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Evaluating Micro- and Macro-Effects of Regional Development Policies: The Case of the Northeast Regional Fund (FNE) in Brazil, 2000-2006[1]

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Abstract

The goal of this paper is to carry out two outcome evaluations of the northeast regional fund (FNE) in Brazil. With this aim, the paper assembles two types of outcome evaluation often implemented separately in the evaluation literature. The results of the micro- and macro-evaluations show that although there is a positive and statistically significant impact of the FNE industrial loans on job creation at the (micro) firm level, this impact is still too limited to have any significant effect on GDP per capita growth at the municipal (macro) level and thus reduce the regional inequalities in Brazil.

Keywords: Evaluation; Regional Development Policy; Regional Inequality; FNE; Brazil.

JEL Classification: C52, O20, R58

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1. Introduction

It is well known that regional inequalities have persisted in Brazil for decades. For example, the Gross Domestic Product (GDP) per capita of the poorest region, which is the Northeast, was only 43% of the national average in 1989 and 47.5% in 2006. On the other hand, the per capita GDP in the Southeast region, the wealthiest region, was 139% of the national average in 1989 and 133% in 2006 (see Table A.1 in Appendix A). The main Brazilian regional development policy has been enacted since 1989 by the Constitutional Financing Funds for the Northeast (FNE), the North (FNO), and the Central-West (FCO) (henceforth referred to as regional funds), seeking the economic and social development of lagging regions through loans at interest rates below market rates, mainly to small-scale farmers and industrial small firms. However, the evaluation of regional policies in Brazil has rarely occurred over the years. Thus, the goal of this paper is to contribute to filling – at least partially – this gap in the literature by carrying out two outcome evaluations of the FNE. Given the availability of data, the analysis includes only the FNE loans for firms in the industrial, commerce and services sectors, which represents roughly 40% of the FNE loans granted during the period of analysis.

The inquiry involves two types of outcome evaluation that are often implemented separately in the evaluation literature. First, it measures the effectiveness of the FNE (does the FNE create jobs and/or increase productivity at the firm level?). Second, it assesses the impact of the FNE on regional inequalities (does the FNE reduce regional GDP per capita gap?). This combined approach is useful because evaluations can prove, for instance, that the regional funds create jobs and/or increase productivity (proxied by wage growth) at the micro level. However, it is still necessary to demonstrate that the program has solved, or at least reduced, the regional inequalities (at the macro level)[3]. These micro and macro effects have been overlooked in the literature dealing with the impacts of regional funds. In the international context – for example, in the context of the European Union (EU) regional policy – most of the studies focus on the macro impacts of EU-regional funds on regional inequalities. These studies include RODRÍGUEZ-POSE and FRATESI (2004), DALL'ERBA (2005), LEONARDI (2006), ESPOSTI and BUSSOLETTI (2008) and DALL'ERBA and LE GALLO (2008). Other studies are focused on the micro impact of specific policies: e.g., ROMERO and NOBLE (2008), which evaluates England's 'New Deal for Communities' programme.

[3] The definition of BARTIK and BINGHAM (1995) is employed here, which looks at evaluation as a continuum moving from the simplest form of evaluation, monitoring daily tasks, to the more complex – assessing impact on the problem. To demonstrate that a program (or policy) accomplishes its targets, the evaluation must be at the highest level: measuring effectiveness (for instance, it actually does create jobs) or assessing impact (there has been an improvement in the situation). Also, a cost-benefit analysis needs to be carried out to prove that the program benefits outweigh the costs. However, because the data necessary to carry out this cost-benefit analysis are not available, this type of evaluation is left for future research.

With regard to the Brazilian literature, there are few papers related to the FNE evaluation at the firm level (namely, SILVA et al., 2009; SOARES et al., 2009) and none at the macro level[4]. For instance, SILVA et al. (2009) measure the effectiveness of regional fund (FNE, FNO, and FCO) loans using propensity score estimates of firms that received loans (treatment group) and those of others that did not receive them (control group) over 2000-2003. The results show that FNE has a positive impact on the growth rate for employment and no impact on the growth rate for wages. The study found that employment growth is approximately 60 percentage points higher for those firms that received loans than for those that did not receive them over the period 2000-2003. With regard to FNO and FCO, there is no observed impact of the regional funds on the two variables under study.

The contribution of the current paper based on those previous studies is threefold. First, it brings together two types of outcome evaluation, which are often implemented separately in the evaluation literature. Second, as regards micro-evaluation, the paper employs the first-difference estimation technique to eliminate the unobservable factors that are constant over time and may be biasing the previous results. This method has not been used in previous studies. Moreover, this paper also assesses the impact of FNE on employment and wage growth until 2006. Third, concerning macro-evaluation, this is the first study to evaluate the macro effects of FNE loans awarded to the firms in the industrial and commerce/services sectors on GDP per capita growth at the municipal level. With regard to this macro analysis, other levels of spatial aggregation of the observational units are employed because an aggregation problem [Modifiable Areal Unit Problem (MAUP)] might prevent us from identifying the effects of FNE loans on GDP per capita growth at the municipal level. In this sense, this paper seeks to provide a more complete picture of FNE performance during 2000-2006.

The paper is organised as follows. In Section 2, the background of the FNE is discussed. Section 3 describes the micro and macro data employed in this paper. Section 4 carries out the effectiveness micro estimates for employment and wage growth using the first-differences method. Section 5 shows the macro empirical model in which the instrumental variable approach is used to assess the macro impact of the FNE on regional inequalities in Brazil. Section 6 presents the conclusions.

2. Background of the FNE

The regional funds (FNE, FNO, and FCO) were created by Federal Law 7827 in 1989 – based on articles 159.I.c and 161.II of the Federal Constitution of 1988. An equal portion (3%) of income taxes (from individuals and firms – "IR") and of the tax on industrialised goods ("IPI") represents the transfer of resources from the National Treasury to the regional funds. The total resources allocated to these funds each year is divided as follows: 60% goes to the FNE, 20% to the FNO, and 20% to

[4] OLIVEIRA and DOMINGUES (2005) employ a municipal dataset to examine if the Brazilian regional funds (only FNO and FCO are analysed) have a positive impact on regional inequality. The results show that regional growth in Brazil between 1991 and 2000 was not affected by these funds (FNO and FCO).

the FCO. These resources are transferred from the National Treasury to the operating bank via the Ministry for National Integration ("Ministério da Integração Nacional"). Beyond the 3% IR and IPI taxes, the revenues for these funds come from the repayment of the loans (principal + interest). In this way, Federal Law 7827 defines the source of funding and designates the regional banks as being the operators of the regional funds. The operator bank of FNE is the Bank of the Northeast (Banco do Nortedeste/BNB). The regional funds granted loans of € 10 billion in lagging Brazilian regions between 2000 and 2006. This amount represents 1.2% of the national GDP in 2006. For details, see FERREIRA (2004) and ALMEIDA JUNIOR et al. (2007), who conduct comprehensive studies of the resource allocation each year for these funds[5].

Specifically, the operator banks of the regional funds – the BNB in the Northeast region – are the agents responsible for analysing and deciding whether to award the subsidised loans to applicants. The interest rates of the loans are fixed but vary depending on the size of the beneficiary and the sector. In rural FNE operations, the interest rates are between 6.00% and 10.75% per annum, and for the other operations, they are between 8.75% and 14.00% per annum (small businesses have the lower rates). It is worth noting that the average interest rates for the production sector in other banks were around 35% in 2000 (BANCO CENTRAL, 2000). Furthermore, good payers win compliance bonuses in the form of an interest rate reduction of 25% for those located in the "semi-árido" region (the hot-dry hinterland of the Northeast) and 15% for those located in other areas. Applicants can be individuals, small businesses, enterprises or cooperatives/associations that want to finance a new business or an existing one located in the Northeast region. There are some general guidelines that the bank follows when analysing applications: preference is given to (i) productive activities of individual and small farmers and (ii) small firms in other sectors, (iii) activities that intensively use raw materials and are labour-intensive and produce basic food for the population, and (iv) new centres, activities or clusters that can reduce the economic and social differences between regions. Moreover, by law, 50% of the FNE loans must be directed toward the "semi-árido" region (Figure A.1 in Appendix A shows the boundaries of the "semi-árido" region).

