Evaluating Place-Based Policies: The Case of the FNE in Brazil

Avaliando as Políticas de Place-Based: O Caso do FNE no Brasil

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ABSTRACT

The study provides an evaluation of the impact of the FNE, the main Brazilian federal place-based policy, in the state of Pernambuco during the period 2000-2017. The empirical strategy considers recent difference-in-differences estimator with multiple time periods proposed by Callaway and Sant'Anna (2021) and an unique set of information at firm-level that allow us to control for the influence of other policies such as credits from FDNE and BNDES and fiscal incentives from Sudene and Prodepe (the local developemnt policy). The results indicate positive impacts of the FNE on job creation but reduction in average wages. We also found stronger effects for firms located in the semiarid region or in mesoregions further away from the metropolitan area of Recife, small-sized firms, and those in the commerce and service sectors.
Keywords: Public Policy Evaluation; FNE; Diff-in-Diff multiple periods; Pernambuco.

RESUMO

O estudo oferece uma avaliação do impacto do FNE, principal política place-based *brasileira, no estado de Pernambuco durante o período de 2000 a 2017. A estratégia empírica considera o estimador de* difference-in-differences *recente com múltiplos períodos temporais proposto por Callaway and Sant'Anna (2021) e um conjunto único de informações em nível de firmas que nos permite controlar a influência de outras políticas, como créditos do FDNE e BNDES, e incentivos fiscais da Sudene e Prodepe (a política local de desenvolvimento). Os resultados indicam impactos positivos do FNE na criação de empregos, mas redução nos salários médios. Também encontramos efeitos mais fortes para empresas localizadas na região semiárida ou em mesorregiões mais distantes da área metropolitana do Recife, empresas de pequeno porte e aquelas nos setores de comércio e serviços.*
***Palavras-chave**: Avaliação de Políticas Públicas; FNE; Diff-in-Diff múltiplos períodos; Pernambuco.*

Jel codes: R58, O2 and R38.

1 Introduction

Place-based policies refer to government programs designed to enhance the economic performance of specific geographic areas. These policies often involve providing subsidized loans and fiscal incentives to generate more job opportunities and increase local income (for recent surveys, see Neumark; Simpson, 2015, and Bailey; Pitelis; Tomlinson, 2023). Such policies are regularly present in developed and developing contexts despite the lack of consensus among economists about their relevance. On the one hand, some emphasize the loss of efficiency in allocating resources to less productive regions (to the detriment of more productive ones) with uncertain or even negative results (for example, Glaeser; Gottlieb, 2008; Austin; Glaeser; Summers, Austin; Glaeser; Summers; Fajgelbaum et al., 2019). On the other hand, others argue that such actions enable the correction of market failures, the internalization of spillovers, and the generation of agglomeration gains (see Kline; Moretti, 2014; Fajgelbaum; Gaubert, 2020; Fu; Gregory, 2019). Indeed,

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recently, Gaubert, Kline and Yagan (2021) have argued that when poor families are spatially concentrated can yield equity gains that outweigh their efficiency costs, even when income-based transfers are set optimally.

The causal inference regarding the effectiveness of these policies is relatively recent and still does not overwhelmingly favor either side of the dispute (for surveys of empirical results, see Neumark; Simpson, 2015; Beer et al., 2020; and Bailey; Pitelis; Tomlinson, 2023). For example, Ehrlich and Seidel (2018), Rupasingha et al. (2023), and Shenoy (2018) provided evidence of positive labor market effects of such policies in Germany, the US, and India, respectively. But Brachert, Dettmann and Titze (2019) found no impact on employment and wages of specific palce-based policies in Germany and Lu, Liu and Song (2022) evidenced a negative impact on regional innovation due to support for "zombie" firms in China.

In Brazil, such policies have a long tradition, being initially institutionalized with the creation of Sudene in 1959 (Diniz, 2009; Pessôa, 1999). By creating the *Fundos Cosntitucionais de Financiamento*[4] and allowing more fiscal freedom for states, the 1988 Constitution represented an institutional reinforcement for them. Currently, in addition to *Constitutional Financing Funds*, a policy that grants subsidized credit to firms in the Northeast (FNE), North (FNO), and Central-West (FCO) regions, the set of Brazilian place-based policies includes subsidized credit to firms through the Fundo de Desenvolvimento do Nordeste (FDNE) operated by Sudene, fiscal incentives (on federal taxes due by firms) conceded by Sudene and Sudam, and a set o state-level fiscal incentives based on the ICMS (the main state-level tax). However, as highlighted by Oliveira (2020), the *Fundos Constitucionais de Financiamento do Nordeste*, FNE, is the main place-based policy in Brazil. In 2023, for example, the FNE has conceded about R$ 43.7 billion in subsidized credit to firms in the Northeast region and parts of Minas Gerais and Espírito Santo (about 4% of Northeast GDP)[5].

Focusing on the state of Pernambuco, in this paper we evaluate the impact of FNE on the employment and labor income of benefited firms in the period 2000-2017. The exercise provides three contributions to the literature. First, we contribute to litearture by considering the most important place-based policy of an important developring country. As indicated by Neumark and Simpson (2015), while most of the available evidence refers to the experience of developed countries, given the greater scarcity of resources, evaluations of these policies tend to be even more important for developing countries. In this regard, as indicated by a recent study by Oliveira and Neto (2022), most Brazilian regional income disparities in the country are linked to regional inequality in schooling. In addition, Silveira-Neto and Azzoni (2012) discovered that income transfer programs substantially impact regional income inequalities in Brazil, mainly due to the high concentration of poor individuals in economically disadvantaged areas. These findings increase the opportunity cost of applying place-based policies and underscore the critical importance of their evaluation in the country.

Second, according to the authors' best knowledge, this is the first evaluation of FNE that explicitly considers the possible influence of benefits from other place-based or non-place-based policies in Brazil. Previous evaluation of FNE, such as those by Silva, Resende and Silveira Neto (2007), Silva, Resende and Silveira Neto (2009), Sousa, Soares and Pereira Neto (2009), Resende (2012), and Resende (2014), indicate positive effects on job creation at the firm level, but no effect on wages. Galeano and Feijó (2012) and Resende (2014), in turn, did not find significant impacts on municipal per capita GDP or labor productivity. These works deserve merits due to their pioneer status, but they present a major limitation: they do not consider the benefits that companies receive from other policies, in addition to those from the FNE. As a result, the evidence obtained cannot be solely attributed to the FNE. Differently, in our investigation, we can identify benefits to firms from all other place-based policies (including subsidized loans from FDNE, fiscal incentives from Sudene, and fiscal incentives from the state-level program, the Prodepe) and non-place-based policies (subsidized loans from BNDES). Therefore, our results reflect solely the effects of the subsidized loans from FNE. Notice that being able to identify the benefits firms receive from other policies allows us to assess the impact of a combination of policies (FNE plus other benefits). This represents an effective test of the reliability of previous estimates of FNE impacts and a subsidiary contribution of the paper.

Third, by analyzing the period from 2000 to 2017, we can estimate both the short-term and long-term effects of FNE, leading to a discussion of its long-lasting impacts. This aspect is essential from the regional

[4] Created by the Federal Constitution of 1988 and regulated by Law no 7.827/1989, they favor the North (FNO), Northeast (FNE), and Center-West (FCO) regions.

[5] <https://bit.ly/4cVyJHJ>

development perspective but has been largely overlooked in previous works.

Our empirical approach utilizes unique firm-level information during the period 2000-2017 and applies the Difference-in-Differences estimator with multiple periods suggested by Callaway and Sant'Anna (2021) (DiDMP). This comprehensive dataset combines firm-level information from RAIS (*Relação Anual de Informações Sociais*), provided by the Ministry of Labor and Employment, with data on benefits from FNE, fiscal incentives from Prodepe (the state-level fiscal incentive program) and Sudene (the regional development agency), as well as subsidized loans from FDNE and BNDES. In turn, diferent from the traditional Two-Way Fixed Effect model, the DiDMP estimator proposed by Callaway and Sant'Anna (2021) allows considering heterogeneities in groups of firms and variations in the timing of treatment. Our general findings show that, on average, the FNE contributed to an annual employment growth of 8.6% for benefiting firms and a decrease of 4.6% in the average wage paid by these firms. Such effects, however, do not persist over time: employment growth stops after 9 years with the benefit, and the reduction in average wages vanishes after 6 years. These result are robust to different robustness checks. Overall, our evidence does not favor the FNE as an instrument for regional development in Brazil.

In addition to this introduction, the text is organized into six parts. The next section explores the background of the FNE and location-based incentives in the state of Pernambuco. Section three presents the empirical specification used and the study data. Sections four and five present the results and robustness tests and heterogeneities, respectively. Section six presents results considering FNE and economic incentives from other different policies. The section seven presents the final remarks.

2 Background: the FNE and place-based incentives in Pernambuco

The FNE (*Fundo Constitucional de Financiamento do Nordeste*) was created by Law No. 7,827 of 1989, which regulates an article of the 1988 Constitution and operates in 2,074 municipalities (37.2% of the country's municipalities) situated in the nine states of the Northeast region and the North of the states of Espírito Santo and Minas Gerais, including the Vales of Jequitinhonha and Mucuri. Its goal is to contribute to economic and social development by providing access to subsidized credit for firms, individual entrepreneurs, associations, and cooperatives (BNB, 2024).

The resources of the policy come basically from 3% of the resources from the collection of IPI (*Imposto sobre Produtos Industrializados*) and IR (*Imposto de Renda*), two federal taxes. Of this total, the FNE accounts for 1.8%, with the remainder distributed equally across the North and Centre-West regions (through FNO and FCO). The total of resources also comprises the returns and results of their investments, resulting from the remuneration of resources not currently applied. The law requires that at least 50% of the funds be allocated to the semiarid region, which includes 1,477 municipalities. In turn, the interest rates for FNE loans are determined by the National Monetary Council (CMN), based on the recommendations of the Ministry of Integration and Regional Development. FNE loan rates vary according to four dimensions: the sector of activity (rural, irrigation, aquafishing, Manufacturing, agroindustry, tourism, commerce and services, and infrastructure), the type of use of resources (investments, working capital, and projects encouraged in the environment and science and information technology), the size of the firms, and the per capita household income of the region.[6] In general, the lowest rates are obtained by micro and small firms in rural areas. Between 2001 and 2015, for example, the average (weighted by the value of contracts) of these rates varied between 11.71% a.a. in 2001 and 9.54% a.a. in 2015.[7]

In their survey on the FNE, Gonçalves and Esteves (2020) highlighted its growing importance and characteristics. In this sense, they undescored the evolution of amounts contracted via FNE, which went from R$ 2.5 billion in the 1989/1990 biennium to R$ 32.7 billion in 2018. Such resources were distributed among the Manufacturing sector (19.6%), agro-industrial (1.8%), infrastructure (15.6%), commerce and services (21.4%) and rural (41.6%). During all the period, the resources of FNE would have favored both the small (47.3% of total) and large firms (37.9%).[8]

[6] For details, see <https://bit.ly/4bCHlSA>.

[7] See <https://bit.ly/4fb41ws>. Notice that in 2015 the Selic interest rate, the short-run rate of public bonds, was 13.3%.

[8] By the BNB criteria, the following classification by size is considered (according to income gross operational and/or gross agricultural income): i) mini/micro - up to R$ 360 thousand; ii) small - above R$ 360 thousand up to R$ 3.6 millions; iii)

In 2023, the FNE has conceded about R$ 43.7 billion in subsidized credit to firms in the Northeast region and parts of Minas Gerais and Espírito Santo (about 4% of Northeast GDP). As the allocation of resources to firms (within the minimum allocation criterion for the semiarid region) is dependent on the demand for firms, states with larger economic sizes end up receiving larger portions of loans. In 2023 for example, Bahia, Ceará, and Pernambuco received 51.2% of FNE resources, with Pernambuco specifically receiving 13.6% (about R$ 5.3 billion)[9]. In the same year, Pernambuco received approximately R$ 12.1 billion from the Bolsa Família Program and R$ 4.1 billion from the *Benefício de Prestação Continuada*, two important social programs, highlighting the significance of the FNE resources.[10].

