

Revista

Cadernos de

Finanças Públicas

2024

Edição Especial



28° PRÊMIO TESOIRO
DE FINANÇAS PÚBLICAS 2023



TESOURO NACIONAL

ANALYSIS OF SUDENE'S TAX INCENTIVES AND THEIR IMPACT ON THE LABOR MARKET IN THE NORTHEAST OF BRAZIL

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ABSTRACT

Tax incentive policies aim to attract companies to establish themselves in regions with lower economic dynamism. In the Northeast Region, federal incentives are managed by Sudene, with the most comprehensive being a 75% reduction in IRPJ (Corporate Income Tax). Despite this approach involving the relinquishment of millions of reais in revenue, there is a scarcity of studies that seek to evaluate it. Thus, this article conducts an impact assessment of this policy on the quantity of employment in the benefiting firms between 2011 and 2019. To do so, the DiD (Differences in Differences) method proposed by Callaway and Sant'Anna (2021) was used, based on microdata from RAIS (Annual Report of Social Information) and the list of companies with tax incentives administered by Sudene. The results are consistent with the hypothesis that the tax incentive increases the quantity of formal employment, showing an increase of approximately 9.8%. This suggests that the policy was effective in boosting employment in the region.

Keywords: Tax Incentives, Sudene, Northeast Region, Economic Development, Labor Market.

JEL: R12, R28, R5

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1. INTRODUCTION

The economic and social disparities between regions are striking features of Brazilian territory. In this sense, a combination of political and economic factors has led to the concentration of productive activity in the center-south axis, to the detriment of the country's northernmost regions. The Northeast region is a clear example of this disparity, as according to data from the Brazilian Institute of Geography and Statistics (IBGE), in 2020, the Northeast's GDP per capita was the lowest among Brazil's regions, corresponding to less than half of that recorded for the South and Southeast regions.

Various public policies have been used to try to mitigate this regional inequality, including the granting of tax benefits and incentives for productive projects that set up in the Northeast. These instruments are administered by the Northeast Development Superintendence (Sudene) and aim to attract productive capital to finance the development of the region, by generating jobs and income for the local population.

The theoretical justification for these incentives is to correct a possible market failure resulting from economies of location. According to this theory, the concentration of productive activities in a region tends to perpetuate itself due to the growing reduction in the costs of productive inputs and transportation resulting from this agglomeration (KRUGMAN, 1991). Tax incentives therefore act as compensation to companies for giving up these savings.

International empirical literature suggests that, in general, tax incentives result in an improvement in firms' labor market indicators, especially by increasing the number of jobs, although this result varies according to the size and age of the firm (DECRAMER; VANORMELINGEN, 2016), sector (HARGER; ROSS, 2016) and ease of access to credit (LIU; MAU, 2019). At the national level, the evidence reinforces the positive impacts on the number of jobs in firms, but the effects on other indicators are uncertain. Negative effects have been found for income, and a null effect on the wage bill (DE OLIVEIRA; SILVEIRA NETO, 2020), as well as a positive effect on the latter variable (GONÇALVES; De ALMEIDA; BARBOSA, 2018).

In this context, this article assesses the impact of receiving tax incentives via a 75% reduction in Corporate Income Tax (IRPJ) on the hiring of workers by the benefited companies. To this end, microdata from the Ministry of Labor and Employment's (MTE) Annual Social Information Report (RAIS) and the Tax Incentives and Benefits System (SIBF) were used to identify the companies that received tax benefits from Sudene between 2011 and 2019.

To achieve this goal, the staggered difference-in-differences method proposed by Callaway⁴

and Sant’Anna (2021) was used, with the treatment group being companies that received tax incentives over the aforementioned period, while the control group was companies in the same sectors, but which were not incentivized by Sudene with a reduction in corporate income tax. The results suggest that beneficiary companies hire more workers, which could contribute to the objectives of the National Regional Development Policy (PNDR).

The text is divided into four more sections, in addition to this introduction. Section two presents the tax incentives managed by Sudene, describes the policy’s transmission mechanisms and summarizes the empirical literature. Section three details the construction of the database and the methodology used to estimate the causal effect of the tax incentive policy via a 75% IRPJ reduction. The results are then presented and discussed. Finally, the concluding remarks are made.

2. LITERATURE REVIEW

2.1 Characteristics of Sudene’s Tax Incentives

Tax incentives for the Northeast region emerged in the 1960s following the creation of Sudene by Law No. 3,692 of 1959. The aim of this superintendence is to boost the economy of its area of operation (BRASIL, 1959), which currently consists of 2074 municipalities, covering the entire Northeast and the north of Minas Gerais and Espírito Santo¹. The strategy adopted to achieve this goal was to stimulate industrialization by granting tax incentives to enterprises located in Sudene’s area of operation. Despite having undergone changes over time, these incentives continue to be granted to companies located in the region.

In 1963, Law No. 4.239 exempted from the IRPJ, including non-refundable surcharges, industrial and agricultural enterprises that set up specifically in Sudene’s area of operation and benefited other companies in the industrial or agricultural category that had already set up with a 50% reduction (BRASIL, 1963). This is how the IRPJ exemption and reduction incentives were created, according to the wording given in articles 13 and 14, respectively, of Law No. 4,239.

These two incentives remain in force, although their characteristics have changed. The

¹ The latest territorial change comes from Complementary Law 185 of 2021, which included 84 municipalities in the states of Espírito Santo and Minas Gerais (BRASIL, 2021). For this work, the old area of operation was considered, which covered 1990 municipalities, as the data used was not available for the years after the enactment of this law.

exemption incentive is currently aimed at digital technology companies, while the IRPJ reduction also derives from the 1963 incentive, but in 2001 Provisional Measure No. 2,199-14 redefined the rate to 75% (BRASIL, 2001).

In addition to these two forms, Sudene's list of incentives also includes the reinvestment of 30% of the IRPJ, which, like the other incentives in force, has common features since it was created in the 1960s by Law No. 5,508 of 1968 (BRASIL, 1968). The substantial change was in the reduction of the reinvestment rate, which was initially 50%, but through Law No. 9,532 of 1997 this percentage was reduced to 30% (BRASIL, 1997). The reinvestment incentive allows the taxpayer to return part of the IRPJ (30%) to be used in investment projects. The amount returned is deposited in a Banco do Nordeste do Brasil (BNB) account and must be increased by 50% of the taxpayer's own resources.

In order to receive tax incentives, companies must meet certain criteria. In all three modalities in force, the benefiting production unit needs to be located in Sudene's region of operation, adopt taxation based on real profit and its activities need to be a priority for regional development, which are listed in article 2 of Decree 4.213 of 2002, namely: infrastructure, tourism, agro-industry, irrigated agriculture, metallic mineral extraction industry, manufacturing industry, microelectronics and the electronics and related sector, including vehicles and auto parts (BRASIL, 2002).