It is important to note that the goal of the FNE is to reduce regional inequalities through the financing of productive sectors in the Northeast. This imprecisely defined objective (or broad objective) is the major obstacle to outcome evaluations. As pointed out by JANN and WEGRICH

[5] These regional development funds are not the only resources available from a public bank for lagging regions in Brazil. The Brazilian Development Bank (BNDES) – a federal public bank established in 1952 – also offers loans (interest rates are below market rates but are higher than those of the regional funds) to companies of any size and sector in all Brazilian regions. While the focus of the regional funds is the producers in the agricultural sector (60% of total loans), BNDES loans are directed toward large-scale industrial and infrastructure projects (75% of the total loans). Moreover, unlike the operator banks of the regional funds that work only in the lagging regions, BNDES ministers to the demand for funding in all Brazilian regions and does not have an explicit mandate regarding regional policy. In Appendix A, Table A.2 compares the regional funds (FNE, FNO and FCO) loans and the BNDES loans by region for the period between 2000 and 2006.

(2007, p.54) "given the strong incentive of blame-avoidance, governments are encouraged to avoid the precise definition of goals because otherwise politicians would risk taking the blame for obvious failure". In the Brazilian case, the combined approach of micro and macro evaluation of the FNE is relevant because the FNE goal is broadly defined at the macro level (reducing regional inequalities) along with the policy tool operating at the micro level by means of subsidised loans to producers within the Northeast region. While the objectives at the firm level are not defined by federal law, some official documents[6] have highlighted that the FNE loans seek more efficient resource allocation to increase the productivity of firms and generate new jobs. In this sense, given the availability of the data, this study defined the reduction of the GDP per capita gap as the policy objective at the macro scale level and job creation and increases in productivity (proxied by wages growth) as the objectives at the firm (micro) level.

Another issue that requires explanation is that the micro-evaluation focuses only on the firms that can be traced in RAIS[7] during the period under analysis. Most of the FNE loans (approximately 60%) are granted to individuals who have small farming businesses in the informal sector – i.e., they do not have a CNPJ identifier[8] – and for this reason, they are not covered by RAIS, which is the source of information for the micro-evaluation. The formal rural firms found in RAIS are few and are not statistically representative of the FNE rural population. For this reason, the agricultural sector was excluded from the micro-evaluation in this paper. The government still needs to formulate a specific survey to cover the individuals and small rural businesses in the Northeast to evaluate this important, targeted FNE population. For the sake of comparability between the micro- and macro-evaluations, the macro-evaluation at the municipal level was restricted to assessing only the amount of FNE loans granted to the industrial and commerce/services sectors.

3. Data description

This section describes the micro and macro datasets. The micro-analysis relies on a firm-level dataset and on policy evaluation models in which treatment and control groups are used to investigate the effects of FNE on employment and wage growth. The complete description of this dataset is in section 3.1. At the macro level, the objective of the outcome evaluation is to investigate the effects of FNE on economic growth at the municipal level in the Northeast region, so it is used econometric

[6] For example, see the webpage of the Ministry for National Integration <http://www.integracao.gov.br/fundos/fundos_constitucionais/diretrizes.asp?id=diretrizes> and BANCO DO NORDESTE (2001, 2009).

[7] Annual Social Information Report (Relação Anual de Informações Sociais) of the Ministry of Labor. The RAIS data were used under a cooperation agreement between the Labor Ministry and the "Instituto de Pesquisa Econômica Aplicada" (IPEA). More details in section 3.1.

[8] "Cadastro Nacional da Pessoa Jurídica" – literally, national juridical person registration – as opposed to the CPF number for persons. CNPJ is an identification number for Brazilian companies assigned by the Brazilian Ministry of Revenue ("Ministério da Fazenda"). The CNPJ number is comprised of a base of 8 digits, a 4-digit radical and 2 check digits, such as 22.222.222/0001-05.

growth models that include the FNE loans variable along some other conditioning variables that are described in detail in section 3.2.

3.1. Micro Data

First, it is important to highlight that the micro-evaluation approach relies only on information about firms that are found in the annual censuses for firms in the formal sector (those that have the CNPJ identifier), namely RAIS. The annual RAIS is supposed to cover all Brazilian formal firms; however, as explained earlier, some of the FNE loans (approximately 60%) are granted to individuals who have small farming businesses – i.e., they do not have a CNPJ identifier and are not covered by RAIS. For this reason, the agriculture sector was excluded from this micro-evaluation. Thus, the entire micro-analysis is only carried out for those firms in the industrial and the commerce/services sectors.

Based on the information provided by the Bank of Northeast (BNB) it was possible to identify those firms included in the RAIS dataset from 2000 that had received the FNE loans[9] (the treatment group) and those that had not received the FNE loans (the control group). This matching between the BNB information and the RAIS dataset was made possible by using the CNPJ identifiers[10]. The dataset used here is basically the same as that employed by SILVA et al. (2009). These authors constructed a dataset containing several firms' characteristics in both groups (treatment and control) using the RAIS dataset and evaluated the variation in their employment and wages at the firm level between 2000 and 2003 using the propensity score technique discussed earlier. However, three improvements have been made to the method used in the current evaluation. First, three other control groups are set up, two based on samples matched to the treated group[11] and another containing all firms in RAIS, to check the robustness of the results. Second, the period of analysis was extended by collecting information about the position of those two groups of firms (the treatment and control groups) in 2006 based on RAIS2006. In this way, it is possible to capture the short-term (2000-2003) and medium-term (2000-2006) effects of the FNE loans granted in 2000. It was also collected information at the firm level for 1998, which represents a previous period in the lending year (2000). With this information from 1998, it is possible to control for unobservable characteristics of the firms

[9] The amount of money received at the firm level was not provided by the BNB. This information was only given at the municipal level and is used in the macro evaluation.

[10] It is worth noting that the construction of the dataset has followed procedures necessary to guarantee the confidentiality of information.

[11] The sample selection strategy chose value ranges for the variables of the control group based on those values observed for the treatment group in order to find a "representative" or a "matched" control sample (because it is similar to the treatment sample). The variables used in this strategy are schooling, wage, sector of activity and number of employees. For the 'perfectly' matched sample, the ranges were shrunk up to find the most similar firm. Furthermore, it is worth noting that in this 'perfect' matching the treated firm and the matched firm are located in the same municipality. For this reason, this control group has only 85 'perfectly' matched firms.

in the treatment and control groups by means of the first-differences estimation technique. These procedures enhance previous evaluations of FNE, as discussed in section 4.1.

With regard to the variables of interest – employment and wage average annual growth – it is worth noting that the former corresponds to an implicit objective of FNE (i.e., job creation), while the latter corresponds to the increase in income or value added and may represent a good proxy for measuring impacts on productivity, another implicit[12] goal of FNE. Moreover, because it is possible that productivity gains involve job losses, at least in the short term, the joint consideration of these two variables allows a more consistent evaluation of FNE.

All information is found in the RAIS datasets from 1998, 2000, 2003 and 2006. The variables are the following at the firm level: number of employees, average wage[13], average age of employees, average years of schooling of employees, dummy for the commerce/services sectors defined by the CNAE/IBGE[14] (the industrial dummy was excluded) and dummies for states where the firm is located (the dummy for the Ceará state was excluded). As explained earlier, the data are exclusively for firms in the industrial and commerce/services sectors. The loans granted to individuals[15], most working in the agricultural sector, cannot be evaluated in this micro-analysis.

The dataset is comprised of two different groups. The first group, or the treatment group, corresponds to the 85 firms that received FNE loans only in 2000 and could be traced to RAIS 2000 and the datasets for the years 1998, 2003 and 2006. This treatment group is the same as that used in the study of SILVA et al. (2009). However, the current study uses fewer firms because 17 firms in the agricultural sector were excluded and only the firms that could be traced in the years 1998, 2000, 2003 and 2006 were used; in contrast, SILVA et al. (2009) considered the 2000-2003 period alone. The second group is the control group, which is comprised of firms that did not receive FNE loans in any year analysed and was selected from industrial and commercial/services firms in the Northeast region that were in the RAIS in 2000 and whose progress could be traced through time. Estimates are carried out using four different control samples: (i) one using all firms identified in RAIS during 1998-2006 (97,452 firms); (ii) a sample matched to the treatment group (9,338 firms); (iii) a sample 'perfectly' matched to the treatment group (85 firms); and (iv) the control sample used in the SILVA et al. (2009) paper, which employed 727 firms drawn from a random and representative sample of

[12] As discussed earlier, Federal Law 7827/1989 has not precisely defined the objective of the regional funds. It only states that the regional policy aims to reduce regional inequalities through the financing of productive sectors in the Northeast, North and Central-West regions. For this reason, the paper supposes that this reduction in regional inequalities is via job creation and/or increasing wages/productivity at the micro level. As explained in footnote number 4, official reports also state that the FNE loans aim to increase the productivity of firms and generate new jobs.

[13] The average wages in all years were converted to constant prices in 2000 using a CPI index, namely IGP-M from Fundação Getúlio Vargas (FGV).

