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USING INTERREGIONAL MULTIPLIERS TO COMPUTE THE EFFICIENCY-EQUITY TRADE-OFF AT THE SUB-NATIONAL LEVEL: AN APPLICATION TO A BRAZILIAN STATE

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Using interregional multipliers to compute the efficiency-equity trade-off at the sub-national level: an application to a Brazilian state*

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Abstract

The paper uses detailed tax data for a state from the Brazilian federation to estimate interregional multipliers. The model considers sectoral transactions of each region with other regions within the state, with other states in Brazil, and with other countries. Interregional multipliers are calculated, which allow for the estimation of the impacts of each unit of investment on the region and on the state as a whole. Based on those results, the trade-off between the effects of investments in each region on state growth and on regional inequality is computed.

1. Introduction

In dealing with regional planning, a policy maker is generally faced with the efficiency versus equity trade-off. If massive resources are allocated to poor and/or lagging regions in a country, the results in terms of country growth could be harmed. If efforts are concentrated in maximizing country growth, resources should be probably directed to the richest and most dynamic regions of the country, therefore increasing regional inequality. Haddad (1999) exemplifies this situation for the automobile sector in Brazil: if a plant is established in the poor Northeast region, that region will growth, and so will the country, but at a smaller rate than if the same plant was established in the richer Southeast region.

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This trade-off is always present and demands a choice between these two outcomes. This choice is based on political values, such as the importance of regional inequality for country, for the policymaker constituency, etc. Usually the alternatives are not so clear and decisions are made on the basis of political opportunities. The effects of such decisions are usually not known, or are based on beliefs and prejudices. Therefore, different policy makers can come up with different reasons and motivations for implementing either concentrating or deconcentrating policies.

In this paper we use information on the effects of investments in different parts of a state in Brazil and compute their effects on regional inequality within that state. The study is based on a model ….

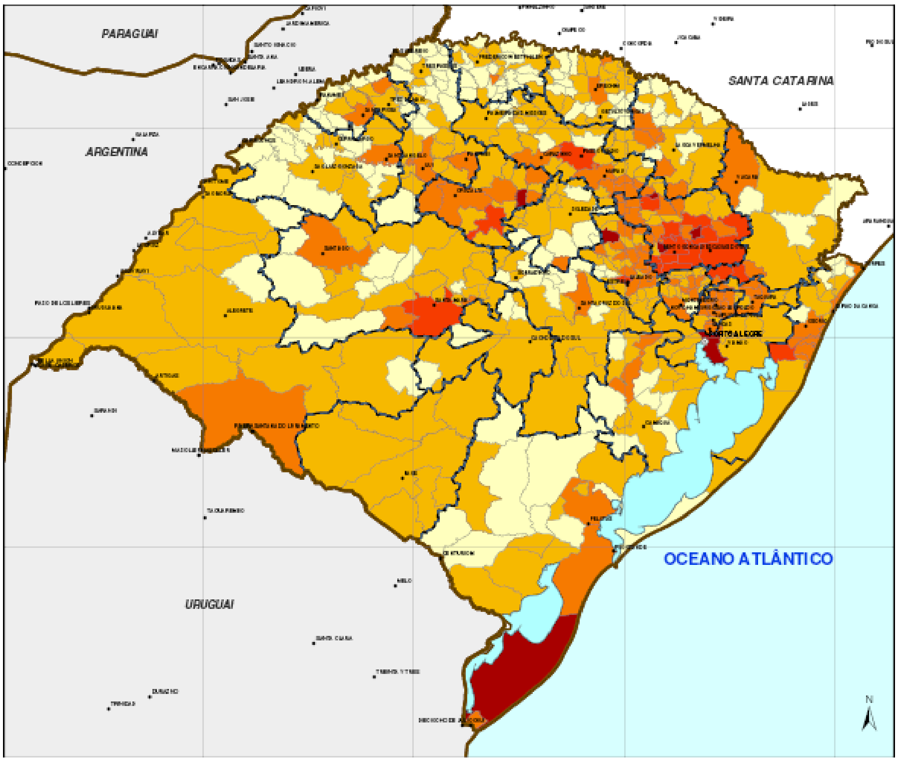
The paper is organized in four sections, besides this introduction. Section 2 describes the political scenario in the region considered in this study and provides general information on its economy. Section 3 describes the interregional model applied in the study and presents the final multiplies. In Section 4 the impacts in terms of state growth and regional inequality are compared. Finally, Section 5 presents the conclusions of the study.

