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# Does Access to Credit Reduce Gender Wage Inequality? A Study on The Impacts of the National Employment Fund (FNE) in Municipalities in the Northeast Of Brazil

**Felipe de Sousa Bastos**

**Diego Rafael Fonseca Carneiro**

**Maitê Rimekka Shirasu**

**Guilherme Diniz Irffi**

Universidade Federal do Ceará - UFC

## ABSTRACT

Gender inequality remains a structural challenge in Brazil, particularly in the Northeast. Therefore, this article assesses the impact of greater female participation in FNE financing on average wages and gender wage inequality in municipalities in this region. Using the Generalized Propensity Score (GPS) method, it was found that in municipalities where more than 60% of credit was allocated to women, there was an increase in female wages and a reduction in gender income inequality. The effects intensify as this proportion increases, reinforcing credit as a tool for economic empowerment.

**Keywords:** dose-response function, gender wage inequality, FNE.
**JEL Classification:** J16, O18, G21.

**SUMMARY**

## 1. INTRODUCTION

The financial inclusion of women is a strategic factor in promoting gender equality and female financial empowerment, which can even contribute to sustainable growth and the reduction of social inequalities (De Jesus, Batista, and Zuqui, 2025). Historically, however, women face significant barriers to accessing credit, which limits their opportunities to start businesses, invest, and achieve greater economic autonomy (Alperstedt *et al*., 2014).

Expanding access to credit for this population not only promotes economic development but also represents a measure of social justice. Access to financial resources allows women to invest in their businesses, expand their networks, and contribute more effectively to the economy.

Credit plays a role in empowering women, especially in low- and middle-income countries, by stimulating entrepreneurship and economic autonomy (Hashemi, Schuler, and Riley, 1996). Microcredit, in particular, has shown positive results in countries such as Bangladesh (Ali and Hatta, 2012), India and Indonesia (Esmaeil Zaei et al., 2018), Ghana and Nigeria (Amankwa *et al*., 2021; Ekpe, Mat, and Che Razak, 2010), and Peru (Garcia, Lensink, and Voors, 2020). Other financial instruments, such as microinsurance and savings accounts, have also proven effective in increasing women's autonomy (Ashraf, Karlan, and Yin, 2010; Sanders and Schnabel, 2006). However, the positive impacts of credit are not automatic, and in order to be lasting and effective, it is essential that they be integrated with complementary policies, such as financial training, institutional support, and changes in social norms (Agarwala, Maity, and Sahu, 2022; Tambunan, 2017; Panda, 2018).

In the Brazilian context, the Northeast Region faces structural challenges in terms of development and gender inequalities in the labor market, which affects women's participation more intensely and makes it a priority area for the implementation of inclusive credit policies.

In 2024, women in the Northeast represented 51.8% of the region's economically active population (IBGE, 2025). Despite this, according to data from the 2024 Continuous National Household Sample Survey (PNAD Contínua), only 44.9% of them were in the labor market, a percentage considerably lower than that observed among men (66.4%). In addition, they face an unemployment rate of 10.7%, which is higher than the national average and much higher than the male rate of 7.1% (IBGE, 2025). These figures indicate that, in addition to the difficulty of accessing the labor market, women in the Northeast have more difficulty finding and maintaining stable jobs. The low female participation in the labor market is closely related to structural

barriers, such as cultural expectations about the role of women in society and the overload of domestic and family work, which restricts their professional mobility (Miro, França, and Barreto, 2025).

When analyzing gender inequality in terms of wages, the disparity is equally evident, albeit with regional variations. The average income for women in the Northeast in 2024 was R$2,102, or 87% of the average income for men (IBGE, 2025). Although this wage inequality is lower than in other regions, it occurs in a context of lower incomes for both parties, with the Northeast being one of the regions with the lowest overall average wages. This situation reflects the profound regional inequalities in Brazil, especially in the Northeast, where the labor market is marked by high informality and a high concentration of occupations in low-income sectors, mostly dominated by women (Miro, França, and Barreto, 2025).