[14] National Economic Activity Classification (Classificação Nacional de Atividades Econômicas – CNAE) from the Brazilian Institute of Geography and Statistics (IBGE).

[15] It is worth noting that only persons with a CNPJ – the identifier for a juridical person – can be traced in the RAIS.

the population of the Northeast with records in RAIS. The control samples matched to the treated group (ii and iii) aims to ensure that the treatment and control groups have similar characteristics, making the two groups more comparable.

Table 3.1 shows some summary statistics of the RAIS dataset in 2000 for (a) the FNE sample and (b) the four control samples: (b.i) all firms (excluding the FNE sample); (b.ii) the sample matched to the treatment group; (b.iii) the sample 'perfectly' matched to the treatment group; and (b.iii) a random sample used in SILVA et al. (2009).

Table 3.1
Summary statistics for the dataset at firm level in the RAIS 2000

Variables	(a) FNE sample* (treatment group) (85 firms)	(b.i) Control sample - All firms in RAIS2000 (excluding the FNE sample)* (97,318 firms)	(b.ii) Control sample - Matched sample to the treated group* (9,250 firms)	(b.iii) Control sample - 'Perfectly' matched sample to the treated group* (85 firms)	(b.iv) Control sample - Random sample* (727 firms)
Average age of employees	31.3	32.8	33.0	31.4	33.5
Average schooling	4.9	5.5	4.8	4.9	5.4
Average Wage (R$ in 2000)	287.5	346.8	292.0	281.3	391.6
Sector of activity (%)					
Agriculture	0.0%	0.0%	0.0%	0.0%	0.0%
Industry	64.7%	13.5%	65.0%	64.7%	16.8%
Commerce/Services	35.3%	86.5%	35.0%	35.3%	83.2%
Size (%)					
Small firms (1-49 employee)	77.6%	92.9%	77.5%	77.6%	82.7%
Medium firms (50-99 employees)	7.1%	3.1%	11.6%	7.1%	7.4%
Large firms (>99 employees)	15.3%	4.0%	11.0%	15.3%	9.9%
Northeast states (%)					
Maranhão	9.4%	5.7%	5.5%	9.4%	5.4%
Piauí	7.1%	5.1%	5.6%	7.1%	4.7%
Ceará	16.5%	16.0%	19.3%	16.5%	19.4%
Rio Grande do Norte	5.9%	7.1%	7.7%	5.9%	7.0%
Paraíba	21.2%	7.9%	8.2%	21.2%	6.2%
Pernambuco	15.3%	19.6%	19.9%	15.3%	20.8%
Alagoas	3.5%	4.8%	4.8%	3.5%	3.9%
Sergipe	7.1%	4.8%	4.3%	7.1%	4.4%
Bahia	14.1%	29.0%	24.7%	14.1%	28.3%

Note:* Only firms that can be linked through time in the RAIS in 1998, 2000, 2003 and 2006 are selected. Own elaboration based on RAIS data in 2000.

3.2. Macro Data

To evaluate the impact of FNE on economic growth in the Northeast region in Brazil, it is employed a municipal dataset from the Brazilian National Accounts (IBGE), the Bank of the Northeast (BNB), the Brazilian Census of 2000 (IBGE), and IPEADATA. It is worth noting that this macro-evaluation is also restricted to the industrial and commerce/services sectors (as in the micro-analysis). The macro dataset provides the total amount of FNE resources at the municipal level granted to the individuals and firms in the industrial and commerce/services sectors, which represents roughly 40% of the total amount of FNE loans.

The dependent variable is the average annual growth of the per capita gross domestic product (GDP) at the municipal level over the 2002-2006 period. The GDP per capita of the municipalities has been

computed annually by the IBGE since 1999. However, due to changes in the IBGE methodology for calculating the municipal GDP in 2002, only the GDP from 2002 onwards is comparable and used here. In the results section (5.2), some robustness checks are also carried out using other sub-periods such as 2003-2006, 2002-2004 and 2004-2006. Due to the permanent creation of new municipalities during 2000-2006, there are few municipalities that did not exist in 2000. To construct a consistent dataset, it is used the boundaries of the 1,787 Northeastern municipalities in 2000 instead of those of the existing 1,793 municipalities in 2006. The solution was to assign the new municipalities to the existing municipalities in 2000. Finally, all GDP per capita variables were obtained directly at constant 2000 prices in R$.

The FNE variables come from the Bank of the Northeast (BNB), which provided information about the amount of loans for individuals and firms in the aggregate by programme at the municipal level over the 2000-2003 period. Using this information, the FNE industrial ratio was constructed, which is the amount of FNE loans to the industrial sector between 2000 and 2001 as a proportion of GDP in the industrial sector in 2002. For the sake of comparability with the micro-evaluation, the FNE industrial ratio also includes the loans to commerce/service programmes[16], which totalled 1% over the 2000-2001 period (the industrial programmes alone represented 36% of the total loans). The results section focuses on the analysis of the FNE industrial loans between 2000 and 2001; however, it also provides a robustness check using the FNE industrial ratio between 2000 and 2003, which totalled 43% of the total loans (the industrial programmes alone represented 37% of the total loans, and the programmes for the firms in the commerce/services sectors represented 6%). See Table 3.2 for the summary statistics. The FNE loans were converted to R$ at the 2000 level using a CPI index (namely, the IGP-M index from Fundação Getúlio Vargas-FGV).

Table 3.2
Summary statistics for the dataset at municipal level

Variables	Obs.	Mean	Minimum	Maximum	St. Dev.
Amount of FNE loans to the industrial sector between 2000 and 2001 as a proportion of industrial GDP in 2002*	1787	0.001	0.000	0.376	0.010
Amount of FNE loans to the industrial sector between 2000 and 2003 a proportion of industrial GDP in 2002*	1787	0.002	0.000	0.376	0.012
Average years of schooling of the working force population in 2000	1787	3.6	1.1	8.7	1.1
Infant mortality rate in 2000	1787	53.5	20.3	109.7	13.9
Housingl infrastructure index in 2000	1787	-1.2	-6.3	2.9	1.7
Gini index in 2000	1787	0.58	0.36	0.80	0.05
Transportation cost to São Paulo in 1995	1787	2523.1	1200.1	3400.3	431.9
Population density (inhab./km2) in 2000	1787	81.4	0.9	9656.2	389.3

Note: * This variable also includes the loans to commerce/services sectors and industrial GDP includes commercial/service GDP. Own elaboration based on IBGE, IPEADATA and BNB datasets.

IPEADATA provides the variables at the municipal level: (log of) average years of schooling of the population, (log of) the infant mortality rate in 2000, (log of) the Gini index in 2000, (log of)

[16] Moreover, to calculate the FNE industrial ratios, the industrial GDP also includes the GDP in the commerce and services sectors.

population density in 2000, and (log of) the transportation cost to São Paulo in 1995, which is the result of a linear program procedure for calculating the minimum transportation cost between the municipalities' majors headquarter to São Paulo. The local infrastructure index is made using the principal components analysis by DA MATA et al. (2007b) that employs the Census2000 information. It takes into account seven dimensions of public housing services and utilities: electricity, sewage, water provision, garbage collection, public lighting, pavement and addressing. This variable is supposed to capture the quantity of housing infrastructure in Brazilian municipalities. Also, the econometric models include dummies for the Northeast states (the dummy for the Ceará state was excluded). Table 3.2 provides the summary statistics for these variables.

4. Measuring Effectiveness: The Micro Approach

First, the empirical strategy for evaluating the impact of the FNE loans on firms' employment growth and wage growth is discussed. As noted earlier, the analysis of both variables is important because, at least in the short-term, productivity gains may entail job losses. The estimates are based on policy evaluation regression models that control for observable and unobservable variables. More precisely, the techniques try to solve the problem of evaluation under insufficient information about the treated. Next, the results regarding the effectiveness of the FNE loans at firm level are shown and discussed.

4.1. Method: First-Differencing (FD)

The main challenge of any policy evaluation is to deal with the selection bias introduced when random assignments are not possible. To describe this problem more precisely, it is possible to think about the FNE loans granted to firms in the Brazilian Northeast by means of the binary variable that represents participation, $D_i = \{0,1\}$ which is 1 if the firm is treated (i.e., received the loan) and 0 otherwise. The observed outcome of variable Y (for instance, employment growth between 2000 and 2003) for firm *i* would be as follows:

$$Y_i = DY_{1i} + (1-D)Y_{0i} \ , \qquad (4.1)$$

where Y_{0i} is the employment growth of a firm had it not received the FNE loan and irrespective of whether it was actually received, whereas Y_{1i} is the firm's employment growth if it receives the loan. The result of interest is the difference between Y_{1i} and Y_{0i}, which is the causal effect of the FNE loan for firm *i*. This analysis would be feasible if it was possible to go back in time and change a firm's treatment status. However, ANGRIST and PISCHKE (2009) point out that because it is never possible to observe both potential outcomes for any one firm, it must be learned about the effect of this policy by comparing the average employment growth of those who were and were not granted the FNE loans.