The FNE, however, is not the only spatial-based policy implemented in Brazil, even considering federal-level government. At the federal level, for Sudene's area of activity, there is the FNDE (*Fundo de Desenvolvimento do Nordeste*), which also offers subsidized loans to companies, and tax incentives operated by Sudene. Since its establishment in 1959, Sudene has been providing tax incentives to promote economic development. The current version, valid until 2028, offers companies the following benefits: complete exemption of IRPJ (*Imposto de Renda de Pessoa Jurídica*) for manufacturing machines, equipment, and digital technology devices, a 75% reduction in IRPJ for modernization and expansion projects, and an option to reinvest 30% of the IRPJ for new investments. All of these incentives are valid for 10 years.[11] The FNDE, which was created in 2001, operates within the scope of Sudene. It provides subsidized loans to companies for up to 80% of the project value for a period of up to 12 years. The eligible projects include infrastructure, public service, structuring investments, and other sectors of interest. The financing limit ranges between 40% and 80% of the project value, with the higher limit applicable to projects in the semiarid region and infrastructure areas. In 2023, the FNDE had a total of R$4.99 billion available for new projects, which corresponded to less than 13% of the amount available from the FNE in the same year.[12]

With the greater fiscal freedom of states provided by the 1988 constitution and a certain weakening of the coordination of territorial policies in the 1990s, states also established local tax incentive programs based on ICMS (*Imposto sobre Circulação de Mercadorias e Serviços*) credits. In the state of Pernambuco, the Prodepe (*Programa de Desenvolvimento do Estado de Pernambuco*) was created in 1995 (Law 11,288/1995). The incentive is obtained through the granting of presumed ICMS credit, which varies from 47.5% to 95% (according to the region and activity). The fruiting period in this case is 12 years (which can be extended until December 31, 2032). Other northeastern states have implemented similar programs: in Maranhão, there was the *Sistema de Apoio à Indústria e ao Comércio Exterior do Estado do Maranhão* - SINCOEX; in Piauí, the *Lei de Incentivos Fiscais do Piauí*; in Ceará, the *Fundo de Desenvolvimento Industrial do Ceará* - FDI; in Rio Grande do Norte, the *Programa de Apoio ao Desenvolvimento Industrial do Rio Grande do Norte* - PROADI; In Paraíba, the *Fundo de Apoio ao Desenvolvimento Industrial da Paraíba* - FAIN; in Alagoas, the *Programa de Desenvolvimento Integrado do Estado de Alagoas* - PRODESIN; in Sergipe, the *Programa Sergipano de Desenvolvimento Industrial* - PSDI, and in Bahia, the *Programa de Desenvolvimento Industrial e de integração Econômica do Estado da Bahia* - DESENVOLVE.

Finally, although the spatial dimension does not affect its loan rates, given the reduced rates, BNDES (*Banco Nacional de Desenvolvimento Econômico e Social*) credits are regular sources of resources for firms in the Northeast states. In 2017, for example, of the companies from Pernambuco that received FNE resources and some other aid in 2017, 97.8% also received loans from BNDES. In other words, despite its non-spatial character, the loans from BNDES may have an important role in incentivizing the economic performance of firms in the Northeast.

As there is not any legal obstacle to receiving aid from different sources for a firm in Sudene's area of activity, the existence of different policies creates an additional challenge in assessing the impact of the FNE. As mentioned previously, we faced this challenge by accessing a unique set of information about companies in the state of Pernambuco (see Figure 1). This dataset contains information on companies that received

small-medium - above R$ 3.6 million to R$ 16 million; iv) medium - above R$ 16 million to R$ 90 million; and v) large - above R$ 90 million.

[9] In 2022, the FNE resources corresponded to about 1.4% of the Pernambuco GDP. We do not yet have the official Pernambuco GDP for 2023.

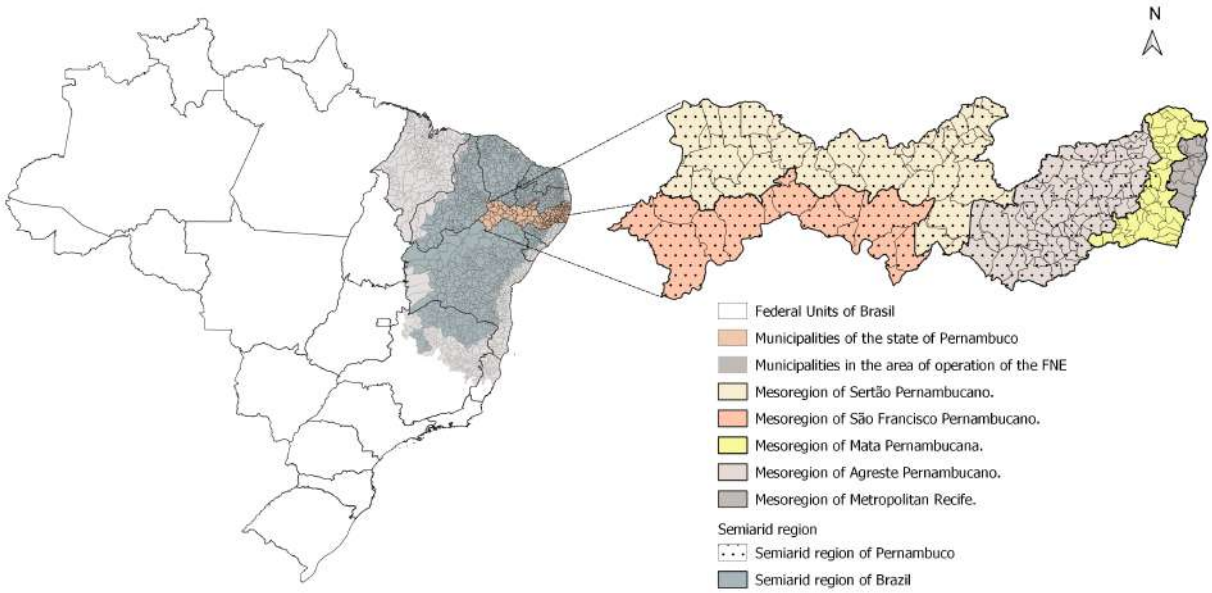
[10] <https://bit.ly/3xD9nzK>.

[11] See Carneiro et al. (2024) for a recent evalution of the application od these incentives.

[12] <https://bit.ly/3WdR4Jk>.

loans from FNE, BNDES, and FDNE, and tax incentives from Sudene and Prodepe (the local tax incentive program) from 2000 to 2017 and allows the identification of companies that only received incentives from FNE.

Although the focus on Pernambuco may lead to some loss of external validity, we believe that, if any, this should be reduced and the gains in precision in the assessment of FNE should easily compensate for it. In this regard, it should be noted that the aforementioned state, with about 9 million of pleople and a GDP of R$ 254.9 billion in 2022, is the second most populous and has the second-highest GDP in the region, with 16.3% and 17.8% of the Northeastern population and GDP, respectively (IBGE, 2022). Furthermore, given its geography, Pernambuco presents all the typical natural environments of the Northeast region (Coast, Atlantic Forest, Agreste, and Sertão) and approximately 66.5% of its municipalities are in the semiarid region, a region priority for the FNE. Notice that Pernambuco also contains the Metropolitan Region of Recife, the largest in the Northeast and the fifth largest in the country (with about 4 million people). Historically, the state has been the third with the most resources received from the FNE (Gonçalves; Esteves, 2020) and, in 2022, for example, FNE loans represented around 1.4% of the state's GDP.



Source: Author's own elaboration.

Figure 1 – Map of the area of activity of the municipalities of FNE and Pernambuco

Table 1, below, presents the number of firms in Pernambuco identified in RAIS (*Relação Anual de Informações Sociais*) and the number of firms benefiting from some incentive spatially based or not in the period 2000-2017. Note that these benefits refer to subsidized credits from FNE, FDNE, and BNDES, and fiscal incentives from Sudene and Prodepe. The information is organized into four blocks: total RAIS firms (column (A)), firms benefiting from any policy (columns (B) and (B/A)), firms benefiting from the FNE (columns (C), (C /B), (D), and (D/B)), and firms not benefiting from the FNE (columns (E), (E/B), (F), and (F/A)).

The information reveals the importance of the FNE and other incentives. We highlight three pieces of evidence here. First, it is possible to notice a clear increase in the number of firms benefiting from incentives, including the FNE, in the period. It is possible to perceive in 2017 about 12.8% and 7.1% of firms benefited from any incentive and by FNE, respectively. These numbers corresponded to only 0.7% and 0.06% in 2000, respectively. Second, there is a clear tendency for the FNE to gain importance compared to other incentives in the period. For example, while in 2000 only 8.3% of benefiting firms received FNE loans, this percentage rose to 56.0% in 2017. Last but not least, despite the previous trend, there is a clear tendency for firms benefiting from the FNE to also benefit from other policies. While in 2000 87.9% benefiting from the FNE only received such assistance, in 2017 this percentage is 72.7%. In 2017, for example, of the 6,948 firms that received FNE credits, 1,893 of them (27.2%) also received other types of aid. A reliable assessment of the

effects of the FNE on benefiting companies must, therefore, consider such a situation of overlapping benefits. Otherwise, we will be evaluating the effects of a "cocktail" of benefits.

Table 1 – **Firms benefited and not benefited by credit and fiscal incentives - spatial-based and non-spatial-based policies - Pernambuco**

Year	Total	Firms benefited	%	Firms benefited by the FNE				Firms not benefited by the FNE			
				FNE	%	Only FNE	%	Other policy	%	No policy	%
	(A)	(B)	(B/A)	(C)	(C/B)	(D)	(D/B)	(E)	(E/B)	(F)	(F/A)
2000	48.389	336	0,7	28	8,3	25	7,4	308	91,7	48.053	99,3
2001	50.573	501	1,0	31	6,2	25	5,0	470	93,8	50.072	99,0
2002	53.366	681	1,3	40	5,9	31	4,6	641	94,1	52.685	98,7
2003	55.077	928	1,7	82	8,8	67	7,2	846	91,2	54.149	98,3
2004	57.757	1.071	1,9	184	17,2	148	13,8	887	82,8	56.686	98,1
2005	60.802	1.421	2,3	387	27,2	320	22,5	1034	72,8	59.381	97,7
2006	63.811	2.105	3,3	829	39,4	715	34,0	1276	60,6	61.706	96,7
2007	66.122	2.798	4,2	1.286	46,0	1108	39,6	1512	54,0	63.324	95,8
2008	69.147	3.603	5,2	1.782	49,5	1508	41,9	1821	50,5	65.544	94,8
2009	73.344	4.834	6,6	2.364	48,9	1949	40,3	2470	51,1	68.510	93,4
2010	79.360	7.442	9,4	2.969	39,9	2227	29,9	4.473	60,1	71.918	90,6
2011	84.850	9.487	11,2	3.496	36,9	2511	26,5	5.991	63,1	75.363	88,8
2012	90.698	11.077	12,2	4.148	37,4	2880	26,0	6.929	62,6	79.621	87,8
2013	95.008	12.024	12,7	4.655	38,7	3180	26,4	7.369	61,3	82.984	87,3
2014	99.548	12.862	12,9	5.287	41,1	3612	28,1	7575	58,9	86.686	87,1
2015	100.212	13.090	13,1	5.929	45,3	4114	31,4	7161	54,7	87.122	86,9
2016	98.164	12.819	13,1	6.344	49,5	4481	35,0	6475	50,5	85.345	86,9
2017	97.261	12.408	12,8	6.948	56,0	5055	40,7	5460	44,0	84.853	87,2
Total	**1.343.489**	**109.487**	**8,1**	**46.789**	**42,7**	**33.956**	**31,0**	**62.698**	**57,3**	**1.234.002**	**91,9**

Note: (A) Total number of firms established in the state of Pernambuco; (B) Total number of firms benefited by any policy; (C) Firms benefited by the FNE and another policy (state or federal); (D) Firms exclusively benefited by the FNE; (E) Firms not benefited by the FNE but received benefits from another policy at some point; (F) Firms not benefited by any policy. Firm-year data are considered for the panel from 2000 to 2017.
Source: Author's own elaboration based on information from BNB, BNDES, Sudene, Prodepe, and RAIS microdata.

3 Empirical Strategy

3.1 Econometric Specification

In our assessment of the impact of the FNE, no external shock or natural experiment has influenced the firms' condition of being benefited by the FNE. However, our database enables us to monitor both beneficiary and non-beneficiary firms over time. This allows us to use a Difference in Differences strategy to estimate the impact of the policy. When considering this strategy, two important challenges arise. Firstly, we need to accurately identify companies that have received benefits exclusively from FNE. Secondly, due to the time variation in the treatment across firms, we must ensure that we are comparing treated and non-treated firms correctly over time. As discussed in the previous section, focusing on Pernambuco allowed us to access unique information about the benefits obtained by firms from other policies. To face the second challenge we consider the Multiple Periods Difference-in-Differences estimator proposed by Callaway and Sant'Anna (2021).

As recently highlighted by Borusyak and Jaravel (2017), Chaisemartin and d'Haultfoeuille (2020) and Goodman-Bacon (2021), the traditional two-way fixed effect model (TWFE) may not provide an unbiased estimate of treatment effects when there are multiple periods, and firms become treated at different points in time. Essentially, this happens because the TWFE estimates a weighted average of treatment effects, including a problematic comparasion between newly treated units and already treated units. As shown by Sun and Abraham (2021), the problem extends to the "dynamic" version of TWFE used to estimate leads and lag effects. To address these issues and potential variations in treatment across units, Callaway and Sant'Anna (2021) proposed a semi-parametric approach that involves estimating the treatment effect for each treatment cohort (g), each period (t), and each period since exposure to treatment within a Differences-in-Differences framework. Indeed, the strategy enables aggregating these impacts into average treatment effect parameters of interest.