These companies still need to present investment projects that justify the use of the financial amount resulting from the tax incentives. Thus, the amount provided by the incentives is linked to projects that involve setting up a production unit in the Sudene area, modernizing the production process, diversifying production lines or expanding the actual installed capacity of the enterprise. All these projects can be financed by the incentives of a 75% reduction in the IRPJ and exemption from this tax, while the reinvestment incentive is restricted only to projects to modernize and complement equipment.

For the incentives to be granted, it is not enough just to present the project, the investment needs to have already started, because to be admissible, the projects need to have completed at least 20% of the investment. For example, the diversification project will be accepted when the diversified production line achieves effective production of more than 20% of its actual installed capacity².

Once the eligibility criteria have been met and there is an admissible project, the request

² For more details on the projects and the admissibility criteria, see the Tax Incentives Regulations in the form of the annex to Ordinance No. 283 of July 4, 2013 (BRASIL, 2013).

for exemption, reduction or reinvestment of the IRPJ is made by the person legally responsible for the company, who must access Sudene's SIBF and inform the incentive of interest, the investment project, the company's economic sector, the estimated number of new direct and outsourced jobs needed to carry out the project, as well as the estimated value of the investment. In addition, the company's identification data must be included, such as the National Register of Legal Entities (CNPJ), company name and the municipality in which the company is based.

Sudene's analysis department, in turn, checks the documentation provided to prove the validity of the eligibility criteria and inspects the incentive unit in order to examine the admissibility of the project. If it meets the requirements, a Constitutive Report will be issued (in the case of exemption or reduction incentives) or an Ordinance (in the case of reinvestment incentives) attesting to the right to the incentive.

Once the incentive has been confirmed, the benefiting unit can still receive it in the same year that the supporting document is issued or in the following year, depending on when the investment project comes into operation, i.e. reaches the admissibility criterion (20% of actual capacity). If the project comes into operation in the year in which the Report or Ordinance is issued, it will begin to benefit from the incentive in the following year; if it came into operation in an earlier period, it will still receive the incentive in the same year.

There is also the possibility of accumulating tax incentives, since none of the incentive categories excludes the possibility of taking advantage of another modality³. However, it is important to note that obtaining a new incentive requires the presentation of a new investment project. This means that companies with a single project must opt for one of the incentive modalities.

This being said, in the presence of a single project, companies will resort to the incentive that best suits their investments and that manages to meet the stipulated criteria. As such, it is expected that there will be a variation in the demand for and supply of incentive modalities depending on their scope. In this context, the incentive that appears to be the least restrictive is the 75% IRPJ reduction incentive, as it is not limited to a portion of investment projects, as is the case with the reinvestment incentive, nor is it aimed exclusively at companies in the digital technology sector, as is the case with the exemption incentive. Proof of the scope of the 75% IRPJ reduction incentive is that 70% of the incentives approved between 2011 and 2021 were related to this modality.

³ Of the incentives being implemented, the reinvestment incentive can be used cumulatively with the income tax reduction incentive provided for in article 1 of Provisional Measure 2.199-14 of 2001 (BRASIL, 2001).⁷

In view of the importance of this incentive, expressed by the relative number of approvals, Sudene's incentives can be evaluated by limiting themselves to the effects promoted by granting and receiving this incentive, under the assumption that the instrument used by Sudene to stimulate local enterprises can be summarized only in the form of a 75% IRPJ deduction.

In terms of its characteristics, this incentive has a validity period of 10 years, which means that once it begins to be used, the unit receiving the incentive will have the tax on the profit from its activity reduced by 75% for the next ten years. This allows the effect of this incentive to be measured over the years in which the company receives it. Furthermore, since the incentive can be requested and approved at any time during the year and since the IRPJ is declared annually, it can be concluded that all companies that have had their incentives approved in a specific year can have their IRPJ for that year discounted by 75%, regardless of when the incentive was approved. As a result, new companies receive incentives every year, which means that incentives can be seen as a policy whose intervention takes place annually.

Based on this description, it can be inferred that the 75% reduction in the IRPJ is the public policy instrument dedicated to regional development that best represents Sudene's tax incentives and benefits and that certain characteristics should be taken into consideration for the assessment, such as: the moment the company receives the incentive, considering the year the Report was issued; the multiple treatment periods, given that new companies can be incentivized every year; the fruition period, which provides a period of the evaluation; the possibility of firms self-selecting, given the application process; as well as the eligibility criteria for competing for the incentives and the admissibility of projects.

2.2 Transmission Mechanism

Tax incentives and benefits are part of the PNDR, which aims to mitigate regional inequalities through investments and activities to promote development with a focus on improving the population's quality of life by reducing existing inequalities and poverty. Thus, the mechanism for achieving these objectives can be better understood through the PNDR logic model devised by Shirasu, Corrêa and Irffi (2023).

According to the model proposed by Shirasu, Corrêa and Irffi (2023), the PNDR uses the investment and financing instruments of its plans and actions as inputs: Constitutional Funds for the North, Center-West and Northeast (FNO, FCO, FNE), Development Funds for the Amazon, Center-West and Northeast (FDA, FDCO, FDNE), tax incentives and benefits, as well as

the General Federal Budget (OGU) and other sources of funding.

These inputs make it possible to carry out activities related to the planning, management and execution of the policy's resources. These activities generate products such as the number of requests granted and the number of projects or enterprises benefiting, which can be monitored by sectors and municipalities with companies receiving assistance.

The granting of these tax benefits results in the attraction of new investments to the regions concerned. This, in turn, promotes greater dynamism in the municipalities whose companies benefit, resulting in an increase in employment, local income and company productivity. It can also promote the internalization of regional development, diversification of production bases and a reduction in emigration rates.

If these results are maintained over the long term, the effects of the policy will be identified through the improvement of the local economy, greater and consistent economic growth and development, the reduction of socio-economic inequalities and the alleviation of poverty, thus resulting in an improvement in the quality of life of the region's population. In this sense, the mechanism for granting tax incentives and benefits can have an impact on the labor market indicators of the companies that benefit from them. We hope to be able to verify this hypothesis based on the results of this evaluation.

In this way, the structuring of the PNDR's logical model, as well as its inputs and activities, contribute to achieving the expected results and the desired impact on the regions benefiting from the incentives policy. Thus, considering the PNDR logic model, it is possible to conclude that the labor market plays a crucial role in analyzing the impact and effectiveness of Sudene's incentives and tax benefits policy, because the set of processes result in effects on the labor market, addressing aspects such as income, labor, job creation and quality of life.