2. The Rio Grande do Sul state case

Rio Grande do Sul is the southernmost state in Brazil. It has borders with Uruguay on the South, and Argentina, on the West, and with the Brazilian state of Santa Catarina on the North. The distance between its capital city, Porto Alegre, and the main economic center of the country, São Paulo city, is of 700 miles. It accounts for 7,8% of Brazilian GDP and hosts 5,9% of the country's population, over 10 million inhabitants, of which 1.5 million in the capital city.

The area was disputed in the past by Portugal and Spain, with important areas belonging to the catholic Jesuits (The Missions, As Missões). Besides the local Indians, it was populated mainly by Europeans, initially from the Portuguese island of Azores, than by Germans, and later by Italians. Compared to other states in Brazil, Rio Grande do Sul (as well as Santa Catarina) has the strongest influence of Germans and Italians, what gives a special flavor in terms of the Brazilian federation. This influence manifests itself in many aspects, especially in participation in public decisions.

Map 1 – Income across municipalities of Rio Grande do Sul state, 2000



The state is divided into 24 regions, with a Regional Development Council in each of them. These councils are composed of state government agents, local public administrators, and society at large (universities, NGOs, religious organizations, etc.). The administration and command over the councils lay on the societal organizations. State public investments are decided based on poles made in the regions, in which all voters are able to participate. This is quite a unique system in Brazil (again, Santa Catarina state has similar organizations), and its existence reflects the importance given by its citizens to regional problems. Regional inequality is always an issue in political campaigns and is certainly a key aspect of any political agenda.

As Table 1 reveals, the Metropolitan Area of Porto Alegre accounts for 22.7% of population, and 21.1% of GDP, what gives a per capita GDP level only 0.93 of the state average; considering per capita income (Map 1), however, the metropolitan level is almost 50% higher than the state average. Other neighboring areas of the state are also important, and together with the metropolitan region, account for 41% of GDP and only 30% of population. The poorest areas of the state account for 30% of GDP and 40% of population, and are stagnated for decades.

This study deals with a state in which regional inequality is already an important political issue. This emphasis was expressed in the commissioning of a regional planning study for the state, comprising the period 2005-2015, on which the results presented here are based. For that study, the regions of the state were treated as separated economies, and their commercial relationships to other regions within the state, to other Brazilian states, and to other countries were considered, in a model described in the next section.