In this regard, the primary parameter of interest is the average treatment effect for companies belonging to the treatment cohort g in the period t represented by:

$$ATT(g,t) = E[Y_t(g) - Y_t(0)|G_g = 1], \quad t \geq g \tag{1}$$

where $Y_t()$ is the outcome at time t and $G_g = 1$ indicates units belonging to treatment cohort g.

Callaway and Sant'Anna (2021) demonstrated that, under limited treatment anticipation and the conditional parallel trends hypothesis, the aforementioned effect can be estimated using the augmented inverse propensity weighted (AIPW)/double robust (DR) estimator of Sant'Anna and Zhao (2020). Furthermore, the impacts may be aggregated in different dimensions (cohort and/or time) to obtain specific treatment effects. An overall indicator of treatment effect considers weighted aggregation and can be obtained by:

$$\theta^{all} = (1/k) \sum_{g=2} \sum_{t=2}^{T} 1\{t \geq g\} ATT(g,t) P(G = g|G \leq T) \tag{2}$$

where $k = \sum_{g=2} \sum_{t=2}^{T} 1\{t \geq g\} P(G = g|G \leq T)$ and $P(G = g|G \leq T)$ measures the weight of treatment cohort g in the total.

The strategy also enables the estimation of the average treatment effect for the group of units exposed to treatment for exactly $e = t - g$ periods. These estimates are useful for verifying the assumption of common trends and identifying potential variations in treatment effects over time. The authors' version of the event study can be obtained by:

$$\theta^{event}(e) = \sum_{g=2} 1\{g + e \leq T\} ATT(g, g+e) P(G = g|G + e \leq T) \tag{3}$$

where $1\{g + e \leq \tau\}$ takes the value 1 when the time elapsed after entry into the program is exactly e, and 0 otherwise, and $P(G = g|G + e \leq T)$ is the proportion of treated units in group g at e. The parameter, thus, provides the average effect of the program for units treated for e periods after/before program entry. In the case of the impact assessment conducted here, it is possible to calculate this parameter for $e = 1, 2, ..., 10$ with respect to periods before and after.

In our baseline estimation, we utilized a control group comprising companies that have never received any assistance from federal or state aid programs. This group was identified by gathering information from RAIS about companies in the state and cross-referencing it with data obtained from aid organizations (BNB, Sudene, BNDES, and the State of Pernambuco). Notice that we use longitudinal firm data, which allows us to consider a signifcant set of control variables, including characteristics of the firms and their workers (see Table 2).

3.2 Database

Our set of information results from the matching of companies identified by the *Cadastro Nacional de Pessoas Jurídicas* (CNPJ) in RAIS (*Relação Anual de Informações Sociais*), an official dataset from the Minsitry of Labor and Employment, with information from companies benefiting from aid from the FNE, (through the BNB, *Banco do Nordeste do Brasil*), BNDES (through the BNDES itself), FNDES and tax incentives (through Sudene), and Prodepe (through the Department of Economic Development of the State of Pernambuco). From these matching, we obtained a unique panel of companies for the period 2000-2017 that allows us to identify and monitor companies that were beneficiaries only of the FNE.

From 2000 to 2017, the FNE granted loans to 15,809 firms in Pernambuco, of which 9,772 were found in RAIS. This difference is mainly explained by the possibility of obtaining resources from the FNE without having a CNPJ (*Cadastro Nacional de Pessoas Jurídicas*)[13]. Thus, this database was combined with the Prodepe, BNDES, Sudene, and FDNE databases[14]. Throughout the period, we identified 8,231 firms receiving only FNE loans, which corresponds to the treatment group (with 33,956 company-year

[13] Thus, our investigation is based on formal firms that received loans from FNE.

[14] However, the FDNE contained only 3 CNPJs, making the analysis less significant, which is why they were excluded.

observations). The control group, on the other hand, consisted of 226,996 firms without any type of aid during the period (a total of 1,202,132 company-year observations)

Table 2 presents descriptive statistics of the variables of firms in the treatment and control groups for the years 2000, 2008, and 2016. It should be noted that among the control variables, there are characteristics specific to the firms (age, time in the market, size, and sector of activity), as well as their workers (average age, average tenure, education, and average hours worked) and location (mesoregions of the state and semiarid region). In general, benefited and non-benefited firms are similar in terms of size and characteristics of workers. The biggest differences concern the greater presence, among those not benefiting, of firms in the service sector and, among those benefiting from the FNE, of firms located in the semiarid region.

Table 2 – **Descriptive Statistics - FNE - benefited and non-benefited firms**

Variables	Benefited						Non-benefited					
	2000		2008		2016		2000		2008		2016	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Outcomes												
ln (employment)	1.88	1.04	1.81	0.90	1.80	0.85	1.68	1.03	1.66	0.99	1.60	0.97
ln (payroll)	8.15	1.45	8.30	1.34	8.50	1.43	8.02	1.59	8.14	1.58	8.24	1.70
ln (wage)	6.57	0.43	6.76	0.57	6.98	0.79	6.67	0.71	6.81	0.78	7.00	.98
Employment	9.64	9.92	10.43	30.5	9.00	31.10	17.15	283.78	15.74	240.00	13.26	205.88
Average wage	801.6	537.7	938.1	414.3	1206.6	635.16	1002.91	1172.65	1095.70	1080.31	1345.5	1234.8
Payroll	7475.3	7355.9	11936.5	44334.2	12374.0	55048.14	30730.69	632225.9	30182.95	685172.1	31328.5	774433
Firm Characteristics												
Simples program	0.76	0.44	0.78	0.41	0.80	0.40	0.44	0.50	0.53	0.50	0.60	0.49
ln(age)	1.97	0.75	2.18	0.76	2.25	0.75	2.00	0.89	2.16	0.90	2.11	0.93
Time on the market	8.11	6.25	10.38	7.75	11.20	8.48	9.40	8.34	11.17	9.42	11.07	10.39
Micro	0.79	0.42	0.82	0.39	0.82	0.39	0.84	0.37	0.84	0.37	0.85	0.36
Small	0.21	0.42	0.17	0.38	0.17	0.38	0.14	0.35	0.14	0.35	0.13	0.34
Medium/large	0	0	0.01	0.10	0.01	0.08	0.05	0.12	0.02	0.12	0.01	0.12
Agriculture	0.04	0.2	0.02	0.13	0.01	0.09	0.05	0.21	0.04	0.20	0.04	0.19
Manufacturing	0.56	0.51	0.16	0.37	0.14	0.35	0.11	0.31	0.10	0.30	0.09	0.29
Commerce	0.36	0.49	0.68	0.47	0.61	0.49	0.42	0.49	0.45	0.50	0.42	0.49
Services	0.04	0.2	0.14	0.35	0.23	0.42	0.38	0.49	0.37	0.48	0.41	0.49
Construction	0	0	0.01	0.08	0.01	0.11	0.03	0.17	0.03	0.16	0.03	0.17
Others	0	0	0.01	0.05	0.01	0.12	0.05	0.21	0.04	0.18	0.04	0.20
Worker Characteristics												
Age	29.77	7.13	31.21	6.52	33.40	6.79	32.39	7.86	34.09	8.03	36.08	8.66
Age^2	935.11	454.17	1016.60	462.96	1161.53	503.78	1110.69	568.06	1226.78	602.92	1376.51	676.67
Tenure	28.59	35.84	30.14	25.04	38.54	30.27	40.15	45.74415	41.41	46.21	45.97	49.88
$Tenure^2$	2050.93	5807.44	1535.12	3340.39	2400.96	5137.26	3704.66	10380.62	3850.32	10184.01	4601.23	12404.81
Hours	44	0	43.32	3.49	43.32	3.16	42.77	4.37	43.05	3.84	43.02	3.69
Illiterate	0.20	0.65	0.08	0.79	0.04	0.52	0.28	0.98	0.35	0.82	0.10	0.84
Elementary	0.56	0.40	0.29	0.34	0.16	0.26	0.45	0.41	0.32	0.39	0.18	0.32
High school	0.38	0.37	0.61	0.35	0.75	0.31	0.44	0.40	0.57	0.40	0.69	0.37
College	0.05	0.11	0.09	0.21	0.10	0.21	0.08	0.21	0.10	0.24	0.12	0.27
Location												
Agreste	0.16	0.37	0.28	0.45	0.30	0.46	0.16	0.36	0.19	0.39	0.21	0.40
Mata	0.48	0.51	0.15	0.36	0.14	0.34	0.10	0.29	0.10	0.30	0.10	0.30
Metropolitan	0.12	0.33	0.27	0.44	0.30	0.46	0.64	0.48	0.59	0.49	0.57	0.50
Sertão	0.2	0.41	0.19	0.39	0.14	0.35	0.06	0.23	0.06	0.24	0.06	0.24
São Francisco	0.04	0.2	0.10	0.31	0.13	0.33	0.05	0.22	0.06	0.24	0.07	0.25
Semiarid	0.4	0.5	0.54	0.50	0.54	0.50	0.26	0.44	0.31	0.46	0.32	0.47
Non-semiarid	0.6	0.5	0.46	0.50	0.46	0.50	0.74	0.44	0.69	0.46	0.68	0.47
Observations	**25**		**1,508**		**4,481**		**48,053**		**65,544**		**85,345**	

Notes: Descriptive statistics of firms benefiting exclusively from the FNE and firms not benefiting from any policy in the state are considered.
Firm-year data for the panel from 2000 to 2017 are considered.
Source: Author's own elaboration based on microdata from BNB and RAIS.

4 Baseline Results

This section explores the main findings of the study. We present baseline results of the general impact of FNE subsidized credit on employment, average wages, and payroll of benefiting companies. We then present robustness checks for our estimates.

4.1 The Impact of FNE

Table 3 presents the general average effects of the FNE on employment, average wages, and firms' payroll of firms that benefited exclusively from its benefits (estimates corresponding to equation (2)). Columns (1)-(3) show the general effects of the FNE without control variables, while columns (4)-(6) present such estimates adding controls (municipality and characteristics of firms and their workers). As already stated, we used the doubly robust DiD estimator based on inverse probability weighting and ordinary least squares suggested by Sant'Anna and Zhao (2020) and a control group formed by firms that did not receive any type of incentive (the "never treated" firms).

According to the values in the aforementioned table, the estimates with the increase in the number of controls beyond the firm fixed effect (Columns (4)-(6)) are not significantly different from those obtained

only with the firm fixed effect (Columns (1)-(3)). This is consistent with the similarity between the treated and untreated groups concerning observable variables. On the assumption of unconditional parallel trends, we observe that the general average treatment effect on employment was positive and significant, with an increase of 8.6% for the benefiting companies. On the other hand, there was a negative and significant average effect on average wages, with a reduction of 4.4%, and no effect on firms' payroll was found. Taken together, these results are consistent with the idea that FNE loans help to expand employment without, however, generating productivity gains. The average reduction in wages is also consistent with the incorporation of less qualified workers into the formal sector of the economy.

Note that our estimates present important differences concerning those available in the FNE evaluation literature that also uses RAIS microdata. For example, estimates of Silva, Resende and Silveira Neto (2009) considering the period 2000-2003 point to a difference in employment growth for firms benefiting from FNE between 55.7% and 65.1%, and no effect on wages is found. In turn, Soares et al. (2014), analyzing the period 2000-2008, found a positive effect on employment and payroll of firms benefiting from the FNE of around 4.7% and 4.4% per year, respectively. Similar to Silva, Resende and Silveira Neto (2009)'s results, these authors did not found any effect on average wages paid by firms.