2.3 Evidence of Tax Incentives on Firms' Labor Market Indicators

The evaluation of tax incentives and benefits may be motivated by an interest in understanding the effects of this public policy and/or by the emergence of new empirical methods. Although relatively incipient when compared to the qualitative literature, the evaluation of tax incentives encompasses studies aimed at various forms of incentives in several countries, including Brazil. In an attempt to narrow down the survey of studies, we sought to emphasize studies that evaluated the effects of tax incentives aimed exclusively at companies on labor market indicators at the firm level.

2.3.1 International evidence

The granting of tax incentives to companies is a practice adopted both in developed countries such as Italy, the United States and Belgium, and in developing countries such as China, India and Brazil. What these incentives have in common is that they encourage industrial investment, mostly for the growth of economically less developed areas. On the other hand, they differ in some aspects, such as the instrument used to grant them, the criteria for eligibility, among other factors. It is these specific characteristics of the incentives that allow empirical methods to be applied to evaluate each case.

In Italy, Law No. 488 of 1992 allowed companies willing to invest in underdeveloped areas to receive a public subsidy that covered a fraction of the value of the investment. Interested companies had to present investment projects related to installation, expansion, modernization, among others, which would be scored according to certain criteria that included the number of jobs involved in the project and the region targeted by the investments. Competitive auctions were held to award the incentives.

Bronzini and Blasio (2006) compared the companies that received incentives with the companies that had their applications rejected using the difference-in-differences method, using the year in which the auctions took place as the point of intervention. To do this, they used official data from Law No. 488 combined with financial and economic data from the companies. They found that the incentives increased investment, especially for the smaller companies in the sample, but this increase occurred in part because the benefited companies anticipated future investments and exploited the investments that would have been made by the non-benefited companies in the absence of the incentives. Thus, the increase in investment occurred by substituting other investments (future or competing).

Also using official data and financial and economic information, but this was collected from another source, Cerqua and Pellegrini (2014) evaluated the effect of incentives on the labor market. They used a discontinuous regression model, adopting the score of approved projects as the cut-off variable, and found positive effects of Italian incentives on employment, investment and firm turnover, but a null effect on output per worker for the period 1995-2004.

Similarly, the government of Flanders in Belgium created an incentive program in 2003 that subsidizes investment by small and medium-sized enterprises that perform well, as measured by the criteria used to score the projects. Unlike the Italian case, there were no criteria relating to the number of jobs generated, nor to the region that would receive the investments.

Decramer and Vanormelingen (2016) analyzed the effects of the Flanders incentives granted between 2004 and 2009 and also explored the scoring of projects to apply the discontinuous regression method. In order to use the benefit, an investment project had to be proposed, in which they scored young companies with good performance in terms of increased employment and productivity per worker, among other criteria. They found that the positive effect of the incentives on employment, productivity, added value and sales was concentrated only in small companies (with fewer than 10 employees). They also estimated that each job created cost an average of 500,000 euros and that this cost could be reduced if the program added a criterion that stimulates job creation.

In the United States, one approach to economic stimulus is the New Markets Tax Credit (NMTC), a program that aims to boost low-income areas through private financing. In this program, investors provide capital to companies in these regions and, in return, receive tax credits applied to their federal tax obligations.

Harger and Ross (2016) evaluated the effect of the NMTC also using the discontinuous regression method, supported by the criterion that to be eligible for the program companies must be located in regions whose household income from the census tract corresponds to a maximum of 80% of the state's income. They found that the program increased employment in the retail sector for both existing and newly installed firms, but reduced employment for new firms in the wholesale, transport and services sectors. The authors argue that this variation in results is consistent with the amount received for each sector.

From 2004 to 2009, the Chinese government carried out a tax reform to implement a consumption-based Value Added Tax (VAT). Under the new system, the purchase of fixed assets is now deducted from final product sales when calculating a company's final VAT liability. This implies a reduction in the cost of using capital, generating direct tax incentives for companies to invest.

Liu and Mau (2019) evaluated the effects of this reform using a difference-in-differences model, comparing eligible and non-eligible companies and found that the incentive promoted by the reform increases investment (38.4%) and productivity (8.9%) of companies, with a greater effect for companies with financial constraints.

In order to attract industrial investment and create jobs in poorly industrialized states, the government of India began to provide a package of incentives from 2003 onwards, which included exemption from consumption and income tax for new companies, combined with investment subsidies. In order to assess the effects of this policy, Chaurey (2017) adopted 2003 as

the intervention period to apply the difference-in-differences method. As a result, he identified positive impacts on employment, wages and the wage bill of companies.

In summary, it can be said that the practice of giving incentives to companies is common in several countries and that the evaluation of these incentives takes into account the characteristics of the incentive program adopted in each country. In addition, most tax incentives have resulted in an improvement in labor market indicators, especially by increasing the number of jobs, but these results do not seem to be homogeneous, as they vary depending on the size, sector, age of the firm and ease of access to credit.

2.3.2 National Evidence

In Brazil, the PNDR uses tax incentives and benefits as an instrument to finance its plans and actions. These incentives are administered by Sudam and Sudene, whose main objective is the development of the North and Northeast regions, respectively. As for the Central-West region, although it is also a relatively underdeveloped region according to the PNDR, and therefore requires the creation of a Superintendency (Sudeco), the policy does not allocate tax incentives to this region. Therefore, only the North and Northeast regions of Brazil have nationwide tax incentives, in the form of exemptions and reductions in IRPJ.

Garsous et al. (2017) evaluated the impact of Sudene's tax incentives on the number of municipal jobs resulting from the inclusion of the tourism sector in the list of priority sectors in 2002, using a difference-in-differences model to compare municipalities in the Sudene area with municipalities in Rio de Janeiro, Minas Gerais and Espírito Santo, which are not part of the superintendence area. They found that municipal tourism employment increased by 30% compared to a scenario without tax incentives, and that this effect grew over time and persisted even seven years after the tourism sector became eligible for incentives.

In the same vein, Braz and Irffi (2023) used Callaway and Sant'Anna's (2021) difference-in-differences estimator to verify the heterogeneous effects of the 75% IRPJ reduction incentive granted by Sudene on the labor market. They found that the incentive increases the number of jobs and average municipal income, with an increasing effect over time that can last for ten years. However, they point out that the effects are concentrated in large municipalities, with a higher level of development and close to the coastal capitals of the Northeast Region.

In the case of Sudam, Dos Santos (2022) examined the effect on constitutional transfers if the tax benefits were not in force. To do this, they analyzed data on tax expenditures related to

Sudam's tax incentives and mandatory transfers to municipalities. They found that if the values of the tax incentives granted between 2009 and 2018 were converted into federal income, the amounts that would return to the subnational entities via mandatory constitutional transfers would be approximately 90% lower. They therefore conclude that tax incentives are a way of financing investment by federal entities.