Table 1 - Population and production across regions of RS state, 2000

		Regional GDP		Population		Per Capita GDP	
	Region	*US$ 1,000*	*%*	Number	*%*	*US$/year*	*Region/* State
1	Alto da Serra do Botucarai	403.391	0,7%	105.063	1,0%	3.840	0,74
2	Alto Jacuí	873.606	1,6%	160.021	1,5%	5.459	1,05
3	Campanha	891.498	1,6%	217.466	2,1%	4.099	0,79
4	Central	1.702.240	3,1%	505.930	4,9%	3.365	0,65
5	Centro Sul	991.510	1,8%	241.567	2,3%	4.104	0,79
6	Fronteira Noroeste	1.165.847	2,1%	208.027	2,0%	5.604	1,07
7	Fronteira Oeste	2.184.726	4,0%	560.256	5,4%	3.900	0,75
8	Hortênsias	785.481	1,4%	196.641	1,9%	3.995	0,77
9	Jacuí Centro	564.705	1,0%	148.430	1,4%	3.805	0,73
10	Litoral	789.819	1,5%	256.884	2,5%	3.075	0,59
11	Médio Alto Uruguai	723.019	1,3%	180.102	1,7%	4.014	0,77
12	Metropolitano do Delta do Jacuí	11.421.126	21,1%	2.364.918	22,7%	4.829	0,93
13	Missões	976.382	1,8%	259.020	2,5%	3.770	0,72
14	Nordeste	694.122	1,3%	133.759	1,3%	5.189	0,99
15	Noroeste Colonial	1.434.440	2,6%	307.199	3,0%	4.669	0,90
16	Norte	1.057.754	2,0%	218.798	2,1%	4.834	0,93
17	Paranhana-Encosta da Serra	1.000.862	1,8%	192.128	1,8%	5.209	1,00
18	Produção	2.360.322	4,4%	430.377	4,1%	5.484	1,05
19	Serra	6.209.929	11,5%	767.702	7,4%	8.089	1,55
20	Sul	3.297.086	6,1%	842.273	8,1%	3.915	0,75
21	Vale do Caí	1.031.825	1,9%	156.238	1,5%	6.604	1,27
22	Vale do Rio dos Sinos	8.843.263	16,3%	1.232.665	11,9%	7.174	1,38
23	Vale do Rio Pardo	2.594.509	4,8%	401.366	3,9%	6.464	1,24
24	Vale do Taquari	2.231.132	4,1%	309.488	3,0%	7.209	1,38
	State	54.228.593	100,0%	10.396.316	100,0%	5.216	1,00

3. The interregional model and its results

Total sectoral flows for the state were disaggregated into the 24 regional administrative regions[5] with *"SHIN_Tables"* from Horridge, *et al* (2003). The formulas are:

- Intra-regional flows (1):

$$SHIN(i,s,g,g) = MIN\left\{\frac{SCSR(i,s,g)}{TOTDEMREG(i,s,g)},1\right\} * F(i,s) - (i,s)\text{não margem},\ g \in REG$$

- Inter-regional flows (2):

$$SHIN(i,s,r,g) = \left\{\frac{1}{Dist(r,g)} * \frac{SCSR(i,s,r)}{\sum SCSR(i,s,q)}\right\} * \left\{\frac{1 - SHIN(i,s,g,g)}{\sum_{v \neq g}\left[\frac{1}{Dist(v,g)} * \frac{SCSR(i,s,v)}{\sum_{q \in REG} SCSR(i,s,q)}\right]}\right\}$$

The first step to implement those formulas is the estimation of the regional demand and regional supply equations, respectively TOTDEMREG and SCSR. The following steps were implemented:

a) Construction of 25 aggregated matrices of origin and destination based on the inter-regional input-output matrix (RS state and rest of the Brazil, one for each sector of the inter-regional input-output matrix. The structure of aggregated matrix is as follows.

	Region I (state)	Region II (Rest of Brazil)	Region III (ROW)
Region I (state)	(A)	(B)	(C)
Region II (Rest of Brazil)	(D)	(E)	(F)
Region III (ROW)	(G)	(H)	-

[5] For more details about disaggregation see Dixon and Rimmer (2004).

Where: Quadrant (A) – aggregation of the intra-regional flows of sector "i" located in region I (origin – state). These flows include intermediate consumption, household consumption and investment. Quadrant (B) – aggregation of the inter-regional flows of sector "i" located in region I (origin – state). These flows include intermediate consumption, household consumption and investment. Quadrant (C) – sector "i" exports located in the region I (origin – state). Quadrant (D) – aggregation of inter-regional flows of sector "i" located in the region II (origin – rest of Brazil). These flows include intermediate consumption, household consumption and investment. Quadrant (E) - aggregation of intra-regional flows of sector "i" located in the region II (origin – rest of Brazil). These flows include intermediate consumption, household consumption and investment. Quadrant (F) - sector "i" exports located in the region II (origin – rest of Brazil). Quadrant (G) – aggregation of sector "i" imports located in region I (origin – state). Quadrant (H) - aggregation of sector "i" imports located in region II (origin – rest of Brazil)

a) Construction of the *"SHIN_Tables"* based on formulas (1) and (2) and origin and destination matrices (Figure 1). In order to implement this table we use the following data:

Dist (r,g) – using the values from inter-regional distance matrix. This matrix was constructed using the distance from the principal municipality of the COREDE (administrative region).