The comparison of the averages of those firms granted and not granted FNE loans is formalised in the following equation:

$$\underbrace{E[Y_i \mid D_i = 1] - E[Y_i \mid D_i = 0]}_{\substack{Observed_differences_in_average_\\ employment_growth}} = \underbrace{E[Y_{1i} \mid D_i = 1] - E[Y_{0i} \mid D_i = 1]}_{Average_treatment_effect_on_the_treated} + \underbrace{E[Y_{0i} \mid D_i = 1] - E[Y_{0i} \mid D_i = 0]}_{Selection_bias} \quad (4.2)$$

The term "*average treatment effect on the treated*" (ATT) represents the averages differences between the employment growth of firms that received the FNE loan, $E[Y_{1i} \mid D_i = 1]$ and what would have happened to them had not they been granted, $E[Y_{0i} \mid D_i = 1]$. Nevertheless, the *selection bias* must be considered in addition to this causal effect. This last term is the difference in the average for Y_{0i} between those firms that were $(D_i = 1)$ and those that were not $(D_i = 0)$ granted the FNE loans. The point here is that it is not possible to know what would happen if the granted firms had not received the loans, $E[Y_{0i} \mid D_i = 1]$. The selection bias may be negative or positive, causing us to underestimate or overestimate the treatment effect. For instance, one may argue that those firms seeking the loans are more motivated and entrepreneurial and that even without the FNE loans, they would perform better than others.

The random assignment of FNE loans (D_i) solves the selection problem. Formally, in the absence of the selection bias, it would have the following:

$$E[Y_{0i} \mid D_i = 1] - E[Y_{0i} \mid D_i = 0] = 0\,, \quad (4.3)$$

that is, on average, there would be no differences between the potential outcomes for the untreated and treated firms if they had not been granted. This does not mean that the FNE loans should be randomly granted, but it demonstrates that the goal of the empirical economic research is to overcome this selection bias using the appropriate policy evaluation techniques.

The benchmark estimation carried out in the next section is the difference between the means of employment growth – without controls – for those who are treated and those who are not. The regression of $Y_{growth,i}$ on $D_{i,2000}$ [17] can be used to test the significance of the treatment effect:

$$Y_{growth,i} = \alpha + \rho D_{i,2000} + \eta_i\,, \quad (4.4)$$

where $Y_{growth,i}$ is the employment growth of firm *i*, α is the constant term, ρ is the coefficient of the treatment effect and η_i is the random term. In this case, the treatment effect estimation relies on the weaker assumption that D_i is independent of Y_{0i} without placing any restriction on the relationship

[17] Hereafter, the subscript 'growth' is included in *Y* to highlight that the dependent variables are expressed in terms of average annual growth rates covering two periods (2000-2003 and 2000-2006). In addition, the subscript '2000' is included in *D* to highlight that this binary variable represents participation in the year 2000.

between D_i and Y_{1i} (WOOLDRIDGE, 2002, p.606). It is worth noting that under this assumption of there being no selection bias, it is unlikely that these estimates provide a reliable value for the impact of the policy because the firms were not selected randomly. However, these estimates are shown in the results section for the sake of comparability with other empirical strategies discussed next.

One way to improve the estimation of Equation (4.4) is to add some controls (X_i) that tend to affect – both directly and indirectly motivating participation, D_i – the variables of interest ($Y_{growth,i}$):

$$Y_{growth,i} = \alpha + \rho D_{i,2000} + X_{i,2000}'\beta + \upsilon_i \,, \tag{4.5}$$

In this case, the assumption is that there are differences among firms in the treatment and control groups in terms of their observable characteristics. For this reason, it is necessary to explicitly include all covariates (X_i) that are important for the determination of $Y_{growth,i}$ and participation, D_i. In this situation, as explained by ANGRIST and PISCHKE (2009, p.59), the residual υ_i is uncorrelated with the regressors D_i and X_i, and the regression coefficient ρ is the causal effect of interest. This is the selection-on-observables assumption for regression models (BARNOW et al., 1981), which assumes that the observable characteristics X_i are the only reason why η_i and D_i are correlated in Equation (4.4)[18]. It is worth noting that the estimates might be biased if the Equation (4.5) does not consider all variables important in determining participation that also affect the variable of interest, $Y_{growth,i}$[19].

An issue that has not been dealt in the evaluation literature of FNE is the likely bias due to unobservable characteristics. For instance, this is the case for some dimensions of motivation/ability/entrepreneurship as related to applying for or receiving the FNE loan. Here, the first-differences (FD) method is employed to eliminate the unobservable effects that are constant over time (fixed effect). At least two time periods are needed to carry out this strategy. Now, all the subscripts are included in the equation to indicate the time periods as shown below:

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[18] In other words, WOOLDRIDGE (2002, p.607) highlights that "*when D_i and (Y_{0i} , Y_{1i}) are allowed to be correlated, we need an assumption in order to identify treatment effects. ROSENBAUM and RUBIN (1983) introduced the following assumption, which they call ignorability of treatment (given observed covariates X_i): Conditional on X_i, D_i and (Y_{0i} , Y_{1i}) are independent*".

[19] An alternative to the econometric specification (4.5) strategy is to use matching or propensity score techniques. Although these matching approaches are appealing, they are accompanied by the same explicit statement of the conditional independence assumption required to provide a causal interpretation of regression coefficients, and for this reason, we can say that matching and regression are both control strategies (ANGRIST & PISCHKE, 2009, p.69). ANGRIST & PISCHKE (2009, p.69) argue that "*since the core assumption underlying causal inference is the same for the two strategies , it's worth asking whether or to what extent matching really differs from regression. Our view is that regression can be motivated as a particular sort of weighted matching estimator, and therefore the differences between regression and matching estimates are unlike to be of major empirical importance*".

$$Y_{growth,i,2003-2000} = \alpha + \rho D_{i,2000} + X_{i,2000}'\beta + A_i'\gamma + \upsilon_{i,2000}, \quad (4.6)$$

More precisely, $Y_{growth,i,2003-2000}$ is the average annual growth of employment of firm *i* between 2000 and 2003[20], α is the constant term, $D_{i,2000}$ is the dummy variable indicating if the firm received a loan in 2000, $X_{i,2000}$ is a vector of observed time-varying covariates in 2000, and $\upsilon_{i,2000}$ is the random term. More important is the vector of unobserved but fixed covariates, A_i, which will be ruled out with the first-difference strategy.

As described in the micro dataset section, it was collected information at the firm level for a previous period represented by the subscript 1998:

$$Y_{growth,i,2000-1998} = \alpha + \rho D_{i,1998} + X_{i,1998}'\beta + A_i'\gamma + \upsilon_{i,1998}, \quad (4.7)$$

where, $Y_{growth,i,2000-1998}$ is the average annual growth of employment of firm *i* between 1998 and 2000, $D_{i,1998}$ is the dummy variable (which is now zero for all firms in 1998), and $X_{i,1998}$ is a vector of observed time-varying covariates in 1998.

Subtracting (4.7) from (4.6) yields the following:

$$Y_{growth,i,2003-2000} - Y_{growth,i,2000-1998} = \alpha + \rho(D_{i,2000} - D_{i,1998}) + (X_{i,2000} - X_{i,1998})'\beta + (\upsilon_{i,2000} - \upsilon_{i,1998}) \quad (4.8)$$

Note that in the first-difference regression model, the unobserved fixed effect, A_i, is eliminated by subtracting the observation for the previous time period from the observation for the current time period. Then, equation (4.8) can be estimated by OLS, and the coefficient of the dummy variable, ρ, means the average impact on the differences for the variable of interest.

The first-difference approach is not pursued at the macro (municipal) level because the information on the covariates is only available for 2000 and the municipal GDP is only comparable from 2002 onwards due to an alteration in the IBGE methodology in 2002. For the macro level evaluation discussed in section 5, the IV approach is followed.