In addition to the incentives supported by the PNDR, Brazilian states grant tax incentives based on the reduction or exemption of state taxes. It is important to verify the effects of state incentives in order to understand the effects of Sudene's incentives, as they share some characteristics: they aim to promote regional development by stimulating companies, with a focus on labor market indicators, through tax reductions.

State regional development programs use the ICMS as an instrument, guaranteeing tax benefits to companies by reducing the payment of this tax, triggering the phenomenon known as the fiscal war (LIMA; LIMA, 2010). This mechanism of granting tax incentives can displace companies that have their costs reduced by the incentive policy throughout the country (DULCI, 2002). However, the tax burden is only one part of the costs and may not be enough to attract companies, since the business decision also depends on other factors such as the distance to its suppliers and the consumer market for its product or service (FROTA; LIMA; De AZEVEDO, 2014).

As for the effects of state incentives at the municipal level, Oliveira Júnior, Dias and Tabosa (2014) found zero effects of incentives in Pará on revenue, employment and added value. Silva (2018), for Goiás, found a positive effect on average income and a null effect on employment and municipal revenue. In the same vein, Carvalho Júnior, Barreto and Oliveira (2006) found no effects of Ceará's tax incentives on the number of jobs.

In the context of impacts on firms, Gonçalves, De Almeida and Barbosa (2018) examined the effects of Paraíba's Industrial Development Support Fund (FAIN) on labor market indicators from 1996 to 2014. They used the method of differences in differences with propensity score adjustment and observed that the tax incentives provided by the program resulted in an increase of 41.2% and 44.3%, respectively, in employment and the wage bill of the benefited companies, whose effect is progressive over time.

Using the same methodology, De Oliveira and Silveira Neto (2020) examined the effectiveness of the Pernambuco State Development Program (Prodepe), in terms of its impact on employment, average income and the wage bill of companies during the period from 2000 to 2017. They isolated the exclusive effect of Prodepe, separating it from other incentive policies,

including Sudene's initiatives. The results indicated that the isolated effects of the policy resulted in an 8.6% increase in the number of jobs, while there was a 10.3% reduction in the average salary of the benefited firms, without identifying any significant impact on the wage bill. These effects were more intense when state tax incentives were combined with Sudene incentives.

Additionally, they observed that the program influenced the three variables of interest in the same direction when analyzing a sample of companies belonging to the Metropolitan Region of Recife (RMR), while no significant effects were identified for companies located outside the RMR. In conclusion, the researchers emphasized the importance of the level of urban agglomeration in finding the effects of the incentives.

In summary, it can be said that the tax incentives formalized by the PNDR have been little evaluated, given that only two studies have assessed Sudene's incentives on the labour market at municipal level, one of which was restricted to the effect on the number of jobs in a labour-intensive sector (the tourism sector). In this respect, it is essential to verify the effects of incentives at firm level, especially taking into account other sectors, as the effects can be heterogeneous.

In addition, the literature evaluating state incentives at the firm level has shown that incentives increase the number of jobs, but the effect on the wage bill and workers' income is uncertain.

3. METHODOLOGY

In order to assess the effect of the incentives on the benefited companies, the number of jobs was selected as the performance indicator. This choice was based on the objectives of the PNDR, as it reflects the quantitative variation in jobs created by the companies.

The treatment group was made up of companies that received tax incentives through Sudene's 75% IRPJ reduction from 2011 to 2019⁴. On the other hand, the control group was made up of similar companies located in the same region that did not benefit from this policy. As a delimitation of treatment, this analysis considered that the company acquired treated status after the date of the report authorizing the receipt of the incentive. In addition, for both groups, the database includes information prior to the intervention period starting in 2006.

⁴ The evaluation begins in 2011, as this is the year in which data is available on the approval of tax incentives and benefits, and ends in 2019, as this is the last year in which information is available on the economic, financial and social variables of the companies in the sample.

3.1 Database

In order to carry out the impact assessment, we used RAIS microdata and the list of companies benefiting from the tax incentives administered by Sudene, Table 1 lists the variables used in the analysis. The treatment group selected were companies that benefited from the 75% reduction in IRPJ between 2011 and 2019, available on the SIBF. To establish a counterfactual for these companies, we started from the universe of companies contained in the RAIS and carried out some filters based on the eligibility criteria for access to the tax incentive. In addition, information on companies from 2006 onwards was used.

Table 1: Description of the variables used

Variable	Description
Links	Log of the number of active company links
Elementary School Completed	Percentage of employees with complete primary education
Complete high school	Percentage of employees with complete secondary education
Man	Percentage of male employees
Not White	Percentage of employees who declare themselves non-white
Exper. Average	Average employee experience
Average Ages	Average age of employees
Average Hours	Companies' average working hours

Source: Prepared from RAIS/MTE data.

One of the conditions for receiving tax incentives is that the benefiting company opts for Real Profit. Generally speaking, companies in Brazil can opt for three tax regimes: (1) Real Profit, in which the IRPJ is calculated based on the actual profit within the calculation period; (2) Presumed Profit, in which the tax is calculated based on an arbitrary rate on the company's turnover; and, (3) Simples Nacional, in which income tax is paid in a simplified way, along with other taxes through a reduced rate on Total Gross Revenue.

It should be noted that companies with an annual turnover of more than R\$78 million are obliged to declare using Real Profit and those with a turnover of up to R\$4.8 million are allowed to opt for Simples Nacional. In the RAIS database, it is not possible to identify whether the company is opting for Real or Presumed Profit, only whether the company is opting for Simples Nacional. Therefore, in order to make the sample more homogeneous, it was decided to exclude those companies opting for the simplified regime.

According to the IBGE definition⁵, companies can be classified according to size, depending on the sector, by the number of employees. Considering that tax incentives predominantly reach large companies and in order to improve comparability between treatment and control groups, it was decided to disregard companies with fewer than 50 employees, which are considered small for most sectors of the economy⁶.

The database was also restricted to companies belonging to the following legal types: 2038 - Mixed Economy Company; 2046 - Public Limited Company; 2054 - Closed Limited Company and 2062 - Limited Company. This restriction was due to the fact that almost all of the companies covered belong to these categories.

Finally, the last filter seeks to restrict the companies applying for control to the strategic sectors covered by Decree No. 4.213 of 2002. In order to make this restriction possible, we sought to identify the main National Classification of Economic Activities (CNAES) of the companies that benefited and to match them with the sectors, as classified by Sudene. It should be noted that some inconsistencies were found in this process, so it was considered parsimonious to remove companies whose main CNAE was not directly related to the supported sectors. At the end of this process, the database is represented by a panel of 318 companies, 98 of which benefited from the tax incentives and 220 belonging to the control group.