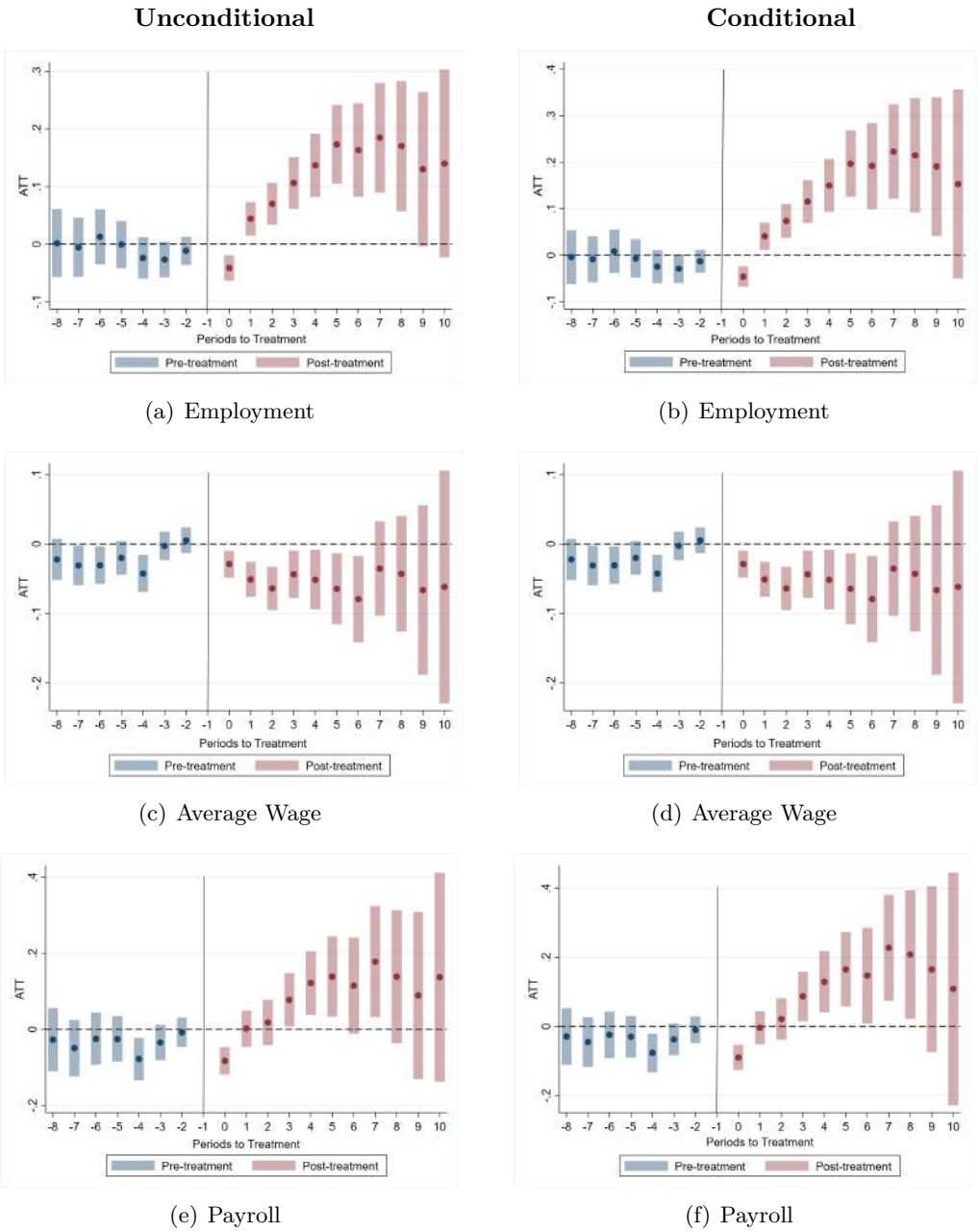
Table 3 – **General Average Effects of FNE on benefited firms**

	Employment (1)	**Wage** (2)	**Payroll** (3)	**Employment** (4)	**Wage** (5)	**Payroll** (6)
ATT FNE	**0.079*** (0.020)**	**-0.047*** (0.012)**	**0.042 (0.029)**	**0.086*** (0.021)**	**-0.044*** (0.012)**	**0.049 (0.042)**
Controls	-	-	-	√	√	√
N. of FNE Firms	8,231	8,231	8,231	8,231	8,231	8,231
N. of Total Firms	235,227	235,227	235,227	235,227	235,227	235,227
Observations	1,267,958	1,267,958	1,267,958	1,267,958	1,267,958	1,267,958

Notes: Wbootstrap firm-level clustered standard error in parenthesis. [1]ATT = The effect of the FNE on employment, average wage and payroll of the benefited firms estimated based on the assumption of unconditional parallel trends (Columns (1)-(3)) and the assumption of conditional parallel trends (Columns (4)-(6)). Statistical significance level: (*) $P < 0.1$; (**) $P < 0.05$; (***)$P < 0.01$.
Source: Author's own elaboration.

The confidence in the results obtained so far crucially depends on the absence of pre-existing trend differences between treated and non-treated firms related to outcome variables. We address this point by conducting an Event Study. The estimates are presented in Figure 2, both for conditional and unconditional specifications. The values indicate estimates of the impact of the FNE on beneficiary companies, taking as a reference a period before the start of the program and considering up to 8 years before the treatment (in blue) and up to 10 years after it (in red), alongside confidence intervals of 95% with standard deviation clustered at the firm level.

As can be seen in Figure 2, for all three outcomes, there is no evidence that the results are affected by anticipatory effects, which increases confidence in our estimates. On the other hand, the estimates revealed indicate that the positive effect on employment, despite the increase up to 7 years after receiving FNE aid, does not persist over time, ceasing to exist after 10 years of receiving the credit. Note that this non-persistence of time also occurs with the negative effect of the FNE on the average wage paid by firms, which disappears after 7 years from the date of the loan. These two pieces of evidence indicate that, at least when all types of FNE financing are considered together, the FNE's effects are temporary.



(a) Employment (b) Employment

(c) Average Wage (d) Average Wage

(e) Payroll (f) Payroll

Figure 2 – Event Study: Effects of FNE on employment, average wage, and total payroll - unconditional and conditional

We explore more specific results for the effects of the FNE on employment, average wage, and payroll of benefiting companies, considering different groups of companies according to the start date of receiving the loan.[15]

4.2 Robustness checks

To verify the reliability of the above results of the study, we conducted some robustness checks. These checks involve considering a different control group, discarding potential outliers, and using different estimators.

The first test considers a control group composed of firms benefiting from the FNE in later periods, instead of firms that never received FNE resources (as in our baseline). The motivation is the possible

[15] Due to space constraints, differences between treated groups according to the start date of FNE assistance are not fully explored here. However, such results can be immediately upon request.

existence of time-varying factors that affect firms financed by the FNE differently after the start of the loan. As never treated firms would not suffer such influences, they could not be good counterfactuals. The new set of evidence is presented in columns (4)-(6) of Panel A of Table 4. To facilitate the comparison, in columns (1)-(3) of Panel A we also present our estimates with a control group composed of "never treated" firms (our baseline).

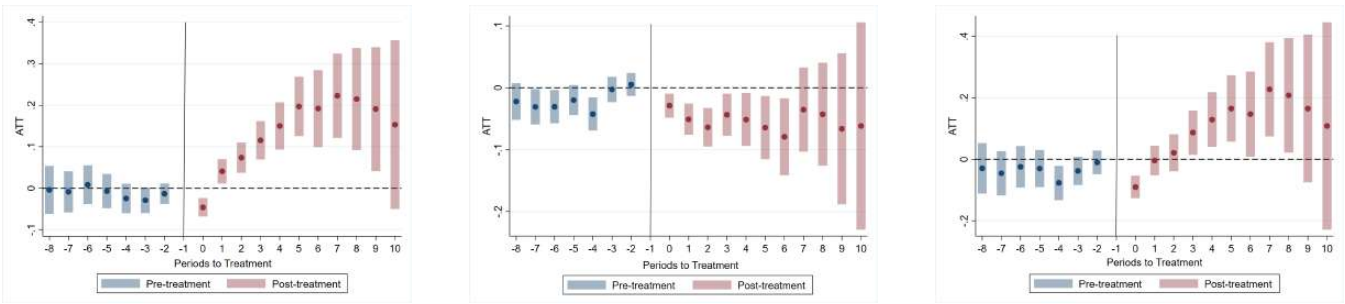
As can be immediately seen by comparing the corresponding columns of Table 4, the new estimates are very close to those already obtained in our baseline specification. Such an inference makes it very unlikely that our results are influenced by unobserved factors that particularly affect the firms benefiting from the FNE.

Table 4 – **Robustness tests: different control groups and estimators**

Panel A: complete sample	**Never Treated**			**Not-yet Treated**		
	Employment	**Wage**	**Payroll**	**Employment**	**Wage**	**Payroll**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
ATT FNE - CS (cond)	0.086***	-0.046**	0.049	0.084***	-0.039**	0.059*
	(0.033)	(0.015)	(0.042)	(0.026)	(0.015)	(0.015)
ATT FNE - CS (Uncon)	0.079***	-0.047***	0.042	0.079***	-0.045*	0.049
	(0.020)	(0.012)	(0.029)	(0.045)	(0.104)	(0.089)
ATT FNE - TWFE	0.102***	-0.051***	0.039***	0.092***	-0.041***	0.093*
	(0.007)	(0.006)	(0.012)	(0.007)	(0.006)	(0.012)
N. of FNE firms	8.231	8.231	8.231	8.231	8.231	8.231
Observations	1,267,958	1,267,958	1,267,958	70,702	70,702	70,702
Panel B: without the highest and lowest 2.5%	**Never Treated**			**Not-yet Treated**		
	Employment	**Wage**	**Payroll**	**Employment**	**Wage**	**Payroll**
	(7)	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
ATT FNE - CS (cond)	0.085***	-0.042**	0.057	0.080***	-0.039***	0.060**
	(0.028)	(0.010)	(0.019)	(0.016)	(0.010)	(0.003)
ATT FNE - CS (Uncon)	0.080***	-0.045***	0.039	0.073***	-0.040**	0.064*
	(0.019)	(0.006)	(0.023)	(0.015)	(0.006)	(0.025)
ATT FNE - TWFE	0.097***	-0.049***	0.043*	0.084***	-0.049**	0.072*
	(0.010)	(0.010)	(0.010)	(0.003)	(0.004)	(0.010)
N. of FNE firms	7.390	8,196	8,016	7.390	8,196	8,016
Observations	1,262,663	1,267,547	1,266,338	65,829	70,438	71,284

Notes: Wbootstrap firm-level clustered standard error in parenthesis. [1]ATT = The effect of the FNE on employment, average wage and payroll of the benefited firms estimated based on different control groups: i) never treated in columns (1)-(3) and (7)-(9); ii) Not-yet treated in columns (4)-(6) and (10)-(12).
Statistical significance level: $(^{*})$ $P < 0.1$; $(^{**})$ $P < 0.05$; $(^{***})P < 0.01$.
Source: Author's own elaboration.

This finding is reinforced by the evidence obtained from the event studies using this new control group of firms presented in Figure 3. The event studies in this figure are practically indistinguishable from their counterparts in Figure 2.

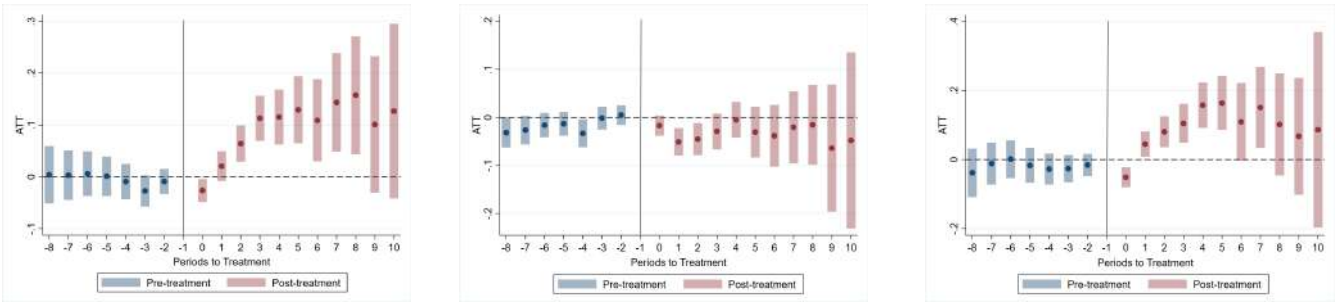


(a) Employment (b) Average Wage (c) Payroll

Figure 3 – Robustness Test: Event study of the effects of FNE on results only with groups not yet treated by the policy.

The second robustness checks verify if the baselline results for FNE are influenced by potential outliers.

To this end, we generated new estimates excluding the firms belonging to the groups of the 2.5% highest and lowest value of outcomes. These new estimates are presented in Panel B of Table 4: in columns (7)-(9) using those never treated as controls and in columns (10)-(12) using those not yet treated as controls. As can be seen from the numbers of these columns, these new estimates are similar to those obtained using our baseline specification. The estimates corresponding to the event studies using the new samples and never treated as control group are shown in Figure 4. Once more, we note no important differences when comparing the new estimates with those of our baseline in Figure 2. This again reinforces confidence in our initial results.



(a) Employment (b) Average Wage (c) Payroll

Figure 4 – Robustness Test: Event study of effects of FNE on outcomes without outlier firms.

5 Heterogeneities

In this section, we explore three important heterogeneities associated with the effects of the FNE on beneficiary companies. As described previously, interest rates on FNE loans vary according to three dimensions: spatial, sectoral, and company size. Such differentials reflect presumed differences in the importance of loans and policy self-interest. Notice that although all of these dimensions are represented in our control variables, this does not prevent the effects of FNE from varying across categories within these dimensions. We, thus, obtain specific estimates of the impact of FNE exploring differences within each of these dimensions.

5.1 Different regions

Here, we obtain new separate estimates of the impact of the FNE on benefiting companies in the Metropolitan Region of Recife, Agreste, Sertão, and the semiarid northeastern region. We can visualize these regions in Figure 1. Note that, of all the companies benefiting from fund credit between 2000 and 2017, about 28,7% were in the Agreste, while 28% were in the metropolitan mesoregion of Recife, 16.6% in the Sertão Pernambucano, 12.7% in the Sertão do São Francisco, and 14% in the Mata Pernambucana.