4.2. Results: The Micro Approach

In this section, the results of the micro-evaluation are discussed. It is worth noting once again that this approach measures the effectiveness of FNE loans only to firms in the industrial and commerce/services sectors, seeking to answer the question of whether the regional fund creates jobs and/or increases productivity (proxied by wage growth). As noted earlier, the joint consideration of

[20] In the results section, I also show the results using employment (and wage) growth between 2000 and 2006. The average annual employment (and wage) growth rates are calculated as follows: $Y_{growth,i}$ = ((yt,i / y0,i)^(1/T))-1 , where yt,i and y0,i, are, respectively, the final period and the initial period of employment stock (average wage) for firm i and T is the time period in years.

these two variables – employment and wages growth – in the analysis is important because they correspond to implicit objectives of FNE and because, at least in the short term, productivity gains may involve job losses.

Table 4.1 shows the results of the FNE impact using three different control samples and covering two periods (2000-2003 and 2000-2006). Also, heteroskedasticity-robust standard errors are indicated in parenthesis for all estimates because the diagnostics for this problem are statistically significant.

The most important results of this table are shown in the second and the third part, which employ, respectively, a sample matched to the treated group and a sample 'perfectly' matched to the treated group. These are better samples than the others for carrying out the micro-evaluation estimates because they ensure that the treatment and control groups have similar characteristics, making the two groups more comparable as shown earlier in the summary statistics in Table 3.1. For the sample matched to the treated group, the first results (ii. OLS without covariates) are obtained using Eq. (4.4), which does not control for observable and unobservable characteristics. With this assumption in mind, the results show a statistically positive significant impact (at 7% level) of FNE on employment growth between 2000 and 2003. If controls for observable characteristics are added – which means estimating the FNE impact using Eq. (4.5) – the results in Table 4.1 (ii. OLS with covariates) also show that there is only a positive impact (statistically significant at 6% level) of FNE on employment growth over the 2000-2003 period. More precisely, average annual employment growth is 5.41 percentage points higher for the financed firms than for the non-financed firms between 2000 and 2003. On the other hand, it is not possible to verify any impact of FNE on average annual wage growth in the two periods.

However, the most important estimation is the one (ii. first difference with covariates, FD) that controls for observable and unobservable (constant over time) characteristics using Eq. (4.8). When the first differences are estimated, a positive impact of FNE on employment growth is observed for the period between 2000 and 2003 (it is statistically significant at 8% level). This result suggests that average annual employment growth among those firms that received the FNE loans was about 9 percentage points higher than average annual employment growth for those firms that were not granted them. Furthermore, the results are robust to alterations in the conditioning set of the variables, and the significance level ranges from 5% to 10%, depending on the set of variables included in the estimation (in the Appendix B, Table B.1 shows the complete results for these FD estimations). Moreover, if the 'perfectly' matched sample is used (part iii, in Table 4.1) the impact of FNE on employment growth between 2000 and 2003 is even larger. For instance, the first difference estimation shows that average annual employment growth is 15.9 percentage points higher for the

financed firms than for the non-financed. These results in (ii) and (iii) using matched samples are in line with those of previous studies discussed in the literature review section (SILVA et al., 2009 ; SOARES et al., 2009).

Table 4.1
Micro approach of FNE impact on employment and wage average annual growth using four control samples

	Employment growth between 2000-2003	Wages growth between 2000-2003	Employment growth between 2000-2006	Wages growth between 2000-2006
i. All firms				
OLS without covariates	0.0176	-0.0056	-0.0051	-0.0033
	(0.0280)	(0.0057)	(0.0180)	(0.0045)
OLS with covariates	0.0232	-0.0094*	0.0018	-0.0049
	(0.0282)	(0.0050)	(0.0180)	(0.0038)
First Difference with covariates (FD)	-0.0194	0.0021	-0.0419	0.0043
	(0.0484)	(0.0097)	(0.0425)	(0.0091)
Observations	97,403	97,403	97,403	97,403
ii. Matched sample to the treated group				
OLS without covariates	0.0512*	-0.0057	0.0222	0.0008
	(0.0281)	(0.0057)	(0.0181)	(0.0046)
OLS with covariates	0.0541*	-0.0079	0.0236	-0.0019
	(0.0285)	(0.0048)	(0.0184)	(0.0036)
First Difference with covariates (FD)	0.0905*	0.0027	0.0621	0.0093
	(0.0519)	(0.0098)	(0.0454)	(0.0093)
Observations	9,335	9,335	9,335	9,335
iii. 'Perfectly' matched sample to the treated group				
OLS without covariates	0.0951***	-0.0035	0.0288	0.0076
	(0.0355)	(0.0104)	(0.0236)	(0.0138)
OLS with covariates	0.0959***	-0.0035	0.0277	0.0087
	(0.0363)	(0.0101)	(0.0242)	(0.0143)
First Difference with covariates (FD)	0.1593*	0.0224	0.0970	0.0356*
	(0.0942)	(0.0177)	(0.0876)	(0.0214)
Observations	170	170	170	170
iv. Random sample				
OLS without covariates	0.0414	-0.0032	0.0102	-0.0003
	(0.0289)	(0.0065)	(0.0187)	(0.0053)
OLS with covariates	0.0449	-0.0053	0.0162	-0.0049
	(0.0324)	(0.0068)	(0.0206)	(0.0048)
First Difference with covariates (FD)	0.0370	0.0061	0.0003	0.0036
	(0.0513)	(0.0455)	(0.0115)	(0.0110)
Observations	812	812	812	812

Note: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. OLS Dependent variable: Employment growth (or wages growth)= (((yt,i / y0,i)^(1/T))-1) , where yt,i and y0,i, are, respectively, the final period and the initial period of employment stock (average wage) for firm i and T is the time period in years. OLS estimations with covariates include: average age of the employees in 2000, average years of schooling of the employees in 2000, dummy for the commerce/services sector, average wage in 2000, number of employees in 2000, dummies for Northeast states. FD Dependent variable= [(Employment growth between 2000-2003) - (Employment growth between 2000-1998)]. FD estimations with covariates include: diff. average age of the employees (2000-1998), diff. average years of schooling of the employees (2000-1998), diff. average wage (2000-1998), diff. number of employees (2000-1998).

The first (i) and the fourth (iv) part of table 4.1 show, respectively, the results using the control sample with all firms identified in RAIS during the period under analysis and the control sample used in the paper of SILVA et al. (2009), which employed 727 firms drawn from a random and representative sample of the population of the Northeast with records in RAIS. Actually, this last dataset is different from that of the one used in SILVA et al. (2009); the few firms in the agricultural

sector and those not present in the RAIS dataset during the years 1998 and 2006 were excluded (see section 3.1 for details). The results in parts (i) and (iv) of Table 4.1 demonstrate that the evaluation of FNE impact depends on the choice of control sample. As can be observed, there are no statistically significant effects when the FD estimates are carried out using samples (i) and (iv). The results in Table 4.1 suggest that the control sample should be analysed with caution.

Altogether, the results that are presented in this section suggest – using a method that controls for observable characteristics and unobserved fixed effects – that the FNE loans granted in 2000 played a role in attracting and stimulating employment growth during the following three years. However, even the FNE's being effective – i.e., creating jobs – does not mean that the FNE loans have been able to eliminate – or even to reduce – Brazilian regional inequalities. Indeed, the observed employment growth might still be too limited to have any significant impact on GDP per capita or on other socioeconomic variables. The macro-evaluation presented in the next section aims to investigate this issue.

5. Assessing the Impact of FNE on Regional Inequalities: The Macro Approach

In this section, the evaluation of the impact of FNE on regional inequalities in Brazil is detailed; testing whether FNE loans foster GDP per capita growth at a municipal level. First, this section discusses the empirical model where the instrumental variable approach is used to assess the macro impact of FNE on GDP per capita growth for the targeted municipalities. Then, the results are analysed using some robustness checks with different periods, controlling variables, and spatial scales.

5.1. Method: Instrumental Variables (IV)

Many papers that examine the impact of regional funds on regional economic growth – for instance, the studies about the EU structural funds, such as RODRIGUEZ-POSE and FRATESI (2004), DALL'ERBA and LE GALLO (2008), and ESPOSTI and BUSSOLETTI (2008) – are based on the neoclassical growth model described in BARRO and SALA-I-MARTIN (1991, 1992). Because the primary purpose of this outcome evaluation (at the macro level) is to investigate the effects of the regional fund on economic growth in the Northeast region, the so-called Barro-regression is used, which includes the FNE loans variable as showed in Eq. (5.1) which is estimated by means the Ordinary Least Squares (OLS) method:

$$g = \alpha + \beta_1 y_0 + \beta_2 FNE + \mathrm{X}\beta_3 + \varepsilon \qquad (5.1)$$

where g is the average annual GDP per capita growth rate for each municipality[21], y_0 is the (log of) initial GDP per capita, *FNE* represents the FNE industrial loans as a proportion of industrial GDP in 2002, and the X matrix ($N \times K$) represents other municipal characteristics that are important to economic growth dynamics; the omission of relevant variables is avoided; and to minimise the problem of endogeneity, values for all explanatory variables (X) are included at the start of the sampling period. Finally, α is the ($N \times 1$) constant vector, and ε is the $N \times 1$ vector of errors. A negative correlation between the growth rate and the initial GDP per capita (β_1<0) suggests either mean reversion or conditional β-convergence. Most importantly, if β_2 is positive and statistically significant, then FNE has a positive impact on economic growth, increasing the transitional growth rate of each municipality towards its own steady state.