3.2 Econometric strategy

In order to estimate the effect of tax incentives on the number of formal jobs in benefited companies, an expanded version of the difference-in-differences method proposed by Callaway and Sant'Anna (2021) will be used. This method addresses the identification and estimation of treatment effect parameters using the Differences in Differences (DiD) methodology in scenarios with multiple time periods, variation at the time of treatment and situations in which the assumption of parallel trends may only be valid after considering observable variables.

Callaway and Sant'Anna (2021) start by grouping the treated units according to when they first took part in the treatment. The aim is to estimate the Average Effect of Treatment on the Treated for each group, “g”, in each period of time, “t”. In addition, estimation can be carried out when there is a set of “never treated” units. When this group is not available or is very

5 For more details, see: <https://biblioteca.ibge.gov.br/visualizacao/livros/liv102005.pdf>

6 It is important to note that company size, as defined in labor economics literature, is generally measured based on turnover. Due to the impossibility of obtaining this variable for the companies in the sample, we opted for the IBGE definition.

small, the group of “not yet treated” units is used⁷.

The authors propose a weighting to bring treated and untreated units closer together in terms of their likelihood of participating in the program. This is done by estimating the following propensity score:

$$P_g X = P(G_g = 1 | X, G_g + C = 1) \quad [1]$$

The vector X denotes the set of observable variables; G_g is a binary variable that takes on a value of 1 if the company benefited in period g; and variable C is also a dummy whose value is 1 if the company belongs to the control group. Thus, the propensity score is estimated for each year of entry into the treatment, “g”, which generates greater flexibility to obtain the similarity of characteristics between controls and each treatment group.

Under these assumptions, the average treatment effect for group-time, with the inclusion of anticipatory behavior δ ⁸, can be identified semi-parametrically as:

$$ATT(g, t) = E \left[\left(\frac{G_g}{E[G_g]} - \frac{\frac{P_g(X)C}{1-P_g(X)}}{E\left[\frac{P_g(X)C}{1-P_g(X)}\right]} \right) (Y_t - Y_{g-\delta-1}) \right] \quad [2]$$

Where Y_t and $Y_{g-\delta-1}$ denote, respectively, the outcome variable in t and in the period immediately preceding the receipt of the benefit by group g, considering the anticipation. Due to the presence of the dummies G_g and C in the first term in brackets of Equation [2], the difference $(Y_t - Y_{g-\delta-1})$ is calculated separately for each group g and its respective control group. In the process of estimating ATT (g, t), estimators based on outcome regressions (HECKMAN; SMITH; CLEMENTS, 1997; HECKMAN; ICHIMURA; TODD, 1998), inverse probability weighting (ABADIE, 2005) and doubly robust methods (SANT’ANNA; ZHAO, 2020) can be used.

The estimator proposed by Callaway and Sant’Anna (2021) is a weighting of the difference in results between the treated ($G_g=1; C=0$) and control ($G_g=0; C=1$), before and after the intervention, whose weights are given respectively by:

$$w_g^G = \frac{G_g}{E[G_g]} \quad e \quad w_g^C = \frac{\frac{P_g(X)C}{1-P_g(X)}}{E\left[\frac{P_g(X)C}{1-P_g(X)}\right]} \quad [3]$$

As a result, it not only allows for the balancing of observable characteristics between

⁷ Athey and Imbens (2006) and de Chaisemartin and D’Haultfoeuille (2018) also explore the use of “not yet treated” units as comparison groups in DiD procedures.

⁸ To understand the importance of considering potential anticipatory behavior, see: Laporte and Windmeijer (2005) and Malani and Reif (2015).

benefited and non-benefited companies, but also controls for unobservable characteristics that are fixed in time. Furthermore, because it is a non-parametric estimator, ATT (g, t) identifies the effect of the program without imposing functional forms typical of linear regressions used in the differences-in-differences literature that control for observable characteristics.

Another advantage of this estimator is that it allows for different aggregations of the results, making it possible to estimate the effect of the tax incentive on specific groups, specific periods or time elapsed since the treatment. The average effect of participating in the treatment in time period t (among groups that adopted the treatment up to period t) is given by:

$$\theta_c(t) = \sum_{g \in G} 1\{t \geq g\} P(G \leq t) ATT(g, t) \quad [4]$$

An extension of this parameter is the average cumulative effect of participating in the treatment up to a certain period of time. To consider this cumulative effect, consider the following parameter:

$$\theta_c^{cumu}(\tilde{t}) = \sum_{t=2}^{\tilde{t}} \theta_c(t) \quad [5]$$

It is θ_c^{cumu} interpreted as the average cumulative effect of the treatment among the units that have been treated up to time \tilde{t} . While the effect of exposure to treatment, called dynamic ATT (g, t), can be obtained by:

$$\theta_{es}(e) = \sum_{g \in G} 1\{g + e \leq T\} P(G + e \leq T) ATT(g, g + e) \quad [4]$$

This is the average effect of participating in the treatment after e periods since the adoption of the treatment, considering all groups by e periods. Here, the average effect immediately after participating in the treatment occurs when $e=0$.

However, in event study regressions, it is common to plot βe at different values of e and interpret the differences as being due to the dynamics of the treatment effect. Similarly, it is possible to plot $\theta_{es}(e)$ at different values of e to better understand the dynamics of the treatment effect. Callaway and Sant'Anna (2021) show that these comparisons can incorporate changes in composition, which can make it difficult to interpret the differences in $\theta_{es}(e)$ between different values of e values as being real dynamic effects of participation in the treatment.

According to Callaway and Sant'Anna (2021), an alternative causal parameter that can be

used to understand the dynamics of the treatment effect in relation to exposure time, and which does not face the complications of compositional changes, arises by “balancing” the groups in relation to the time of the event. This means aggregating only the ATT (g, t) for a fixed set of groups that have been exposed to the treatment for at least a certain specific number of periods, thus avoiding the problem of compositional changes at different values of e . This parameter is denoted by:

$$\theta_{es}^{bal}(e; e') = \sum_{g \in G} 1\{g + e' \leq T\} ATT(g, g + e) P(G + e \leq T) \quad [5]$$

Thus, the definition of $\theta_{es}^{bal}(e; e')$ is very similar to $\theta_{es}(e)$ with the difference that it calculates the average treatment effect over the group-time for units whose event time is equal to e and which are observed participating in the treatment for at least e' periods.

It is also possible to define general treatment effect parameters by calculating the average of $\theta_{es}^{O, bal}(e')$ for all event times. That is, the average effect of participating in the treatment during the first e' periods of exposure to the treatment.

$$\theta_{es}^{O, bal}(e') = \frac{1}{e' + 1} \sum_{g \in G} \theta_{es}^{bal}(e; e') \quad [6]$$

The hypothesis is that the control group represents the trajectory of the mean of the outcome variable after the treatment for the treated groups if they had not participated in the treatment. This hypothesis is not directly testable, but evidence of its validity can be obtained by testing the similarity of the average trajectories of the outcome variable for the treated and control groups before receiving the incentive for each cohort of benefited companies.