SCSR (i,s,r) – supply of goods: the vector SCSR was constructed in the following way:

- the total value of intra-regional flows of each sector (intermediate consumption, household consumption and investment) in the inter-regional input-output matrix (Rio Grande do Sul x rest of Brazil) was aggregated (see Figure 1) and the total value was distributed by the vector of share of each sector in the total output flows of sector *"i"* inside the state (based on the SEFAZ database).

TOTDEMREG (i,s,g) – demand of goods: the vector TOTDEMREG was constructed in the following way:

- the total value of intra-regional flows of each sector (intermediate consumption, household consumption and investment) in the inter-regional input-output matrix (Rio Grande do Sul x rest of Brazil) was aggregated (see Figure 1) and the total value was distributed by the vector of share of each sector in the total input flows of sector "i" inside the state (based on the SEFAZ[6] database).

- F(i,s) – the parameter between 0.5 and 1. Values near from 1 for non-tradables sectors.

Based on the above data it was possible to estimate the intra-regional flows (equation 1) and the inter-regional flows (equation 2) for each one of the 25 sectors and for each one of the 24 regions. Thus, at the end of the estimation the intra-regional flows (in the case of the present paper, flows inside the state) were disaggregated into 24 administrative regions.

We implemented a RAS[7] on the "SHIN-Tables" in order to balance them with the sector SCSR (i,s,g) and with the vector TOTDEMREG (i,s,g). This enables us to maintain the consistence with the inter-regional input-output matrix. The other quadrants of the matrix have to be disaggregated for the 24 administrative regions (COREDES). Thus, in order to enhance the consistence with the values of inter-regional input-output matrix (Rio Grande do Sul x rest of Brazil) the distribution of the aggregated values was constructed as follows:

Quadrant (B) – distribution of the aggregated value of origin and destination product matrix by the shares'vector of each sector in the total output of sector "i" for the others states (database from SEFAZ).

Quadrant (C) – distribution of the aggregated value of the origin and destination product matrix by the shares'vector of each sector in the total output of sector "i" for the rest of the world (database from SEFAZ).

Quadrant (D) - distribution of the aggregated value of origin and destination product matrix by the shares'vector of each sector in the total inputs of sector "i" from the other states (database from SEFAZ).

Quadrant (G) – distribution of the aggregated value of the origin and destination product matrix by the shares'vector of each sector in the total inputs of sector "i" from the rest of the world (database from SEFAZ).

As a result of this process, we got a matrix with the inter-regional flows for each of the 24 sectors, with trade flows (exports and imports) for the rest of the Brazil and

[6] SEFAZ (2005). Secretaria da Fazenda do Rio Grande do Sul.
[7] More details about RAS see Miller and Blair (1985).

the rest of the world originated in each one of the 24 administrative regions. This matrix is consistent, for it is obtained from the disaggregation of the flows of the inter-regional input-output matrix (Rio Grande do Sul x rest of Brazil). Thus, the sum of the inter-regional flows equals the flows of the inter-regional input-output matrix.

The inter-regional input-output model was constructed based on an inter-regional technical coefficient matrix, A[8]. This matrix can be described as block matrices with dimension 25x25. This dimension corresponds to the number of productive sectors in each region. The structure of the model is formed by 25 regions (24 regional administrative regions – COREDES and the rest of Brazil). In each region we specify the intermediate consumption of the sectors ($A^{r,r}$), the household consumption coefficients ($C^{r,r}$) and the household income ($H^{r,r}$). Those components form the closed input output model with respect to households (Miller and Blair, 1985). The dimension of the whole system is 650 x 650, and capture the inter-regional and inter-sectoral flows of intermediate consumption. Furthermore, the system treats the household income and its consumption endogenously.