However, the problem of endogeneity remains in the estimation of the FNE impact because the regional fund loans are not allocated randomly but are instead concentrated in the wealthiest areas of the Northeast region. OLIVEIRA and DOMINGUES (2005) suggest that the regional funds are driven by the demand side – that is, they are requested by producers that fulfil the fund's requirements. Thus, it is likely that only the most developed activities, located in municipalities with good access to information and banking infrastructure, have access to these funds. In this sense, the FNE variable potentially introduces a very serious problem of endogeneity into the model and thus introduces bias into the OLS estimates.

Specifically, the problem of endogeneity stems from the simultaneity of FNE loans and economic growth in an SEM (*Simultaneous Equation Model*) framework. Alternatively, it is possible to think in the language of omitted variable bias (OVB), noting that firms or persons located in some municipalities have more motivation or ability to obtain a FNE loan and that this characteristic is unobservable. This makes the FNE variable and the error term correlated. The trick for solving the endogeneity problem is to find a variable (the instrument) that is correlated with the causal variable of interest (in this case, FNE variable) but uncorrelated with any other determinants of the dependent variable; or, equivalently, the instrumental variable is uncorrelated with error term ε (ANGRIST and PISCHKE, 2009). More precisely, the relevant question that the IV technique helps to answer is whether the Northeast municipalities have grown faster than they would have in the absence of the FNE loans.

The two-stage least squares (2SLS) estimation is the workhorse of the IV approach. To implement this technique, the following first-stage equation is estimated by means of the OLS method:

$$FNE = \alpha + \mathrm{X}\pi_1 + \pi_2 z + \upsilon \quad , \qquad (5.2)$$

[21] $g = (1/T)*ln(y_{T,i}/y_{0,i})$, where $y_{T,i}$ and $y_{0,i}$, are, respectively, the final period and the initial period of per capita GDP and where T is the time period in years.

where X is the matrix of the covariates (including y_0) that appear in Eq. (5.1), z is the instrumental variable, α is the constant vector and υ is the error term. Then, Eq. (5.1) is estimated using the fitted values of the FNE variable, $\hat{FNE}$, which is a linear function of the instrument and therefore by assumption uncorrelated with error ε. The idea is to use only the 'good variation' in the FNE variable (or at least some of it) – that is, some part of the FNE variable that is not correlated with the unobserved effects in the error term, ε.

As pointed out by TEMPLE (1999) there is a lack of good instruments because so many variables can be used to explain growth that it is difficult to find variables that are highly correlated with the endogenous variables that can be excluded from the growth regression. In the next section, it is shown the results using the number of loans granted to firms in the industrial sector[22] in 1999 as the instrument because this variable is correlated with the FNE industrial ratio in the 2000-2001 period but uncorrelated with any other determinants of the dependent variable. The intuition is that the number of loans granted in 1999 (or in other words, the number of FNE operations in time t-1) may represent the stock of local ability or knowledge for obtaining FNE loans and, consequently, the likelihood of success of applications for the loans in subsequent years by the firms located in a specific municipality. For this reason this variable is supposed to be correlated with the FNE industrial ratio in time t. Furthermore, the empirical issues regarding power and balancing properties of this instrument will be investigated in detail in the next section when the validity of it is assessed.

5.2. Results: The Macro Approach

As discussed above, the goal of the macro-evaluation is to test if the total amount of the FNE loans to firms in the industrial and commerce/services sectors as a proportion of GDP fosters GDP per capita growth at the municipal level in the Northeast region to reduce the regional inequalities in Brazil.

Table 5.1 shows the results regarding FNE impact on GDP per capita growth during different time periods. Heteroskedasticity-robust standard errors are provided in parenthesis for all estimates because the diagnostics for this problem are statistically significant. The results are shown for four different time periods for the dependent variable: GDP per capita growth between 2002 and 2006, between 2003 and 2006, between 2002 and 2004 and between 2004 and 2006. As explained earlier, the municipal GDP is only comparable from 2002 onwards due to an alteration in the IBGE methodology in 2002. The results using OLS and 2SLS, both with and without covariates, are shown. The first step is to estimate Eq. (5.1) via OLS, paying attention to the FNE industrial coefficients.

[22] It includes firms in the commerce and services sectors.

With regard to the impact of FNE industrial ratio in 2000-2001 on the GDP per capita growth between 2002 and 2006, the OLS estimates (a.1) and (a.2) in Table 5.1 show a negative and statistically significant impact. Municipalities with high FNE industrial ratios in the 2000-2001 period experience slower growth between 2002 and 2006. These results hold with or without conditioning variables (a.2 or a.1, respectively). However, it is important to note that the endogeneity problem discussed earlier may be biasing these FNE macro impact estimates.

Table 5.1
Macro approach of FNE impact on GDP per capita growth over different time periods

	GDP pc growth between 2002-2006	GDP pc growth between 2003-2006	GDP pc growth between 2002-2004	GDP pc growth between 2004-2006
a. FNE industrial ratio between 2000 and 2001				
a.1. OLS without covariates	-0.1695**	-0.1014	-0.3093***	-0.0297
	(0.0671)	(0.0649)	(0.0820)	(0.1047)
a.2. OLS with covariates	-0.1490***	-0.0809	-0.3166***	0.0186
	(0.0510)	(0.0543)	(0.0691)	(0.0948)
a.3. 2SLS without covariates	-6.7122	3.4879	-15.1921*	1.7678
	(5.2132)	(4.6772)	(8.3922)	(5.9426)
First-stage equation:	0.0003**	0.0003**	0.0003**	0.0003**
Instrument (number of loans granted in 1999)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
a.4. 2SLS with covariates	6.5532	17.7597	-6.1412	19.2476
	(8.1137)	(11.1850)	(10.4767)	(14.0910)
First-stage equation:	0.0002*	0.0002*	0.0002*	0.0002*
Instrument (number of loans granted in 1999)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Observations	1787	1787	1787	1787
b. FNE industrial ratio between 2000 and 2003				
b.1. OLS without covariates	-0.1270**	-0.1305*	-0.1122	-0.1418
	(0.0558)	(0.0766)	(0.1260)	(0.1579)
b.2. OLS with covariates	-0.0290	-0.0300	-0.0591	0.0010
	(0.0864)	(0.0712)	(0.1718)	(0.1166)
b.3. 2SLS without covariates	-2.0323	1.0560	-4.5999**	0.5352
	(1.3803)	(1.4035)	(1.9730)	(1.8022)
First-stage equations:	0.0009***	0.0009***	0.0009***	0.0009***
Instrument (number of loans granted in 1999)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
b.4. 2SLS with covariates	3.8724	10.4807	-3.6290	11.3738
	(5.2372)	(7.8534)	(6.2065)	(9.7993)
First-stage equations:	0.0004	0.0004	0.0004	0.0004
Instrument (number of loans granted in 1999)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Observations	1787	1787	1787	1787

Note: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Dependent variable = (1/T)*ln(yT,i/y0,i), where yT,i and y0,i, are, respectively, the final period and the initial period of per capita GDP and T is the time period in years. The estimations with covariates include: ln(GDP per capita in 2002), ln(average years of schooling in 2000), ln(Gini index in 2000), ln(infant mortality rate in 2000), housing infra-structure index in 2000, ln(population density in 2000), ln(transportation cost to SP in 1995), and dummies for Northeast states.