Callaway and Sant’Anna (2021) formalize a test for the parallel trends hypothesis by calculating the ATT (g, t) for pre-treatment periods. This strategy provides the retroactive effect of the treatment, which if significant, is an indication contrary to the hypothesis tested. The test has the null hypothesis:

$$H_0: E[X, G = 1] - E[X, C = 1] \text{ a. s. } \rightarrow 0 \quad [7]$$

Thus, the non-rejection of the null hypothesis is evidence that the control group is a good counterfactual for the treatment group.

Furthermore, as highlighted by Callaway and Sant’Anna (2021), it is possible to represent

both the pre-test of the assumption of parallel trends and the estimates of treatment effects in the post-treatment periods by means of graphical analysis, using a simultaneous 95% confidence interval.

4. ANALYSIS AND DISCUSSION OF RESULTS

4.1 Descriptive Data Analysis

Table 1⁹ shows the variables used to calculate the effect of the 75% IRPJ reduction on labor market indicators, after applying the filters outlined in the methodological section. It shows the characteristics of the treatment groups, before and after the companies benefited from Sude-ne's tax incentive and benefit instrument, and the firms that were used as controls.

In particular, the period from 2006 to 2010, when the incentive did not yet exist, was considered for the descriptive analysis. The number of employees per company is used as an outcome variable, according to the model proposed by Shirasu, Corrêa and Irffi (2023). Other company characteristics are used as control variables, such as the fraction of employees who are non-white, educational characteristics, experience, age and average hours.

The characteristics of the companies considered in this evaluation are provided in Table 1. Note that there are some differences during the period in which the companies do not receive the incentives analyzed, between the companies that received incentives and the companies that did not receive incentives. The companies considered to be treated have a greater number of jobs (on average a 5% difference), as well as having lower average experience and age among their employees (compared to the companies considered to be controls), and the average number of hours is higher for the companies considered to be treated.

9 The monetary variables were deflated by the INPC for 2019.

Table 1 - Descriptive statistics of the variables used

	Control (group 0)	Treatment (group 1)	Difference	p.val difference
Links	271,21	399,84	128,63	0,00
Fund. Complete	0,123	0,119	-0,003	0,53
High School Complete	0,40	0,37	-0,02	0,06
Man	0,81	0,80	-0,01	0,25
Not white	0,93	0,95	0,02	0,01
Exper. Average	89,20	64,04	-25,15	0,00
Average age	37	34,6	-2,43	0,00
Average hours	42,58	43,01	0,43	0,00

Source: Based on the selected sample. Note 1: Employment relationships measured in numbers of workers in companies. Note 2. Other variables measured in proportions. Note 3: The sample consists of 1,100 control units and 490 treated units during the pre-incentive period from 2006 to 2010.

4.2 Analysis of the effectiveness of tax incentives

This subsection presents the results of the estimates¹⁰ of the effects of tax incentives on the benefited companies in relation to the number of active jobs¹¹. This variable is important for the analysis of incentives, as it provides information on the behavior of these companies in relation to the labor market and is in line with the logical model of the PNDR by Shirasu, Corrêa and Irffi (2023).

In addition, the scenario that incorporates the effect of anticipating one year before approval was used (i.e. $\delta = 1$). This is because, as described above, in order for the company to receive the incentive, it must have at least 20% of the project completed, so it is reasonable to assume that the companies would have already hired workers before the start of the incentive, defined as the year in which the Constitutive Report was issued.

4.2.1 Employment relationships

¹⁰ All inference procedures used double robust estimators, clustered standard errors, and were obtained by *bootstrapping* at the company level, taking into account the autocorrelation of the data.

¹¹ It is important to note that estimates were also carried out to assess the impact of the incentive on Average Remuneration and Wage Mass. However, since there was no statistical significance in the parallel pre-trend tests for average remuneration, their estimates were not presented, and consequently it is not possible to measure the impact on the Wage Mass.

In order to check the effect of the 75% reduction in IRPJ on the number of ties of the benefited companies, the base scenario was the control group made up of companies located in the Sudene region that had never benefited from the incentive. As explained above, the method used assumes that the treated companies should follow the same trajectory as those not treated in the absence of treatment. Therefore, to test this hypothesis, the parallel trends test was carried out, which consists of checking whether there is a systematic difference in the trajectory of treated and untreated companies before the treatment (granting of the tax incentive) took place.

Analyzing the pre-treatment estimates, shown in the graphs in Figure 1, shows the validity of the assumption of conditional parallel pre-trends, with the exception of the estimate for the group of companies that received the treatment in 2016 in relation to the control group in 2015. This can be seen from the fact that the estimators in the pre-treatment period remain stable around zero, which is always within the confidence intervals. However, considering the indicative evidence contrary to the assumption of parallel trends for the 2016 group, the results should be analyzed with caution.

Thus, based on the results of the parallel pre-trend test, it is possible to analyze the causal effects of the tax incentive using the Callaway and Sant'Anna (2021) estimator. Table 2 presents the estimates for the average group effect, the dynamic time effects and the calendar effect, which allows groupings at different time intervals, calculating the average treatment effects over the period 2011 to 2019.

As for the average treatment effects by time-group, there was an effect only for the group of companies that benefited in 2013 (25.90%). Furthermore, there was a positive impact on the estimate of the average aggregate effect by time-group. The effect on the number of active jobs in the benefited companies was approximately 0.1101¹². This result suggests that the granting of the 75% IRPJ reduction resulted in an average increase of 11.64% in the creation of jobs in the benefited companies.

As for the balanced dynamic effect over time, the estimated average parameters are basically in the same scenario as the average group-time treatment effect. With regard to the balanced dynamic effect, as the years of exposure to the 75% IRPJ reduction increase, the groups of companies exposed to the treatment decrease until the last period of exposure is reached, where the effect can only be measured for the companies that benefited in 2011.