The semiarid region is mainly made up of municipalities in the Agreste and Sertão mesoregions and receives special attention from FNE management, once in addition to lower rates, by law 50% of loans must be applied to it. The list of municipalities in the semiarid region has changed over time (for example, in 2005, 2017, 2021, 2024) and, to consider the same spatial area, we solely use in the semiarid estimates firms that belonged to municipalities that were in the semiarid region according to the 2000 classification. Of the 118 municipalities belonging to the semiarid region, as defined by SUDENE in 2000[16], 97.5% presented firms benefiting from subsidized credit.

[16] SUDENE conducted new studies, and through Ordinance No. 1182, dated September 14, 1999, an additional 139 municipalities were included, resulting in the semiarid region being redefined as follows: Alagoas (35), Bahia (257), Ceará (134), Minas Gerais (40), Pernambuco (118), Piauí (109), Rio Grande do Norte (140), Sergipe (28), and Paraíba (170), totaling 1,031 municipalities for the purpose of applying the resources from the Constitutional Fund for Financing the Northeast (FNE), which remains in effect to this day. It is also recommended that the Drought Polygon no longer be used as a legal instrument for delineating areas of the Northeast subject to droughts, as the previous delimitation lost its relevance after the creation of the Semiarid Region by Federal Law No. 7,827, dated September 27, 1989. In this context, the 118 municipalities comprising the semiarid region of the state of Pernambuco were analyzed (BRASIL, 2005).

Table 5 presents the effects of the FNE on the benefited firms by regions and in municipalities of the semiarid region.[17] Although most of the new results are qualitatively similar to those already presented, it is possible to notice variations in the magnitude of the FNE effects and even some differences according to the geographic environment.

More specifically, while the results obtained for firms in the RMR and Agreste are well in line with those already discussed (together they represent 56.6% of the firms benefited by the program), the estimates for firms in the Sertão and semiarid region indicate greater impacts of the FNE on employment and even positive on the payroll of the benefited firms. Actually, for the benefited firms located in the Sertão and Semiarid regions, the values indicate stronger employment increases by 14% and 11.3%, respectively, and in both cases growth in the payroll. Notably, the negative effect of FNE on average wages was also the smallest for these two areas. The results suggest that the FNE is more important for the semiarid and Sertão regions of the state, which is consistent with a greater possible lack of credit in these regions. However, we highlight the robust evidence that the effect on firms' productivity, measured by the mean wage, is still negative.

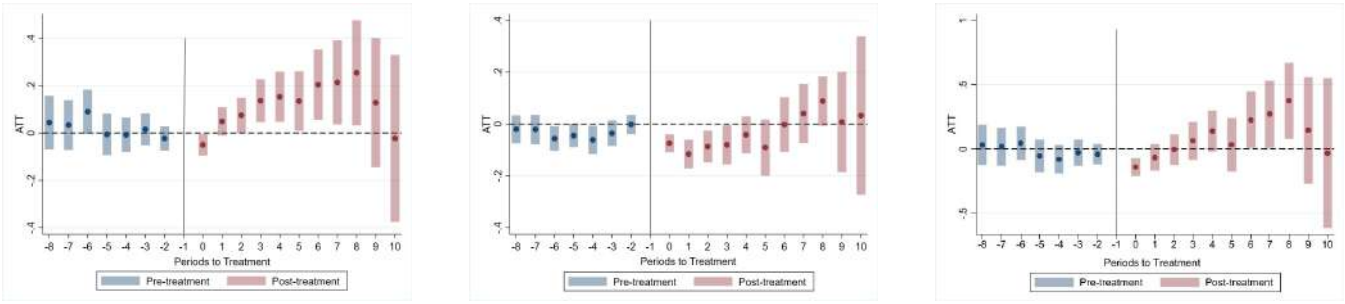
Table 5 – **Effects of FNE on benefited firms by regions**

Panel A	**Metropolitan Region**			**Agreste**		
	Employment	**Wage**	**Payroll**	**Employment**	**Wage**	**Payroll**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
ATT FNE	**0,084****	**-0,064*****	**0,023**	**0,080****	**-0,059****	**0,037**
	(0,037)	**(0,021)**	**(0,052)**	**(0,035)**	**(0,023)**	**(0,052)**
Controls	√	√	√	√	√	√
No. of Firms (FNE)	2,599	2,599	2,599	2,364	2,364	2,364
Total No. of Firms	133,055	133,055	133,055	48,666	48,666	48,666
Observations	738,931	738,931	738,931	244,350	244,350	244,350
Panel B	**Sertão**			**Semiarid**		
	Employment	**Wage**	**Payroll**	**Employment**	**Wage**	**Payroll**
	(7)	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
ATT FNE	**0,139*****	**-0,038***	**0,124***	**0.113*****	**-0.036****	**0.102****
	(0,043)	**(0,021)**	**(0.060)**	**(0.029)**	**(0.018)**	**(0.043)**
Controls	√	√	√	√	√	√
No. of Firms (FNE)	2,189	2,189	2,189	4,369	4,369	4,369
Total No. of Firms	31,961	31,961	31,961	18,709	18,709	18,709
Observations	160,349	160,349	160,349	389,985	389,985	389,985

Notes: Wbootstrap firm-level clustered standard error in parenthesis. Where (1, 4, 7 and 10) refers to the dependent variable of employment, (2, 5, 8 and 11) the average wage and (3, 6, 9 and 12) the Payroll. Statistical significance levels: (*)$P < 0.1$; (**) $P < 0.05$; (***)$P < 0.01$.
Source: Author's own elaboration.

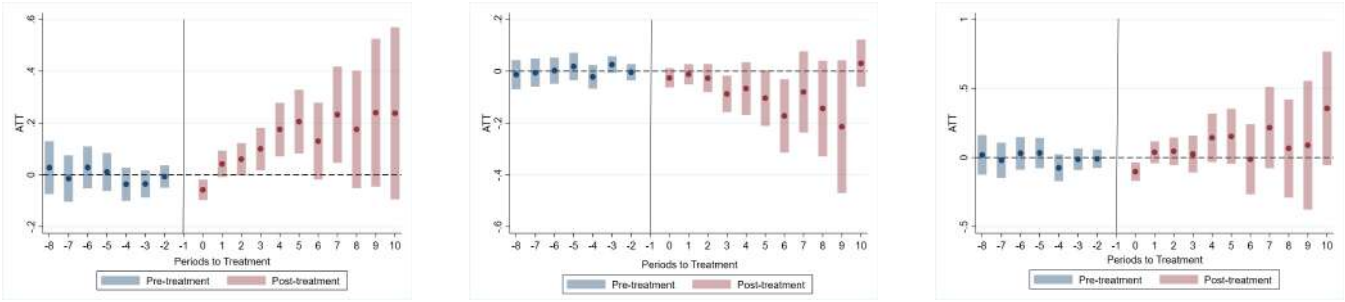
Figure 5 presents a set of event studies for our outcomes in the Pernambuco's mesoregions and semiarid. Note that in all cases, we got evidence favoring parallel trends for treated and non-treated firms. Similar to our previous results, the effects of FNE on employment are transitory for the RMR and Agreste regions. On the other hand, the evidence favors a persistent positive effect on employment in the Sertão and Semiarid regions. Overall, our results are partially consistent with those from Mata and Resende (2020) in they study about the impact of FNE on the semiarid regions. As obtained by these authors, the aggregate results for the semiarid region indicate an increase of 12.1% in employment and a 10.5% increase in payroll. But, unlike what they obtained, our results do not indicate any positive effect on the average wage and we estimate a negative impact of 3.6%.

[17] We have fewer observations for the mesoregion of Mata Pernambucana, which is why it is not considered. Also, note that we treat firms from the two mesoregions of Sertão (Sertão Pernambucano and São Francisco Pernambucano) as belonging to the single region denoted by Sertão.



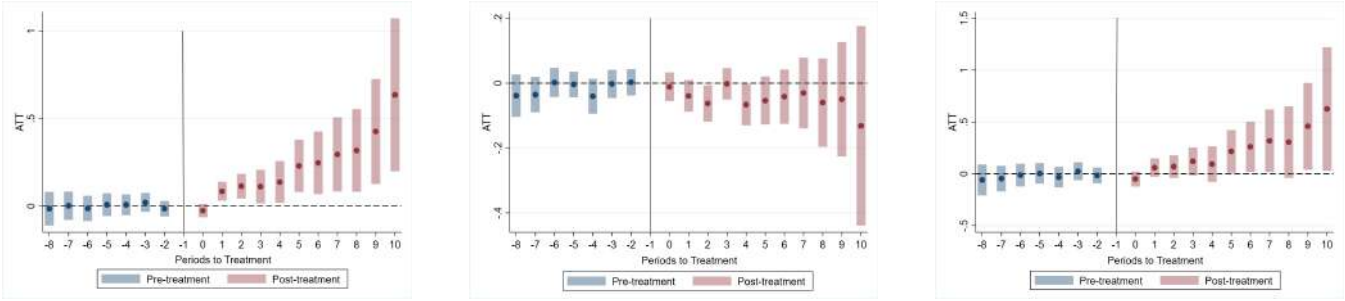
(a) Employment (b) Average Wage (c) Payroll

Metropolitan Mesoregion of Recife.



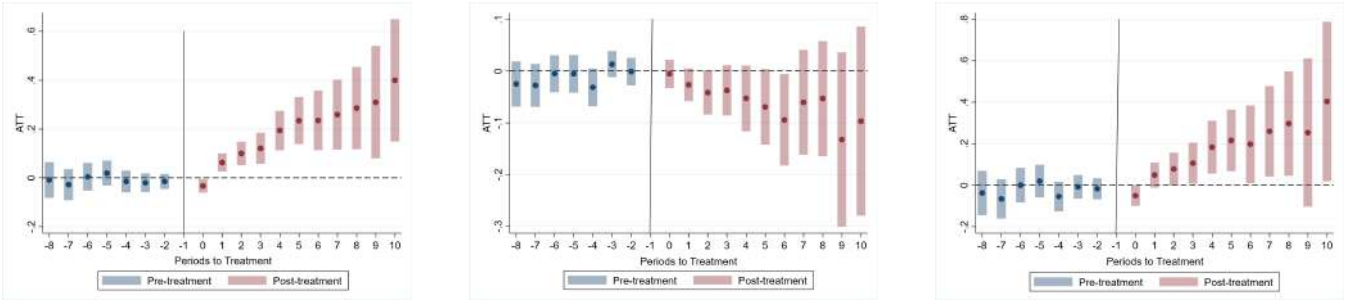
(d) Employment (e) Average Wage (f) Payroll

Mesoregion of Agreste Pernambucano



(g) Employment (h) Average Wage (i) Payroll

Mesoregions of the Sertão and São Francisco Pernambuco



(j) Employment (k) Average Wage (l) Payroll

Semiarid

Figure 5 – Event Study: Effects of FNE by mesoregions and semiarid

5.2 Different economic activities

We also explore additional results considering firms in different economic activities. As we previously pointed out, the interest rates on FNE loans also vary depending on the economic activity of the benefiting firm (BNB, 2024). Furthermore, the degree of dependence on FNE resources and economic performance may

depend on the type of activity, as these circumstances may imply greater or lesser availability of collateral and the more or less tradable nature of the sector's product, respectively. Here we obtain separate estimates for the three sectors of Manufacturing, services and commerce, and agriculture and livestock. While such a high level of aggregation may hide differences within groups, the availability of information prevents us from greater sectoral specificity.[18]

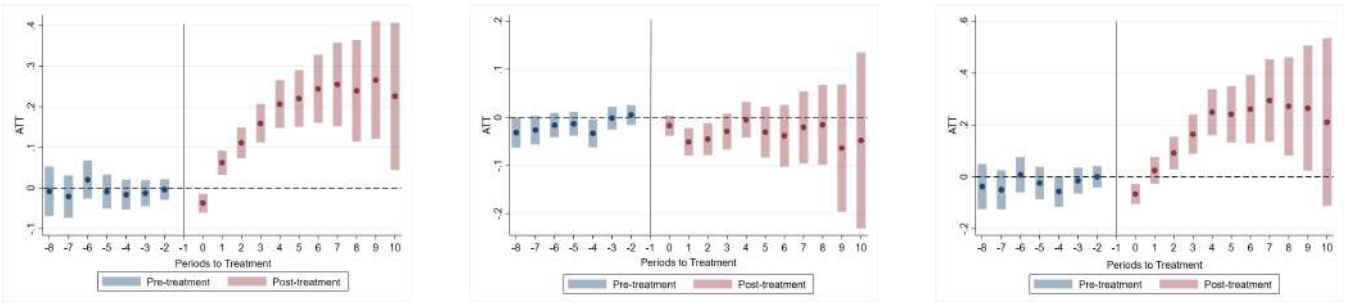
The following Table 6 presents these new general results[19]. The numbers of Table 6 reveal that the average effect of the FNE treatment is negative for the manufacturing sector in terms of average wage and payroll. In contrast, the commerce and services sectors show a positive trend, with estimated impacts of the FNE on employment and payroll, while the average wage decreased. Finally, agricultural and other sectors such as livestock farming did not show statistical significance in the ATT.