$$A = \begin{bmatrix} A^{1,1} & A^{1,2} & \cdots & A^{1,25} & C^{1,1} \\ A^{2,1} & \ddots & & \vdots & \vdots \\ \vdots & & \ddots & & \\ A^{25,1} & \cdots & & A^{25,25} & C^{25,1} \\ H^{1,1} & \cdots & & H^{1,25} & O \end{bmatrix}$$

The inverse Leontief matrix, B, can be partitioned in intra and inter-regional blocks. Thus,

$$B = (I - A)^{-1} = \begin{bmatrix} B^{1,1} & B^{1,2} & \cdots & B^{1,25} & B^{1,26} \\ B^{2,1} & \ddots & & \vdots & \vdots \\ \vdots & & \ddots & & \\ B^{25,1} & \cdots & & B^{25,25} & B^{25,26} \\ B^{26,1} & \cdots & & B^{26,25} & O \end{bmatrix}$$

[8] For a detailed version of Inter-regional input-output model see: Miller and Blair (1985); Isard, *et all* (1998) and Dietzembacher and Lahr (2001).

The multiplier O_j is constructed for the 25 sectors in each region and is calculated through the sum of lines of matrix B. Thus, for a specific region *r*, the vector of multipliers is:

$$O_j^r = \sum_{i=1}^{25} \sum_{r=1}^{26} b_{i,j}^r$$

The multipliers can be decomposed in two parts: an intra-regional and an inter-regional. For a specific region *r*, the decomposition can be implemented as follows:

$$\frac{O_j^r}{O_j^r} = \frac{\sum_{i=1}^{25} b_{ij}^{rr}}{O_j^r} + \frac{\sum_{r=1}^{26} \sum_{i=1}^{25} b_{ij}^{rR} - \sum_{i=1}^{25} b_{ij}^{rr}}{O_j^r} \rightarrow 1 = o_j^{rr} + o_j^{rR}$$

Where, o^{rr} and o^{rR} are the intra and inter-regional components of the multiplier in sector *j* and region *r*, respectively. Those components shows the impact of the multiplier effect upon the local region (o_j^{rr}) and upon sectors from region *r* to region *R* (o_j^{rR}). For example, a multiplier of 1.50, with an intra-regional multiplier of 1.20 and an inter-regional multiplier of 0.30, implies that 80% of the variation in the demand by goods produced by the sector is reflected inside the region (intra-regional component) and 20% is reflected upon the sectors outside the region (inter-regional component).

4. State growth versus regional inequality: what the multipliers indicate

Based on the results of the model presented in Section 3, in this section we analyze the efficiency-equity trade-off. A similar investment (equal amount) is introduced in each region, leading to increases in production in each one of the 24 regions, and, of course, in the state as a whole. Figure 1 presents the results. The horizontal axis shows the share in state's GDP of the region in which the investment is made; the vertical axis shows the final increase in the state's production as a result of that investment.

It is clear that smaller regions (that is, with small percentage of GDP) present higher state level multipliers. This is explained by the fact that they have a sectoral structure that is more concentrated in sectors with less interaction with other states or countries. They tend to be more traditional and closed economies, while the larger economies within the state are concentrated in modern sectors, which are more integrated with other economies, especially out-of-state suppliers of inputs. Therefore, the larger economies present more leakages then the smaller economies.