Thus, when there is an immediate effect, in the case of $e=0$ (2011-2019), the effect is 8.36%. This immediate effect is probably due to companies anticipating hiring. However, as ex-

12 When estimating the log-linear model, the causal effect is given by $[100 \times (\exp(\beta) - 1) \%$.

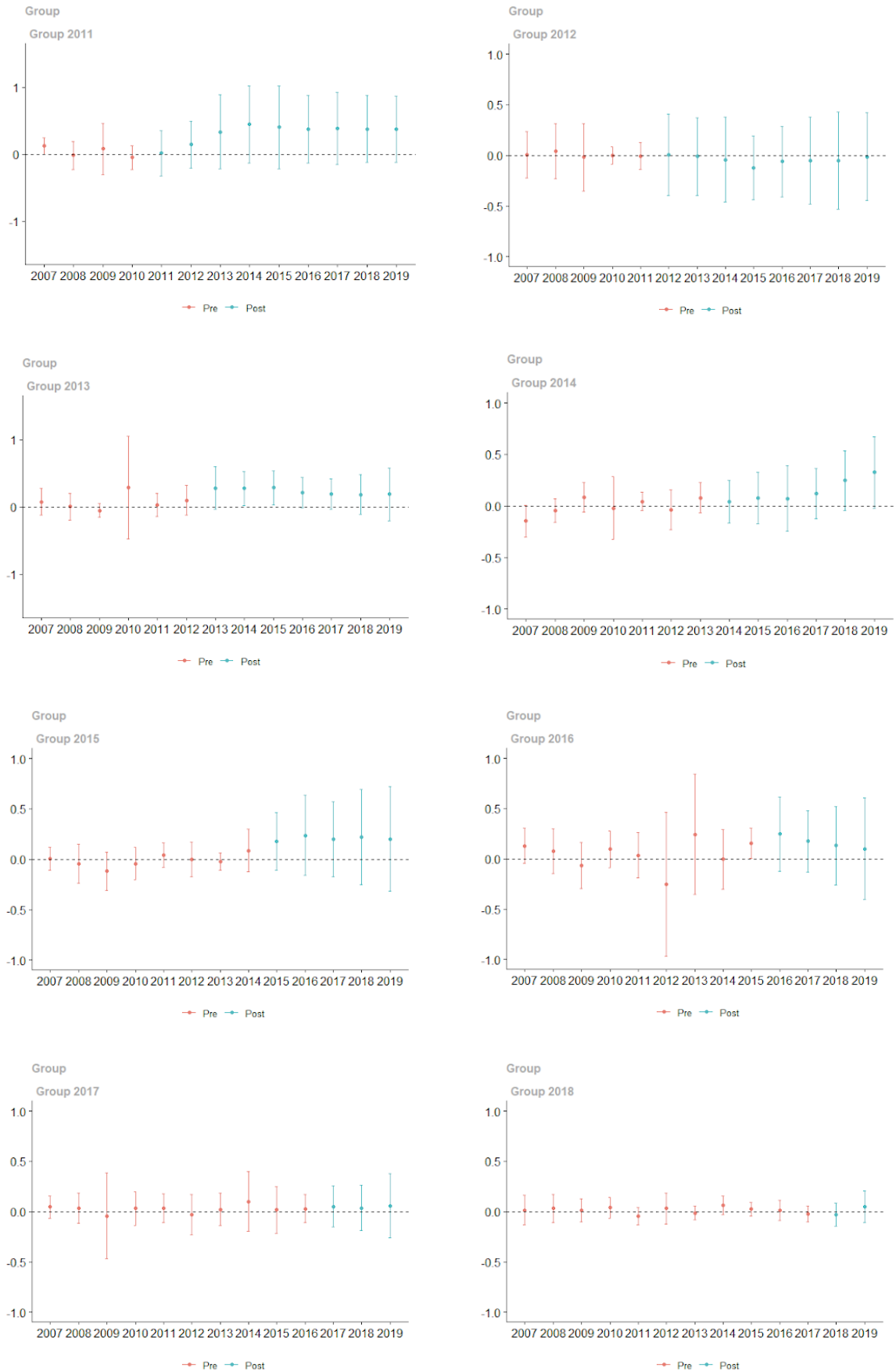
posure increases over the years, this effect increases, reaching its greatest impact for the group of companies that received treatment in the 2011-2013 period, with an average dynamic effect of approximately 19.36%.

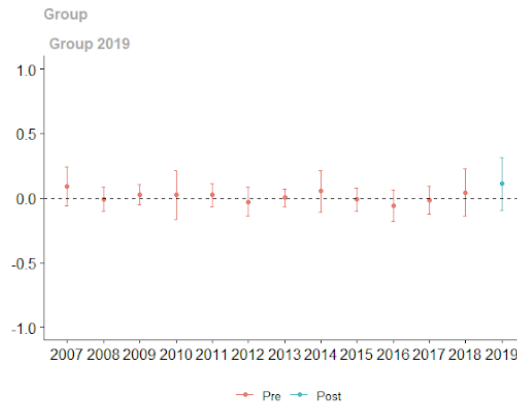
On the other hand, for the group of companies that received the incentive between 2011-2015, there was an average increase in hiring of around 18.33%. Specifically, in the first year after the incentive was implemented, the number of active jobs increased for these companies by around 16.64%. In the fourth year, an increase of approximately 24.45% is estimated.

In general, the positive effect of the 75% IRPJ reduction on the number of jobs in firms is noticeable throughout the period in which the incentive was received, with the exception of the companies that benefited from the incentive in 2011-2012, where the average effect was zero.

When analyzing the average effects of the treatment by year, i.e. the Calendar Effect, it can be inferred that the aggregate results by group and by calendar time period also indicate a positive average effect, as well as showing effects for the years 2015, 2016, 2017 and 2019. In other words, between 2011 and 2014 the tax incentive did not result in an increase in employment for the firms that benefited during this period. In the same way, it did for the firms that benefited in 2018.

Figure 1 - Pre-trend tests for the log of the number of jobs - General.





Source: Based on econometric estimation.

From what we can see, during the period from 2015 to 2017, the companies that received benefits showed impacts that offset the null effects observed in previous periods, but not enough to maintain the positive effect with the addition of new companies to the group of beneficiaries in 2018; however, in 2019 with the addition of new beneficiary companies, there is again an increase in the number of links for these companies.

In this way, these results reinforce the findings obtained by the group-time average effect and the Events Study, in which the tax incentive granted to companies benefiting from Sudene results in an increase in the number of active ties, when compared to what would have happened in the absence of this incentive.

Therefore, it can be said that these results corroborate international evidence that granting tax incentives to companies results in increased hiring by firms (CERQUA; PELLEGRINI, 2014; HARGER; ROSS, 2016; DECRAMER; VANORMELINGEN, 2016; CHAUREY 2017). Specifically for Sudene's area of operation, the result converges with the positive effect on the number of jobs in the municipalities found by Garsous et al. (2017) for the tourism sector.