Table 6 – **Effects of FNE by economic activity**

	Manufacturing			Commerce and Services			Agriculture and livestock		
	Employment (1)	Wage (2)	Payroll (3)	Employment (4)	Wage (5)	Payroll (6)	Employment (7)	Wage (8)	Payroll (9)
ATT FNE	**-0.042**	**-0.135*** **	**-0.201** **	**0.120*** **	**-0.031** **	**0.116*** **	**0.176**	**-0.109**	**0.053**
	(0.060)	**(0.038)**	**(0.087)**	**(0.021)**	**(0.014)**	**(0.031)**	**(0.167)**	**(0.088)**	**(0.231)**
Controls	√	√	√	√	√	√	√	√	√
Number of FNE Firms	1,280	1,280	1,280	6,942	6,942	6,942	269	269	269
Total Number of Firms	27,974	27,974	27,974	196,086	196,086	196,086	21,535	21,535	21,535
Observations	125,727	125,727	125,727	1,042,571	1,042,571	1,042,571	99,660	99,660	99,660

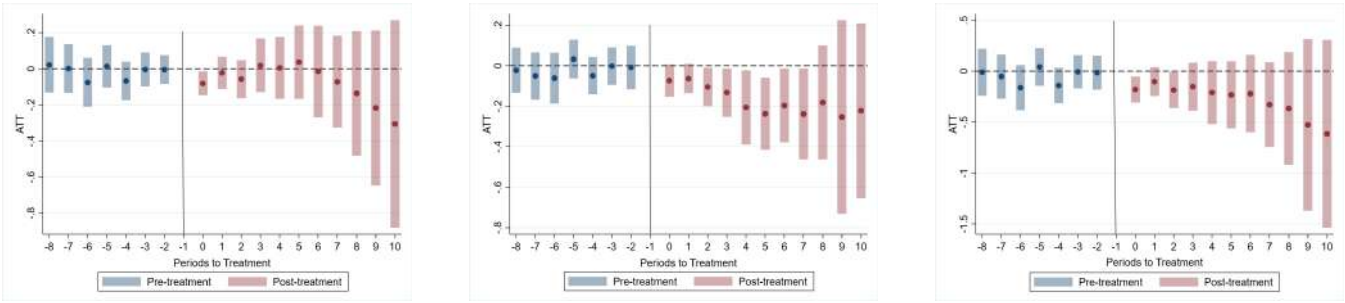
Notes: Wbootstrap firm-level clustered standard error in parenthesis. Statistical significance levels: (*)$P < 0.1$; (**) $P < 0.05$; (***)$P < 0.01$.
Source: Author's own elaboration.

The Figure 6 below presents the results of the event study for the commerce and services sector, where the findings showed significance in job creation and payroll, as well as a smaller decrease in average wage compared to the baseline results.



(a) Employment (b) Average Wage (c) Payroll

Commerce and services sector



(d) Employment (e) Average Wage (f) Payroll

Manufacturing

Figure 6 – Event Study: Effects of FNE by sector

[18] Note that in our sample of formal firms, the firms of commerce sector correspond to 59.9% of the FNE benefited firms, followed by services with 19.1%, and manufacturing with 17.8%. The agriculture, livestock farming, and other sectors receive a smaller share at 3.2%. This allocation reflects a focus on commerce and services, with less emphasis on agriculture.

[19] We separate the analysis for the industry, commerce and services, agriculture and other productive sectors of the economy.

Unlike the industry sector, which showed reductions in average wage (-13.5%) and payroll (-20.1%), the commerce and services sectors show a positive trend, with estimated impacts of FNE at 12% for employment and 11.6% for payroll, while average wage decreased by 3.1%. Although fully understanding these differences requires deeper analysis, possible explanations for these results may lie in the specific dynamics of each economic sector. The negative performance of the Manufacturing sector possibly is associated with production relocation to regions with cheaper labor due to increased international competition (Silva; Resende; Silveira Neto, 2009). On the other hand, the positive relationship between employment in the commerce and services sectors are consistent with the growth of the services sector, driven by domestic demand and changes in consumption patterns (Magalhães; Siqueira, 2014).

The results highlight a persistence in job creation among the firms benefiting from FNE in the commerce and services sector. As for payroll, the positive persistence continues until the ninth year. Regarding average wage, the observed negative effects are short-term and persist until the third year. A downward trend is also seen in the manufacturing sector, with decreasing average wages and payroll.

5.3 Different sizes of firms

The last heterogeneity analysis considers separate estimates of the impact of FNE according to firms' size. Based on the SEBRAE (2020) classification for firm size, as other studies such as Oliveira (2020), we distinguished firms between micro and small and medium/large firms and estimated the ATT FNE for each type of firm according to its size, this provides us with relevant exercises for policy evaluation.

According to this classification, a micro firm is one that has up to 19 employees in Manufacturing or up to 9 employees in commerce, services, agriculture, and other sectors. A small business is defined as one with 20 to 99 employees in Manufactuuring or 10 to 49 employees in commerce, services, agriculture, and other sectors. A medium-sized enterprise is one with 100 to 499 employees in Manufacturing or 50 to 99 employees in commerce, services, agriculture, and other sectors. Finally, a large enterprise is defined as one with 500 or more employees in Manufacturing or 100 or more employees in commerce, services, agriculture, and other sectors. Of the total number of financed companies ofour sample, 75.6% are micro firms, 17.1% are small firms, and the remainder includes medium and large firms. Given the smaaller number of observations for medium and large firms, these categories were combined to estimate their combined effects.

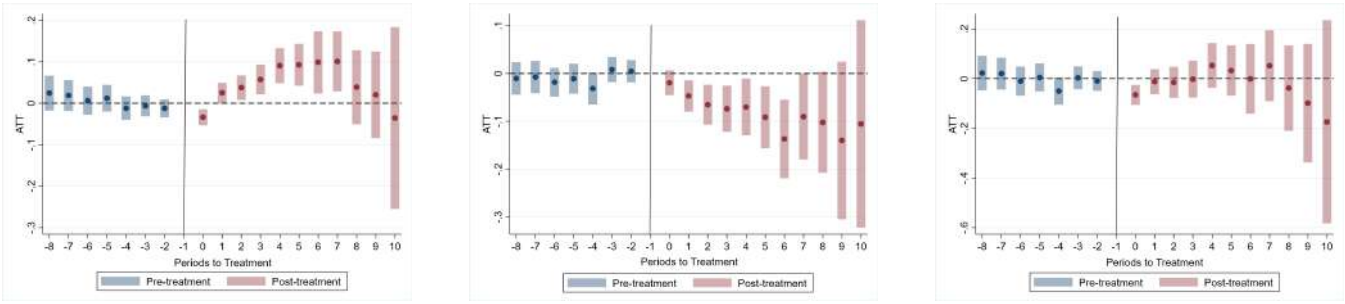
The new estimates are present in the following Table 7. We observed positive effects of FNE on employment for small and micro firms benefiting from the FNE (with an estimated ATT of 3.7% and 3.6%, respectively), as well as an increase in the payroll in small firms. On the other hand, Regarding the average wage, a reduction of 6.5% was observed in the ATT FNE for micro firms. Medium and large-sized firms that benefited did not show significant effects on the variables. Our results are in line with those obtained by Silva, Resende and Silveira Neto (2009), that found impact of FNE on emplyment solely for small firms. The evidence also appear consistent with the possible stronger relevance of the loans of FNE for micro and small firms.

Table 7 – **Effects of FNE by firm size**

	Small Firms			**Micro Firms**			**Medium and Large Firms**		
	Employment (1)	**Wage (2)**	**Payroll (3)**	**Employment (4)**	**Wage (5)**	**Payroll (6)**	**Employment (7)**	**Wage (8)**	**Payroll (9)**
ATT FNE	**0.037****	**-0.001**	**0.032****	**0.036****	**-0.065*****	**-0.016**	**0.069**	**0.086**	**0.015**
	(0.025)	**(0.018)**	**(0.034)**	**(0.015)**	**(0.017)**	**(0.028)**	**(0.088)**	**(0.082)**	**(0.127)**
Controls	√	√	√	√	√	√	√	√	√
Number of FNE Firms	1,920	1,920	1,920	6,804	6,804	6,804	745	745	745
Total Number of Firms	33,096	33,096	33,096	181,487	181,487	181,487	4,292	4,292	4,292
Observations	131,199	131,199	131,199	797,822	797,822	797,822	18,390	18,390	18,390

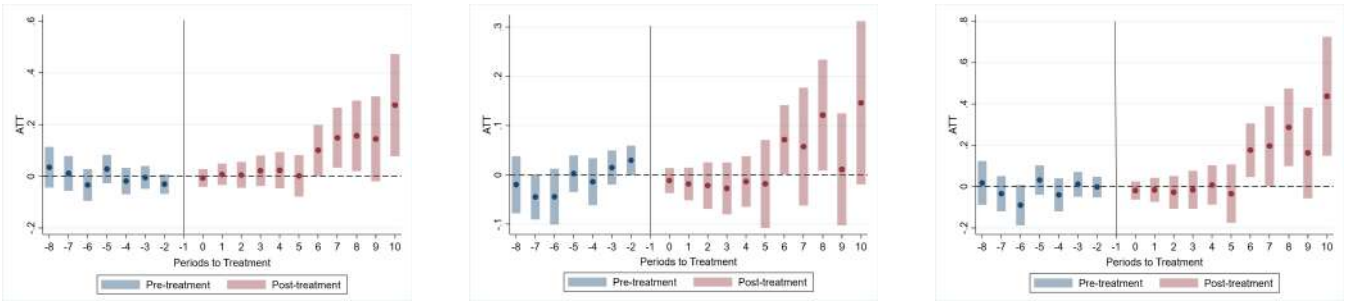
Notes: Wbootstrap firm-level clustered standard error in parenthesis. Statistical significance levels: (*)$P < 0.1$; (**) $P < 0.05$; (***)$P < 0.01$.
Source: Author's own elaboration.

Figure 7 below presents the results of the event study for micro and small firms. Following the pattern of our general result, it is noted that even the positive effects on employment seem temporary, disappearing after eight years from the date of receipt of the loans in micro firms. In small firms, the effects on employment and payroll only tend to appear some time after the benefit of the fund is obtained by the company.



(a) Employment (b) Average Wage (c) Payroll

Micro firms



(d) Employment (e) Average Wage (f) Payroll

Small firms

Figure 7 – Event study: Effects of FNE by firm size.

6 The FNE and other policies

Our final set of exercises investigates the effects of different combinations of FNE with other incentives. As previously discussed, the available evidence on the effects of the FNE has ignored the possibility of overlapping incentives, making it difficult to understand the effects of the FNE. Here, we go a step further and estimate the effects of the FNE when combined with different types of incentives (credit and tax incentives). In addition to informing about the potential degree of inaccuracy resulting from not considering the simultaneous action of benefits, our new estimates thus allow us to discover which other policies may act to more significantly reinforce the effects of the FNE (for example, subsidized credits or tax incentives, state-level or federal incentives).

The following Table 8 presents the general impact of FNE when combined with incentives of other policies. In Panel A, we present estimates of the impact of FNE plus different kinds of tax incentives (state-level Prodepe, through ICMS, and Sudene, through IRPJ) and, in Panel B, the estimates of the impact of FNE plus loans of BNDES and FNE plus any kind of incentive. Notice that in all estimates, we use companies never treated by any type of aid as the control group.

In general, when combined with tax incentives (from Prodepe or Sudene), the estimates of the effects of the FNE on employment, average wages, and the payroll of benefiting companies are qualitatively similar to those previously obtained considering only the FNE loans. The effect on employment, however, is a litlle stronger. Columns (7)-(9) of Panel B indicate much more important effects of the FNE when combined with BNDES loans. More specifically, our estimate for the effect on employment is approximately twice as large as that when only considering the FNE (18.3% versus 8.6%) and, now, we obtain positive effects on the wage and payroll of the benefiting firms (about 2.2% and 22.4%, respectively).

These results indicate that estimates of the impacts of the FNE on benefiting firms can vary significantly depending on the type of additional aid that firms use. Further, our set of evidence indicates that the inaccuracy in FNE impact estimates is greatest when not controlling for the influence of BNDES loans and lowest when ignoring tax incentives. To reinforce the importance of information on additional

benefits beyond the FNE, in columns (10)-(12) of Table 8 estimates of the impact of the FNE are presented when different combinations of benefits are allowed. Here the firm may benefit from the FNE and any other additional set of incentives, in other words, as long as it includes the FNE, different incentive "cocktails" are considered. As indicated by the results in columns (10) and (12) of panel B of Table 8, we now get even stronger effects on employment and payroll of benefited firms. In addition, no negative effect is found for the mean wage of firms' workers.