Figure 1 - Regional GDP and state growth

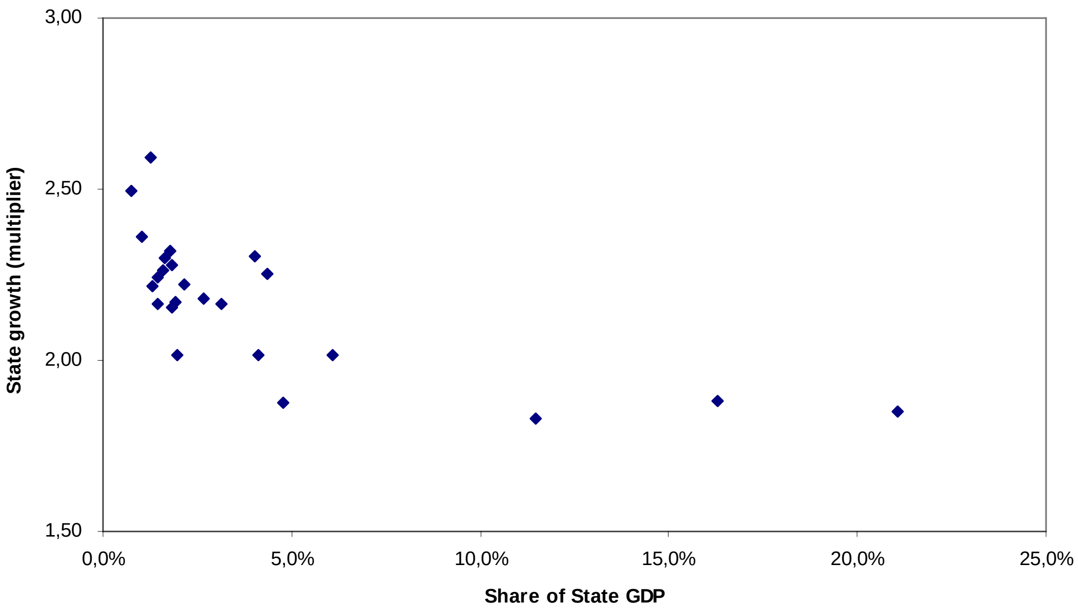
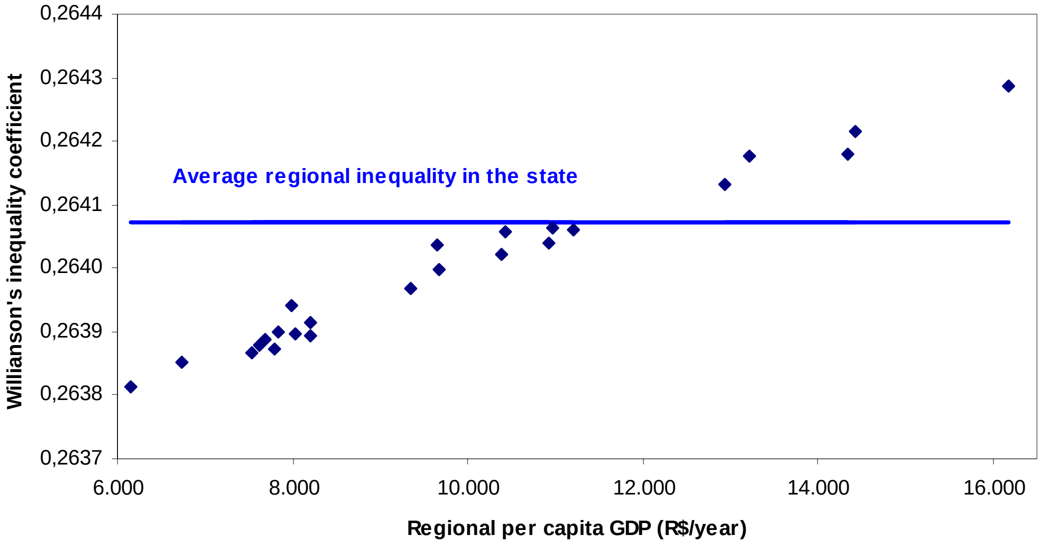


Figure 2 provides another piece of information. It portrays the level of GDP of the region in which the investment is made on the horizontal axis, and the state's Williamson's regional inequality coefficient of the impacts in the vertical axis. It shows thus the effects of an investment in each region on regional inequality at the state level. It can be seen that investments in the five largest regions result in marginal profiles of regional inequality above the previous level (average regional inequality in the state, represented by the horizontal line). That is, investments in those regions increase regional inequality in the state. On the other hand, investments in all other smaller regions lead to a reduction in regional inequality in the state.