Table 2 - Estimates of tax incentives on employment relationships

Efeitos Específicos de Grupos:		2013				(ATT)
		0,2303				0,1101
		(0,0734)				(0,0373)
Estudo de Evento com grupos balanceados						
Período	Efeito Dinâmico de tempo					(ATT)
e=0	0					0,0803
(2011-2019)	0,0803					(0,0301)
	(0,0286)					
e=1	1					0,0928
(2011-2018)	0,1106					(0,0287)
	(0,0373)					
e=2	0	1	2		0,1375	
(2011-2017)	0,1253	0,1392	0,1479		(0,0402)	
	(0,0409)	(0,0481)	(0,0532)			
e=3	0	1	2		0,1587	
(2011-2016)	0,1589	0,1652	0,1710		(0,0493)	
	(0,0483)	(0,0610)	(0,0732)			
e=4		1	2	3	4	0,1683
(2011-2015)		0,1539	0,1751	0,1927	0,2187	(0,0532)
		(0,0513)	(0,0604)	(0,0781)	(0,0785)	
e=5			4	5		0,01651
(2011-2014)			0,2171	0,2360		(0,0592)
			(0,0850)	(0,0780)		
e=6						0,1770
(2011-2013)						(0,0821)
e=8						0,1370
(2011)						(0,0670)
Efeito Calendário						(ATT)
2015	2016	2017	2019			
0,1968	0,1588	0,1050	0,1273		0,0934	
(0,0610)	(0,0526)	(0,0494)	(0,0428)		(0,0315)	

Source: Based on Econometric Estimation.

4.3 Robustness Analysis: “Not Yet Treated” and Companies from Minas Gerais and Espírito Santo that are not located in Sudene’s region of operation

As shown in the previous subsection, the group for 2016 showed signs of not validating the parallel trends in 2015. It is also important to note that the estimates for companies that have not yet benefited, known as “never treated”, may be subject to self-selection bias¹³. This arises from the fact that companies have to apply for the IRPJ reduction incentive. Since the companies considered as controls must be similar to the treated companies, they could also have applied to receive the incentive, but did not. Thus, it is possible that the choice not to participate in the treatment is due to some unobserved characteristic, which may be related to the outcome

13 The occurrence of self-selection between the treated and control groups may stem from a lack of similarity, even when both groups are eligible to receive the treatment. This is because there are unobservable characteristics that may have influenced the assignment of the treatment to some companies and the non-assignment to others.

variable (number of active links).

To mitigate these possible biases, two robustness tests are carried out. The first with the “not yet treated” control group as the control group, these being called “clean controls” according to Callaway and Santana (2021), Athey and Imbens (2006) and Chaisemartin and D’Haultfoeuille (2018), who also explore the use of “not yet treated” units as comparison groups in DiD approaches. The second, with a control group made up of companies that do not operate in the area covered by Sudene and would therefore not be eligible for treatment, eliminating possible self-selection bias. This control group is made up of firms based in the states of Minas Gerais and Espírito Santo¹⁴.

Based on this strategy, it is hoped that the robustness analysis will be able to verify that the results found in this study remain consistent, confirming their validity and, consequently, the reliability of the estimates obtained. To validate the results, estimates were calculated for these control groups.

The results of the pre-trend analyses for the number of links can be seen in Figure 1A and 1B respectively, in the appendix, and show that for all groups, the results corroborate the presence of parallel trajectories between the treated and untreated groups, with the exception of the estimation with controls from MG and ES, which showed differences between the 2014 group in 2007 and 2016 in 2015, strengthening the causal interpretation of the results¹⁵.

Table 3 shows the average treatment effects by time group¹⁶ for those “not yet treated” and those “never treated” outside Sudene’s area of operation. The results indicate that the companies that received the incentive of a 75% reduction in IRPJ increased the number of jobs by 11.65%, practically the same value measured in the estimation for those who never received treatment, which shows the robustness of the impact estimates. Furthermore, when the control group is made up of those “not yet treated”, the effect is 9.95% for the subgroup with controls outside Sudene’s area of operation. Therefore, it can be inferred that the results presented are robust, given that they reinforce the estimates obtained previously, and that the estimate is close to that obtained when the control group is those “never treated” within Sudene’s area of operation.

The results indicate that the incentive policy of reducing the corporate income tax (IRPJ)

14 To achieve this, a sub-group was set up, taking into account all the filtering criteria applied previously, comprising a total of 206 companies. Of these, 108 received treatment, while 98 did not.

15 The Appendices have been removed due to space limitations, but can be requested from the authors via e-mail.

16 Disaggregated effects by group were identified in both estimations. In addition, it was decided not to present the average effects of time and exposure to treatment, but they all followed the results of the previous estimations. If interested, these estimates can be requested from the authors.

of companies in Sudene’s area of operation by 75% contributes to an increase in formal jobs.

Table 3 - Robustness estimates

Control Groups	ATT	Standard Deviation	Confidence Interval [95%]	
“Not yet treated”	0,1102	0,0334	0,0447	0,1757 *
MG and ES outside Sudene	0,0949	0.0352	0.0258	0.1639 *

Source: Based on Econometric Estimation. Note 1 . There were no effects for the groups.

5. FINAL CONSIDERATIONS

Tax incentives and benefits are one of the PNDR’s main instruments for mitigating regional inequality in Brazil. They seek to attract productive enterprises to less developed regions, such as the Northeast, by reducing the rate of some taxes, particularly the IRPJ.

Although this has been a practice for decades, there are few studies that seek to evaluate it in any way. Therefore, in order to fill this gap in the literature, this study sought to evaluate the effect of receiving the incentive of a 75% reduction in the IRPJ, managed by Sudene, on the labor market, specifically on the number of jobs in the benefited companies.

To this end, the staggered difference-in-differences methodology developed by Callaway and Sant’Ana (2021) was used, considering the different years in which the IRPJ reduction incentive was granted, known as treatment, which took place between 2011 and 2019.

The research data comes from RAIS and SIBF microdata. The choice of outcome indicators, with the labor market (the number of jobs and the average wage) as the focus, is in line with the logic model of Shirasu, Corrêa and Irfi (2023). The time frame for the treatment was the date on which the report authorizing the treated companies to use the incentives was issued. The control group included companies of the same size and sector, but which did not receive tax incentives.

The results suggest a positive causal effect of the 75% IRPJ reduction policy on the number of jobs of 9.82%. This result suggests that the policy was effective in increasing the number of jobs in Sudene’s region of operation.

Therefore, it can be concluded that the incentive of a 75% reduction in the IRPJ contributes to greater dynamism in the labor market in the region where Sudene operates. This is due to the creation of new formal jobs that would probably not exist in the absence of this incentive. In line with the PNDR logic model presented by Shirasu, Corrêa and Irfi (2023), this result con-

tributes to achieving the policy's objective of reducing poverty in the region and consequently reducing regional disparities in Brazil.

In light of this result, the positive impact of the policy to reduce IRPJ by 75% for companies located in Sudene's region of operation, future work suggests an economic analysis of the policy, i.e. an analysis of the impact and economic return to analyze the cost-benefit ratio and/or the cost-effectiveness of the IRPJ reduction policy.

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