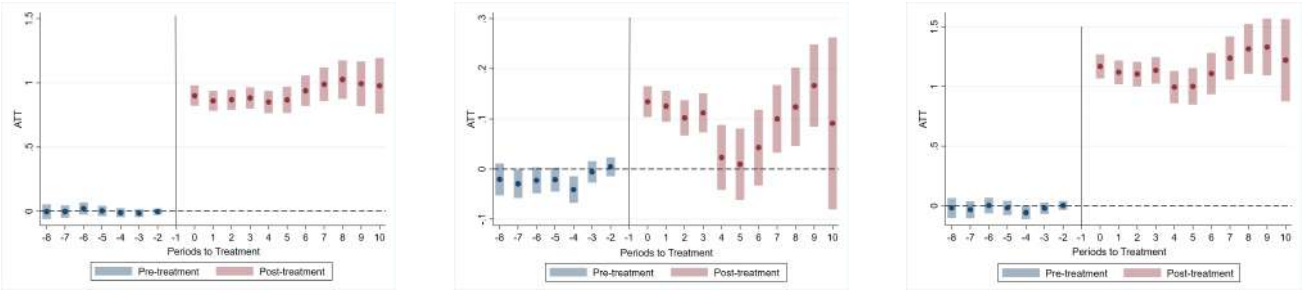
Table 8 – **General effects of the FNE and other policies**

Panel A: tax icentives	**FNE and Prodepe**			**FNE and Sudene**		
	Employment	**Wage**	**Payroll**	**Employment**	**Wage**	**Payroll**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
ATT FNE	**0.100*** **	**-0.032** **	**0.079***	**0.113*** **	**-0.040** **	**0.083**
	(0.031)	**(0.016)**	**(0.044)**	**(0.039)**	**(0.016)**	**(0.034)**
Controls	√	√	√	√	√	√
Nº. of Beneficiary Firms	214	214	214	51	51	51
Total No. of Firms	34,170	34,170	34,170	34,007	34,007	34,007
Observations	235,409	235,409	235,409	235,250	235,250	235,250
Panel B: credit and others	**FNE and BNDES**			**FNE and at least one other policy**		
	Employment	**Wage**	**Payroll**	**Employment**	**Wage**	**Payroll**
	(7)	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
ATT FNE	**0.183*** **	**0.022***	**0.224*** **	**0.338*** **	**0.002**	**0.413*** **
	(0.038)	**(0.013)**	**(0.090)**	**(0.030)**	**(0.017)**	**(0.033)**
Controls	√	√	√	√	√	√
Nº. of Beneficiary Firms	12,549	12,549	12,549	9,772	9,772	9,772
Total No. of Firms	46,789	46,789	46,789	236,768	236,768	236,768
Observations	237,878	237,878	237,878	1,280,791	1,280,791	1,280,791

Notes: Wbootstrap firm-level clustered standard error in parenthesis. Statistical significance levels: (*)$P < 0.1$; (**) $P < 0.05$; (***)$P < 0.01$.
Source: Author's own elaboration.

The Figures 8 and 9 present the event studies for the outcomes of interest considering firms that receive loans from the FNE and BNDES and loans from FNE and at least incentives from one other policy, respectively (the samples of Panel B of Table 8).[20] The figures indicate similar patterns. In both cases, in addition to evidence favoring the hypothesis of parallel trends for the pre-treatment period, we now observe a positive and persistent effect on the employment and payroll of the benefited firms (at least in the researched horizon). On the other hand, the effects on wages do not show such persistence over time.

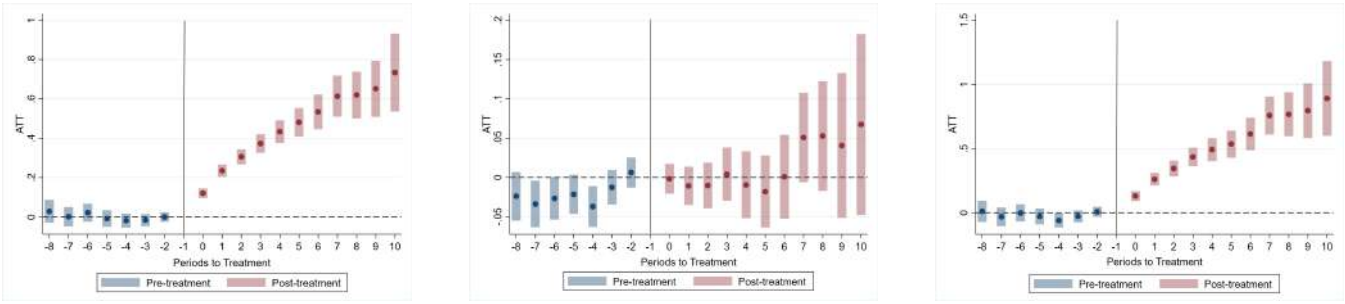
Such evidence indicates that, with the reinforcement of other policies, the FNE's impact on the employment of benefited firms is enhanced and possibly perpetuated. But, even with the accumulation of incentives (FNE and others), there is no persistent positive effect on wages paid by benefiting firms.



(a) Employment (b) Average Wage (c) Payroll

Figure 8 – Event study: Effects of FNE and BNDES

[20] We have no enough information to conduct correspondent event studies for the samples of firms benefited by FNE plus Prodepe incentives and benefited by FNE plus Sudene incentives.



(a) Employment (b) Average Wage (c) Payroll

Figure 9 – Event study: Effects of FNE and at least one other policy.

7 Conclusions

Place-based policies refer to government programs designed to improve the economic performance of specific geographic areas. The FNE is the most important federal place-based policy in action in Brazil. It finances long-term investments and, additionally, working capital or operating expenses. It covers various sectors of the economy, such as agriculture, industry, agro-industry, tourism, commerce, services, culture, infrastructure, among others. One of the most benefited states was the state of Pernambuco, with its strong economic dynamics and per capita growth. Using a unique set of information that allows the identification of firms benefiting from the FNE and other state or federal incentives, we provide an evalutaion of the effects of FNE on employment and wage of benefited firms in the state of Pernambuco.

The research results contribute in three directions to the existing literature. First, by considering the most important spatial-based policy in Brazil, an important developing country. Second, to the best of the authors' knowledge, this is the first evaluation of the FNE that explicitly considers the possible influence of benefits from other place-based or non-place-based policies in Brazil. Third, by analyzing the period from 2000 to 2017, we were able to estimate the short- and long-term effects of the FNE, leading to a discussion about its lasting impact. This aspect, essential for regional development, has been largely neglected in previous works.

The set of evidence obtained indicates that the program in question boosted job creation and reduced the average wage paid to formal workers, while the total payroll showed null values. In addition to some robustness tests to verify the results obtained, we analyzed some heterogeneities. In the period from 2000 to 2017, the exclusive impact of the FNE was 8.6% in job creation and a reduction of 4.4% in the average wage. These effects, however, are temporary and desappear after eight years.

We also observed that the effects of FNE financing varied according to the sector, size, and location of the companies. There was employment growth in the sertão and semiarid mesoregions. Companies in inland areas, especially in the semiarid region, showed stronger increases in employment and payroll over time with exposure to the policy. Additionally, firms in the commerce and services sectors showed better results in the indicators, along with micro and small firms. Micro and small enterprises, which constitute the majority of beneficiaries, showed positive effects on employment and payroll, but there was a negative impact on average wages. In the commerce and services sector, the FNE had a positive impact on job creation and payroll, while in the industrial sector, there was a reduction in wages and payroll of the benefited companies. The results indicate that the FNE had a positive short- and medium-term impact on employment but resulted in negative effects on labor productivity, as evidenced by average wages. The employment expansion seems to be associated with hiring less productive workers, raising questions about the policy's effectiveness in improving the productive efficiency of the state economy.

Revealing an important aspect for evaluating the FNE, our results indicate that when associated with other policies, these effects can be amplified. Specifically, when combined with BNDES subsidized credit, the increase in employment can reach 18.3%, accompanied by a 22.4% increase in the total payroll and a 2.2% increase in the average wage. When combined with Sudene's tax incentives, this increase is estimated at 11.3%. This suggests that the effects of the FNE can be enhanced when combined with other specific

place-based policies.

Overall, the work's set of evidence generally favors the FNE as an instrument for expanding employment in a poor region. However, such an instrument does not affect the productivity of the benefited firms and, in this sense, does little to contribute to the sustained expansion of the well-being of its inhabitants.

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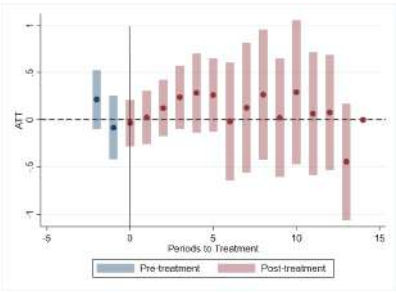
Appendix A

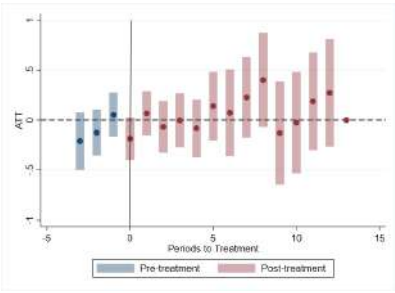
Table 9 – Average Treatment Effect $ATT(g,t)$ of FNE Exclusively on Beneficiary Firms for group

Group/Year	Employment	Wage	Payroll
G2003	0.926	0.757	0.775
	(0.477)	(0.598)	(0.145)
G2004	0.181	-0.154	-0.218
	(0.188)	(0.101)	(0.242)
G2005	0.056	-0.018	-0.147
	(0.100)	(0.085)	(0.141)
G2006	0.096	-0.052	0.064
	(0.066)	(0.036)	(0.093)
G2007	0.076	-0.035	0.062
	(0.065)	(0.039)	(0.095)
G2008	-0.002	-0.099***	-0.102
	(0.055)	(0.026)	(0.078)
G2009	0.097**	-0.004	0.107
	(0.057)	(0.028)	(0.078)
G2010	0.123**	-0.036	0.100
	(0.057)	(0.040)	(0.086)
G2011	0.089**	-0.079***	0.021
	(0.053)	(0.027)	(0.076)
G2012	0.036	-0.081**	-0.057*
	(0.050)	(0.040)	(0.080)
G2013	0.056*	-0.006	0.059
	(0.047)	(0.039)	(0.076)
G2014	0.005	-0.066***	-0.061
	(0.041)	(0.024)	(0.061)
G2015	0.009	-0.102**	-0.099
	(0.040)	(0.041)	(0.070)
Aggregate	**0.049****	**-0.053*****	**-0.005**
	(0.023)	**(0.013)**	**(0.034)**
FE firm	√	√	√
FE Sector/Year	√	√	√
Controls	√	√	√
N. of FNE Firm	8,231	8,231	8,231
Total number of firm	235,227	235,227	235,227
Observations	1,267,958	1,267,958	1,267,958

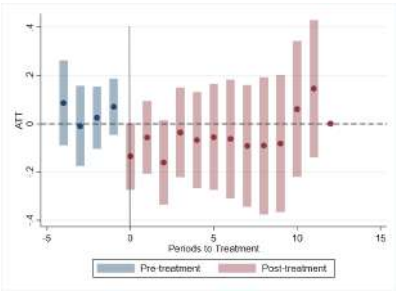
Notes: Wbootstrap firm-level clustered standard error in parenthesis.
[1]ATT = estimate of the impact for each group of firms in the year in which the benefit was granted. Level of statistical significance: (*) $P < 0.1$; (**) $P < 0.05$; (***)$P < 0.01$.
Source: Author's own elaboration.