Figure 2 - Investment in each region and inequality at the state level

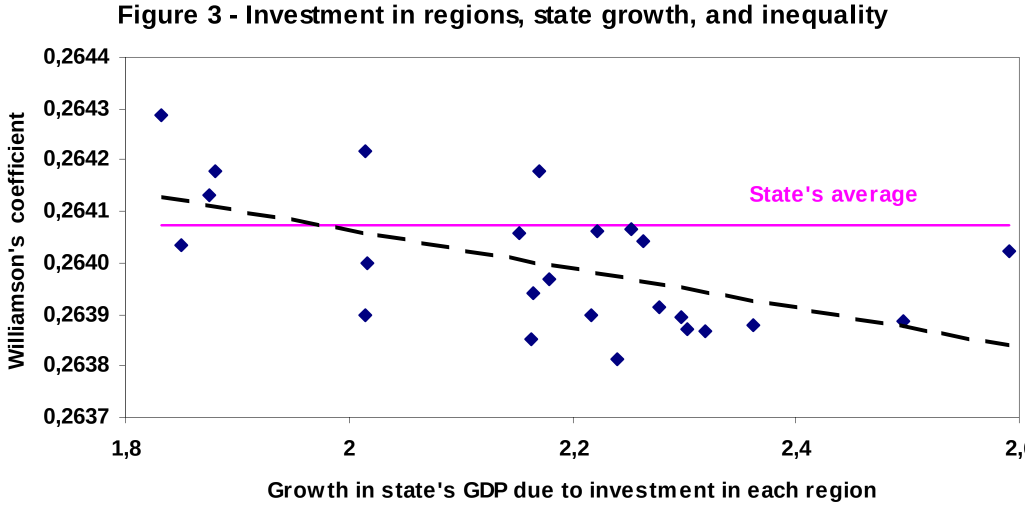


Putting the two pieces of information together, we have that investments in the richer regions tend to increase regional inequality and to result in lower rates of growth for the state as a whole. This is a clear indication that a closer look at the peripheral regions within the state should receive more attention.

To complement this analysis, Figure 3 presents in the horizontal axis the growth in the state's economy (total multiplier) produced by investments in each of the 24 regions; the vertical axis portrays the regional inequality pattern of such effects, as measured by Williamson's regional inequality coefficient. The inverse relationship between these two variables indicates that investments in regions that increase state growth tend to reduce regional inequality within the state.

5. Conclusions

This paper presented the results of the application of a multi regional model for the State of Rio Grande do Sul, in Brazil. This case is unique in Brazil for the high levels of popular participation in regional planning, given the European background of the majority of its inhabitants. The 24 regions considered are in fact political unities, since their councils actively participate in budgetary decisions involving public sector investments.



A 25-sector multiregional model relating each region to other regions within the state, to other states in Brazil, and to other countries was constructed, and the multipliers were calculated. The model results were used to investigate the possible existence of a trade-off between efficiency (state's economic growth) and equity (reduction in regional economic concentration). The main results indicate that investments in smaller economies tend to present higher state growth rates, and decrease regional inequality. Further analysis indicated that investments in regions that increase state growth tend to reduce regional inequality within the state.

This is an interesting conclusion, for it shows that in the case of Rio Grande do Sul, the traditional trade-off equity versus efficiency is not present. On the contrary, the results indicate that a policy to reduce concentration within the state, with investments directed to smaller regions, tend to produce not only reductions in regional inequality, but also faster economic growth for the state.

Of course, nothing was said in this exercise about the market opportunities for investing in sectors important for the smaller regions. Smaller regions in Rio Grande do Sul, in general, are stagnated, meaning that that the private sector is not opting for them in their investment decisions. This paper indicates that, if they did, the results would be as portrayed here, that is, regional inequality would diminish and the state would grow faster. As the experience indicates, sectors in which poor regions in the state are important tend to be less dynamic and more open to external competition at the market level.

On the other hand, the metropolitan area and its expansion receive the attention of private companies, especially in dynamic sectors, leading to increase regional inequality and lower state growth. However, these are the only opportunities available, and should be used by the state level decision maker. In spite of this important disclaimer, this paper has presented an interesting real case of estimation of the trade-off equity versus efficiency at the regional level.

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