An instrumental variable is used in the 2SLS estimations (a.3 and a.4) to overcome the endogeneity problem. DALL'ERBA and LE GALLO (2008) also deal with this problem – in the context of EU structural funds – using the IV technique and highlight that the endogeneity of the allocation of regional funds has been overlooked in the literature. Here, only one instrument is used. This is done avoid the over-identification problem; the inclusion of many weak instruments increases bias. The instrument used is the total number of loans at the municipal level granted to firms in the industrial

sector in 1999. This variable is used in the first-stage equation [Eq. (5.2)] and is supposed to have a clear effect on the FNE industrial ratio, but it should not have an effect on the GDP per capita growth other than through the first-stage channel. The results of the first-stage equation in (a.3) and (a.4) show that the instrument is able to explain the FNE industrial ratio because the instrument coefficient is statistically significant, showing that municipalities with a high number of FNE operations in 1999 will have high FNE industrial ratios in the 2000-2001 period. For this reason, the IV estimator may be used. However, another assumption behind the IV strategy is that FNE industrial ratios are uncorrelated with unobserved municipal characteristics that may influence GDP per capita growth rates. Although this assumption is ultimately un-testable, it is possible to offer some evidence in support of it by demonstrating that the instrument is not strongly correlated with observable municipal characteristics not included in (Eq. 5.1). In doing so, the methodology used in CULLEN et al. (2005) is employed to perform balancing tests for the instrument. The results from balancing tests are in Table B.3 in Appendix B, which show that this instrument is essentially uncorrelated with the proxies for unobservable municipal characteristics.

The 2SLS estimate of FNE industrial coefficients (without covariates) remains negative but now is statistically insignificant (a.3). Moreover, when conditioning variables are added in the model (a.4), the coefficient becomes positive but is still statistically insignificant. This result is robust to alterations in the conditioning set of the controlling variables[23] and is reported in Table B.2 in Appendix B. The most important element of this result is that the FNE industrial ratio does not have any negative effect on the GDP per capita growth as suggested by the OLS estimates. This result shows a more plausible conclusion regarding the micro- and macro-effects of the FNE loans to the industrial sector. In fact, the positive and statistically significant impact of the FNE industrial on job creation verified in the micro evaluation might still be too limited to have any significant impact on the GDP per capita growth at the municipal level and thus reduce the regional imbalances in Brazil.

Another possible explanation for this lack of effect at the municipal level may be the delayed effect of FNE industrial loans on the GDP per capita growth, so that their impact does not appear in the time period analysed (2002-2006). To overcome this issue, at least partially, the same models using other time periods are estimated, trying to find any different significant impact. The GDP per capita growth of the time periods of 2003-2006, 2002-2004 and 2004-2006 was used in those regressions as the dependent variable. In addition, estimations of the FNE industrial ratio between 2000 and 2003 were carried out using GDP per capita growth as the dependent variable for those four different time periods (part b in Table 5.1). Again, the estimates obtained with these regressions do not indicate any significant impact when conditioning variables are added in the model (b.4).

[23] See BROCK et al. (2003), who review the model uncertainty literature.

Finally, the results may change if another spatial scale is used. This fact is linked to a measurement issue that can cause variability in the estimated coefficients due to the use of different levels of spatial aggregation of the observational units. This variability could occur because of the existence of the Modifiable Areal Unit Problem (MAUP) (GEHLKE and BIEHL, 1934; ROBINSON, 1950; OPENSHAW and TAYLOR, 1979). For this reason, a cautious analysis of FNE impact on economic growth on different spatial scales may allow one to identify the appropriate spatial scale for evaluating this regional policy. The macro dataset is available at the municipal level and is merged to form other two spatial scales: 189 micro-regions and 22 spatial clusters in the Northeast region. The micro-regions were defined by IBGE in 1990 as being a group of contiguous municipalities in the same state. They were grouped according to natural and production characteristics. The spatial cluster level proposed by CARVALHO et al. (2007) employs a cluster methodology (algorithmic) that groups contiguous municipalities that share similar characteristics using 46 variables reported in the Brazilian Census of 2000. With regard to the results at both spatial levels (micro-regions and spatial cluster), the conclusions are similar to those at the municipal level[24]. Altogether, the results at various spatial scale levels suggest that there are no statistically significant positive effects of FNE industrial loans on economic growth.

6. Conclusions

One contribution of this paper is that it brings together two types of outcome evaluation that are often implemented separately in the evaluation literature, showing a more complete picture of the FNE loans directed toward firms in the industrial/commerce/services sectors (coined as FNE industrial). These micro- and macro-effects have been overlooked in the literature dealing with the impact of regional development funds.

The micro-evaluation seeks to answer the following question: Did the subsidised FNE loans 'cause' an increase in employment (and productivity) in the target firms? The results based on control samples matched to the treated group – using the first-differences method that controls for observable characteristics and unobserved fixed effects – suggest that the FNE industrial loans play a role in attracting and stimulating employment growth in the Northeast region between 2000 and 2003. However, these effects on employment growth wane and disappear over a long period: 2000-2006. Moreover, it is impossible to verify any impact of FNE industrial loans on firm productivity (proxied by wage growth) in the estimates that control for observable and unobservable characteristics.

As discussed in the paper, the positive effects on job creation at the firm level do not mean that the FNE loans have been able to eliminate – or even to reduce – Brazilian regional inequalities. For this

[24] To save space, these results are not reported; they will be provided upon request.

reason, a second outcome evaluation was carried out to attempt to answer the following question: Have regional inequalities been reduced as a result of the FNE loans? The empirical strategy was performed to test whether FNE loans foster GDP per capita growth at the municipal level in the Northeast region. The instrumental variable approach was implemented because of the potential endogeneity of the FNE industrial variable given that FNE loans are not allocated randomly. The IV results do not indicate any positive impact of FNE industrial ratios on economic growth between 2002 and 2006 or in other sub-periods. This conclusion is robust to combinations of the set of controlling variables and to the use of different levels of spatial aggregation of the observational units.

Altogether, the micro- and macro-evaluation results suggest that the effect of FNE industrial loans on employment growth at the firm (micro) level might still be too limited for it to have any significant impact on GDP per capita growth at the municipal (macro) level in the Northeast region and thus to reduce the regional inequalities in Brazil. It is worth noting that the Brazilian regional funds have the broad objective of reducing regional inequalities as defined by federal law but that no variable or measure of inequality was well defined when the policy was implemented. This study assumed that the reduction of the GDP per capita gap is the policy objective at the macro-scale level and that job creation and increasing productivity (proxied by wage growth) are the objectives at the firm (micro) level. The outcome evaluation may be hampered by this lack of a precisely defined objective; it is always hard to define a measure for policy evaluation if it does not actually exist.

Finally, despite some recent changes in Brazilian regional policy – namely, the adoption of the National Regional Development Policy (PNDR) implemented by the Ministry of National Integration (MI) through Decree n. 6047 of 2007[25] – it is still necessary to define a relevant system for appraisal, monitoring and outcome evaluation covering all designed interventions at both the firm/individual and macro levels. Furthermore, it is important to demonstrate to public administrators and legislators the benefits and costs of more rigorous outcome evaluations. As noted by BARTIK and BINGHAM (1995), it is difficult to convince someone to do something (in this case, outcome evaluation) that has not been done before. In addition, those authors argue that once policymakers have seen that a high-quality evaluation of the regional development funds can help improve policy performance and political viability, the interest in outcome evaluations should increase.

[25] Available at <http://www.planalto.gov.br/ccivil_03/_Ato2007-2010/2007/Decreto/D6047.htm>.

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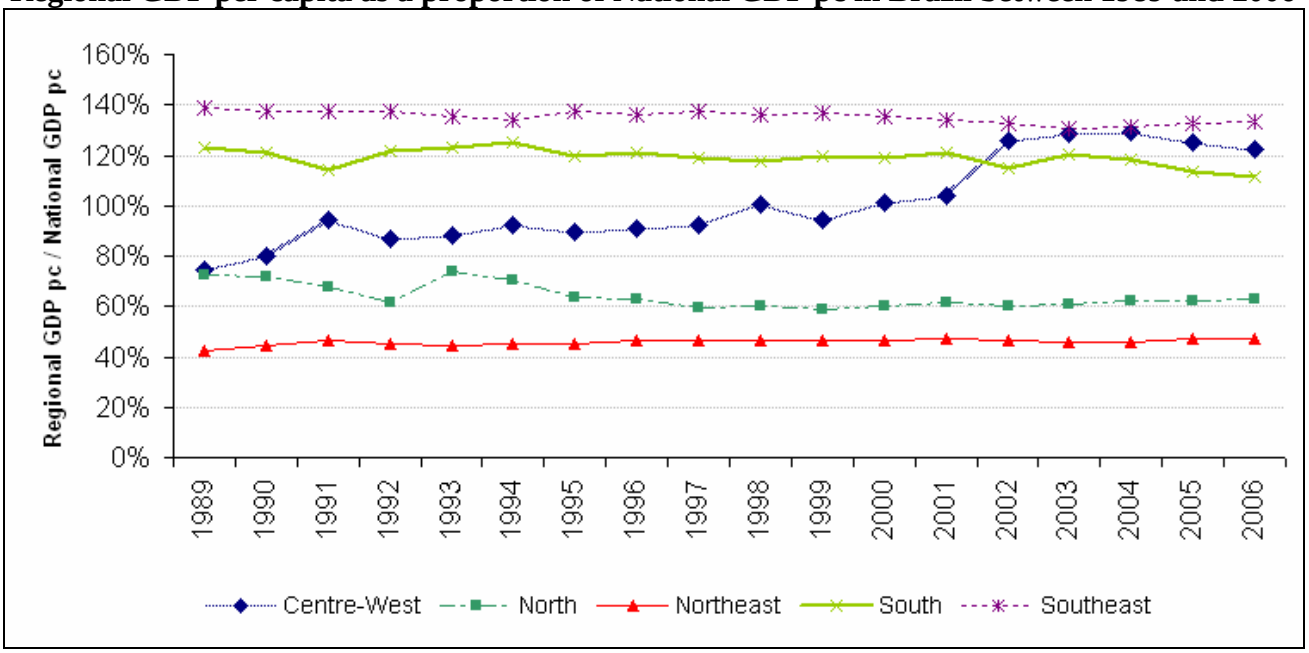
Appendix A

Table A.1
Regional GDP per capita as a proportion of National GDP pc in Brazil between 1989 and 2006



Source: Own elaboration based on IBGE data.