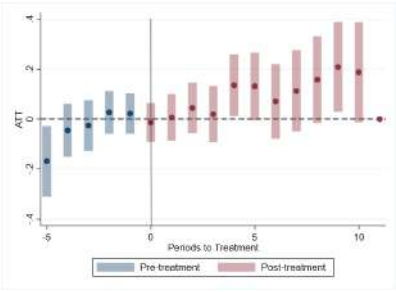
(a) Group 2003



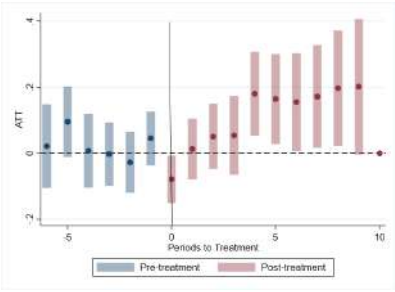
(b) Group 2004



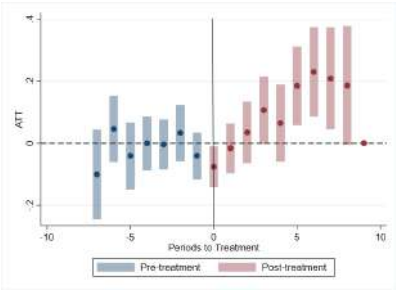
(c) Group 2005



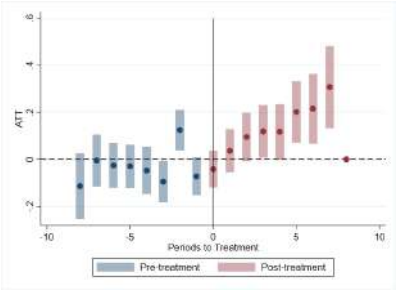
(d) Group 2006



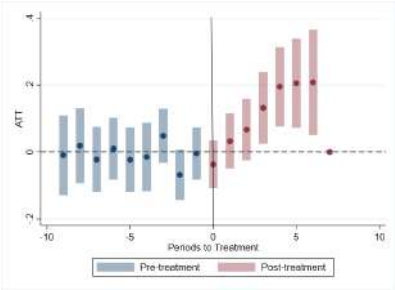
(e) Group 2007



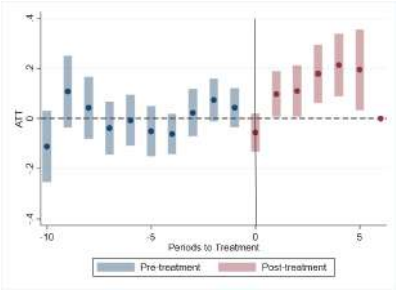
(f) Group 2008



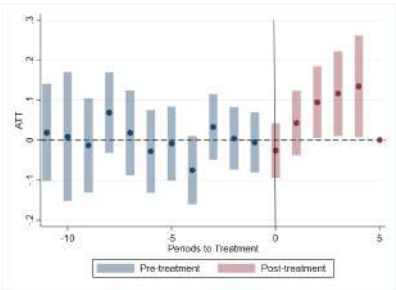
(g) Group 2009



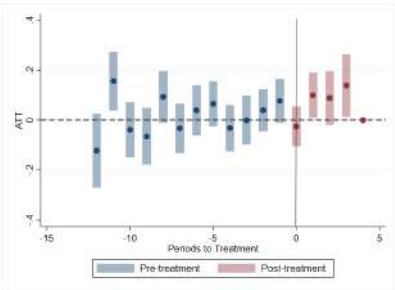
(h) Group 2010



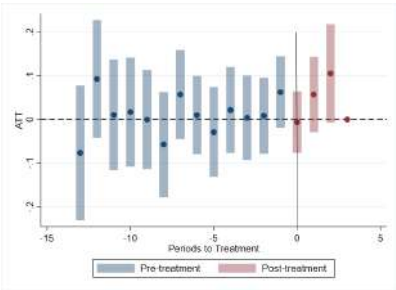
(i) Group 2011



(j) Group 2012



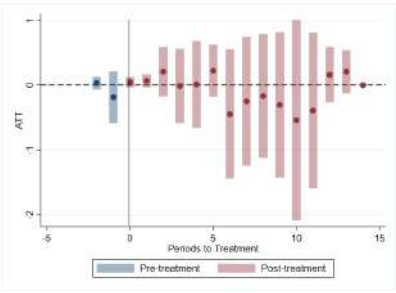
(k) Group 2013



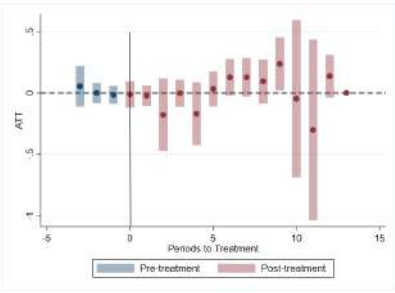
(l) Group 2014

Source: Author's own elaboration.

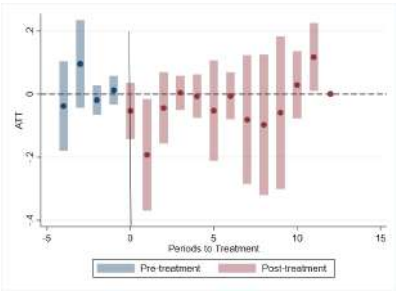
Figure 10 – Assumption of conditional parallel trends across groups - Employment



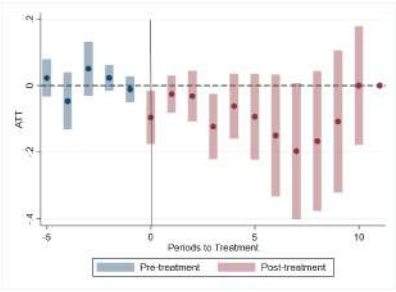
(a) Group 2003



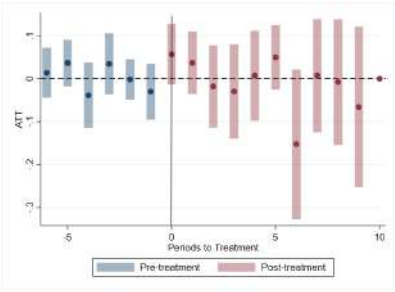
(b) Group 2004



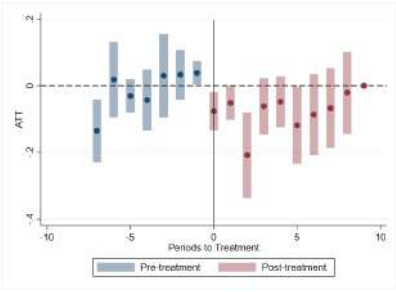
(c) Group 2005



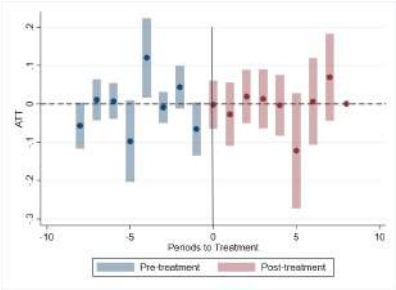
(d) Group 2006



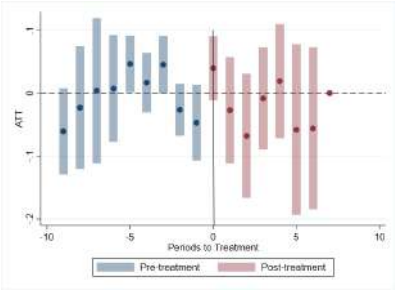
(e) Group 2007



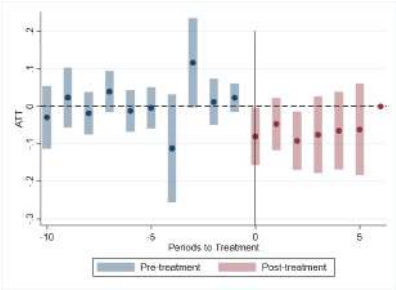
(f) Group 2008



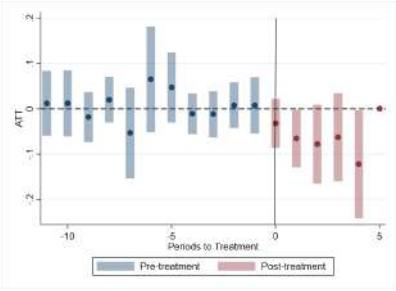
(g) Group 2009



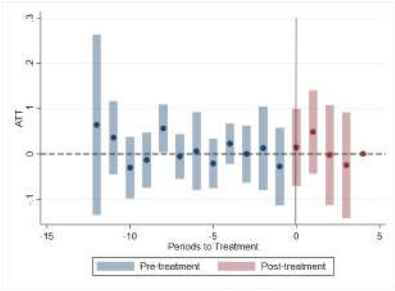
(h) Group 2010



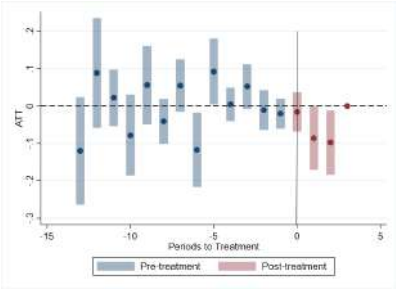
(i) Group 2011



(j) Group 2012



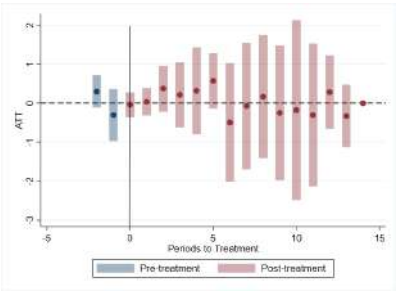
(k) Group 2013



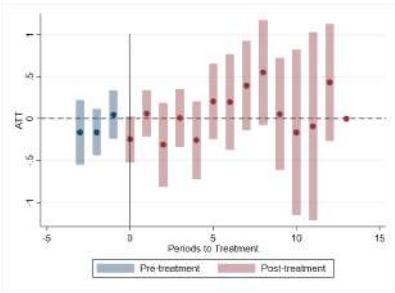
(l) Group 2014

Source: Author's own elaboration.

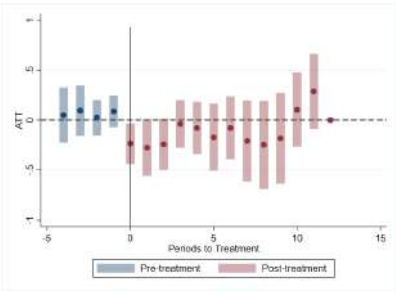
Figure 11 – Assumption of conditional parallel trends across groups - Average wage



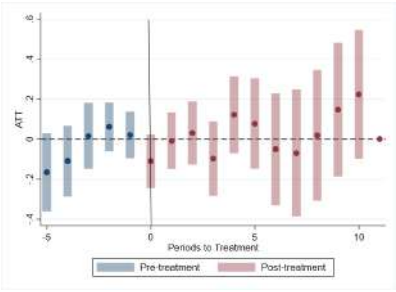
(a) Group 2003



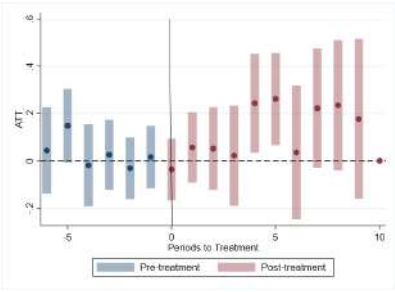
(b) Group 2004



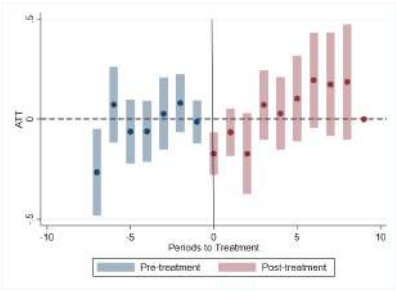
(c) Group 2005



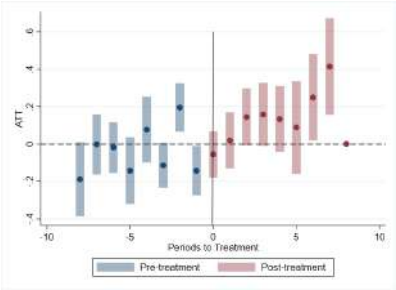
(d) Group 2006



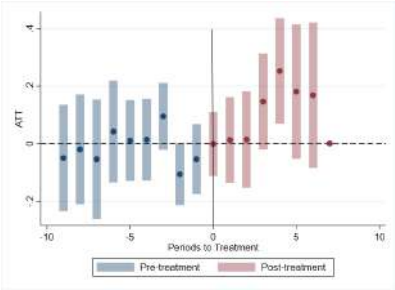
(e) Group 2007



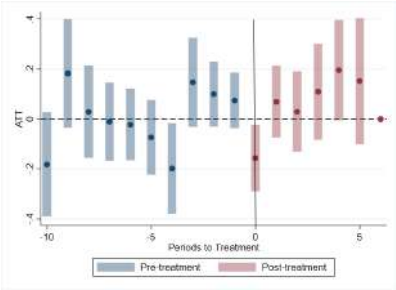
(f) Group 2008



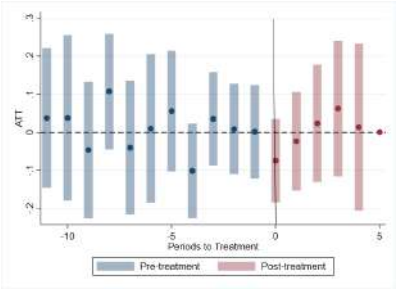
(g) Group 2009



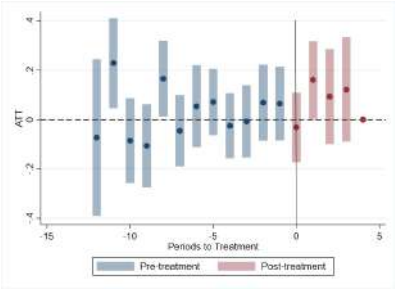
(h) Group 2010



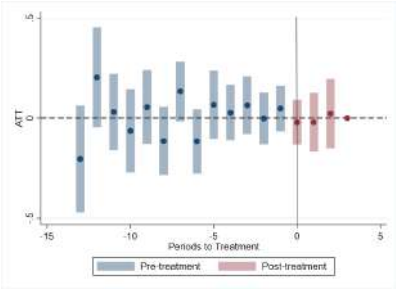
(i) Group 2011



(j) Group 2012



(k) Group 2013



(l) Group 2014

Source: Author's own elaboration.

Figure 12 – Assumption of conditional parallel trends across groups - Payroll