk. This is especially so given the substantial fiscal resources that are necessary in order to attract automotive assemblers to commence operations in non-traditional areas. The experience of Fiat in Minas Gerais shows that it is possible to more fully internalise the benefits of investment but only if certain conditions are in place. One of the most important such conditions is that there be in place a planning framework aimed at encouraging the establishment and maintenance in place of an effective chain of component suppliers. Another important condition is that the creation of new comparative advantages through time requires sustained investment in infrastructure, most especially in energy and telecommunications. Investment in human capital is equally, if not more important. To this effect there should be in place an active local workforce training program.

The increasing emphasis on “economic” rather than “financial” incentives throughout Brazil has given rise to a new form of regional incentive based explicitly on building up dynamic comparative advantages rather than granting fiscal handouts. In this regard, attempts to deepen the regional roots of inward automotive investments should focus on the building up of quality infrastructure and the facilitation of enhanced integration with regional, extra-regional and international markets.

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