Table A.2
Regional Funds (FNE, FNO, FCO) and BNDES loans by region (2000-2006)

(R$ million_current prices)

Region	Source of loans	2000	2001	2002	2003	2004	2005	2006	Total
Northeast	BNDES	2,783	3,334	3,784	3,112	2,737	3,803	4,836	**24,390**
	FNE	569	302	254	1,019	3,209	4,174	4,588	**14,115**
	BNDES/FNE	4.9	11.0	14.9	3.1	0.9	0.9	1.1	**1.7**
North	BNDES	930	860	1,881	712	1,954	1,616	1,626	**9,579**
	FNO	697	454	605	1,075	1,321	976	986	**6,114**
	BNDES/FNO	1.3	1.9	3.1	0.7	1.5	1.7	1.6	**1.6**
Centre-West	BNDES	2,064	1,703	2,589	2,831	5,161	3,271	3,659	**21,278**
	FCO	292	979	1,439	920	1,172	1,468	1,444	**7,714**
	BNDES/FCO	7.1	1.7	1.8	3.1	4.4	2.2	2.5	**2.8**
Southeast	BNDES	13,008	14,494	23,074	20,036	21,299	28,740	31,415	**152,065**
South	BNDES	4,261	4,826	6,092	6,842	8,683	9,551	9,783	**50,036**
Total	BNDES all regions	**23,046**	**25,217**	**37,419**	**33,534**	**39,834**	**46,980**	**51,318**	**257,347**
	BNDES NE+NO+CO regions (A)	**5,777**	**5,897**	**8,254**	**6,656**	**9,852**	**8,689**	**10,121**	**55,246**
	FNE+FNO+FCO (B)	**1,558**	**1,735**	**2,298**	**3,014**	**5,702**	**6,618**	**7,018**	**27,943**
	(A) / (B)	**3.7**	**3.4**	**3.6**	**2.2**	**1.7**	**1.3**	**1.4**	**2.0**

Source: Own elaboration based on BNDES and Ministry for National Integration (MI) data.

Appendix B

Table B.1
Micro approach of FNE impact on average annual growth of employment using the matched sample to the treatment group (Method: First Differences)

Dependent variable= [(Employment growth between 2000 and 2003) - (Employment growth between 2000 and 1998)]	(1)	(2)	(3)	(4)
FNE industrial dummy in 2000	0.0960**	0.0946*	0.0843*	0.0905*
	(0.0479)	(0.0495)	(0.0505)	(0.0519)
Diff. average age of employees (2000-1998)		0.0172***	0.0183***	0.0151***
		(0.0031)	(0.0031)	(0.0030)
Diff. average years of schooling of employees (2000-1998)			0.0913***	0.0782***
			(0.0126)	(0.0123)
Diff. average wage (2000-1998)				0.0006***
				(0.0001)
Constant	-0.1780***	-0.1915***	-0.2105***	-0.1714***
	(0.0067)	(0.0074)	(0.0084)	(0.0101)
Observations (Firms)	9335	9335	9335	9335
R-squared	0.00	0.01	0.03	0.05

Note: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. The FNE industrial dummy also includes firms in the commerce/services sectors based on CNAE/IBGE.

Table B.2
Macro approach of FNE impact on average annual growth of the per capita GDP between 2002 and 2006 (Method: Two-Stage Least Squares)

	Dependent variable= GDP per capita growth between 2002 and 2006								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FNE industrial ratio between 2000 and 2001	-6.7122	1.1680	-0.9438	3.5680	4.2269	5.1598	9.2257	9.1943	6.5532
	(5.2132)	(7.0762)	(5.9635)	(7.8142)	(8.8777)	(10.4766)	(9.8469)	(9.4429)	(8.1137)
ln(GDP per capita in 2002)		-0.0210**	-0.0208**	-0.0264**	-0.0265**	-0.0254**	-0.0293**	-0.0294**	-0.0264**
		(0.0092)	(0.0088)	(0.0113)	(0.0119)	(0.0114)	(0.0118)	(0.0121)	(0.0114)
ln(average years of schooling in 2000)			0.0061	0.0089	0.0166	0.0254	0.0346	0.0347	0.0206
			(0.0052)	(0.0069)	(0.0149)	(0.0273)	(0.0302)	(0.0313)	(0.0267)
ln(Gini index in 2000)				-0.0468**	-0.0509*	-0.0567	-0.0676	-0.0678	-0.0527
				(0.0221)	(0.0282)	(0.0377)	(0.0453)	(0.0473)	(0.0506)
ln(infant mortality rate in 2000)					0.0190	0.0212	0.0305	0.0307	0.0222
					(0.0233)	(0.0286)	(0.0339)	(0.0363)	(0.0315)
Housing infrastructure index in 2000						-0.0024	-0.0026	-0.0026	-0.0007
						(0.0033)	(0.0043)	(0.0044)	(0.0054)
ln(population density in 2000)							-0.0021	-0.0021	-0.0007
							(0.0027)	(0.0029)	(0.0027)
ln(transportation cost to SP in 1995)								-0.0013	-0.0415
								(0.0205)	(0.0959)
Constant	0.0353***	0.0411***	0.0361***	0.0073	-0.0781	-0.1032	-0.1492	-0.1398	0.2283
	(0.0045)	(0.0018)	(0.0048)	(0.0173)	(0.1217)	(0.1659)	(0.2010)	(0.1029)	(0.5798)
Regional dummies	No	No	No	No	No	No	No	No	Yes
Observations (Municipalities)	1787	1787	1787	1787	1787	1787	1787	1787	1787
First-stage equations:									
Instrument (number of loans granted in 1999)	0.0003**	0.0002	0.0002*	0.0002	0.0002	0.0001	0.0002	0.0002*	0.0002*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)

Note: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Dependent variable = (1/4)*ln[GDPpercapita_in_2006/GDPpercapita_in_2002]. The FNE industrial ratio variable also includes the loans to commerce/services sectors and industrial GDP includes commercial/service GDP

Table B.3
Relationship between the instrument and proxies for unobservable municipal characteristics

Share of employment in the primary sector in 2000	W*Share of employment in the primary sector in 2000	Share of employment in the secondary sector in 2000	W*Share of employment in the secondary sector in 2000	Share of employment in the tertiary sector in 2000	W*Share of employment in the tertiary sector in 2000	Urbani-sation rate in 2000	W*Urbani-sation rate in 2000	Number of bank branches per capita in 2000	W*Number of bank branches per capita in 2000
-0.1593	0.1234	0.1718	0.7677	0.1869	-0.4670*	0.0016	-0.0010	234.9955	-2308.324**
(0.1168)	(0.2041)	(0.2276)	(0.6725)	(0.1677)	(0.2426)	(0.0010)	(0.0020)	(298.34)	(994.4005)

Note: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. The variables that are used to test the properties of the instrument include shares of employment in the primary, secondary and tertiary sectors, urbanisation rate, number of bank branches per capita and the spatial lags of the these variables. Regression coefficients obtained from separate regressions of listed variable on the total number of loans at the municipal level granted to firms in the industrial/commerce/services sectors in 1999. The spatial weight matrix W is based on the 10-nearest neighbours. Controls include: ln(GDP per capita in 2002), ln(average years of schooling in 2000), ln(Gini index in 2000), ln(infant mortality rate in 2000), housing infra-structure index in 2000, ln(population density in 2000), ln(transportation cost to SP in 1995), and dummies for Northeast states. Number of observations in each regression: 1,787.