The main financial instrument of the National Regional Development Policy (PNDR) aimed at developing this region is the Constitutional Fund for Financing the Northeast (FNE), established by the Federal Constitution of 1988 to reduce social and regional inequalities through the generation of employment and income. The fund is operated by the Banco do Nordeste do Brasil (BNB) and finances long-term productive investments and working capital in sectors such as agriculture, industry, tourism, commerce, services, and infrastructure.

Among the types of credit operated with FNE resources, the guided productive microcredit programs stand out, such as Crediamigo (for urban entrepreneurs) and Agroamigo (aimed at family farmers in rural areas), which combine credit supply with technical guidance, promoting the productive inclusion of low-income populations. With a focus on gender equality, Banco do Nordeste also operates specific lines for women, such as Crediamigo Delas and Pronaf Mulher, offering easier access to credit, training, and encouragement for the financial autonomy of women entrepreneurs and farmers.

In 2022, the FNE financed more than 650,000 credit operations for individuals, of which approximately half were directed to women, totaling R$ 12.9 billion. These data illustrate the significant scope and transformative potential of the program in the lives of its beneficiaries.

In this context, this article seeks to assess the effects of greater female participation in the volume of credit granted through the FNE on the average salary of women in the formal labor market and on the gender pay gap in municipalities in the Northeast. To this end, the *Generalized Propensity Score* (GPS) method is used with the dose-response function.

Overall, the results indicate that, above a certain threshold, an increase in the proportion of credit granted to women leads to a significant increase in the average wage of formal worke-

rs and a reduction in wage disparities between women and men. This suggests that an indirect effect of granting credit through the FNE is to raise the reserve wage of this group, creating conditions for engagement in more advantageous productive activities.

The article is structured in five sections, in addition to this introduction. Section two presents a review of the literature on the effects of credit on female empowerment. Next, the theoretical channels through which credit influences women's entry into the labor market and its impact on wages are discussed. The description of the database and the empirical strategy adopted are presented in section four. The analysis and discussion of the results are presented in section five. Finally, the concluding remarks are presented.

## 2. TARGETED CREDIT AND WOMEN'S EMPOWERMENT

The international experience on the effects of offering credit to women has been widely discussed in academic literature, highlighting both the positive impacts and the challenges inherent in women's financial inclusion. Access to credit has been one of the pillars of women's empowerment policies, especially in low- and middle-income countries, where financial constraints often limit women's opportunities for entrepreneurship and economic autonomy (Hashemi, Schuler, and Riley, 1996).

One of the most studied mechanisms is microcredit, which aims to provide start-up capital to women entrepreneurs, allowing them to develop small businesses and increase their economic independence. Duvendack *et al*. (2011) and Garikipati (2008) indicate that access to microcredit can significantly improve the well-being of women and their families. However, these benefits are not automatic, as factors such as cultural norms, unequal access to support networks, and persistent gender discrimination can limit the positive impact of credit.

The case of Bangladesh is often cited as an emblematic example of success in the use of microcredit for women's empowerment. Research by Ali and Hatta (2012) indicates that microcredit programs in the country have increased women's bargaining power within the home, reduced economic vulnerability, and provided greater participation in family decisions. However, other studies, such as those by Garikipati (2013), warn of the risk of economic dependence: despite taking out loans, women do not directly control the resources, which remain under the responsibility of their husbands or other male family members.

In other Asian countries, such as India and Indonesia, microcredit has been an important tool for fostering female entrepreneurship. Esmaeil Zaei *et al*. (2018) demonstrate that self-help

groups in India have provided not only access to credit, but also training and social support, strengthening women's confidence and decision-making abilities. However, studies such as those by Agarwala, Maity, and Sahu (2022) indicate that access to credit alone does not guarantee empowerment, requiring a set of complementary policies, including financial training and institutional support.

In Africa, studies conducted in Ghana and Nigeria (Amankwa *et al*., 2021; Ekpe, Mat, and Che Razak, 2010) highlight that microcredit has a positive impact on poverty reduction and women's economic empowerment. However, these studies also point out that the lack of collateral and discrimination by financial institutions make it difficult for women to access larger loans. In addition, in many African contexts, patriarchal social norms restrict women's ability to control their own financial resources, as demonstrated by Nyarko (2022).

In Latin America, the impact of credit on women's empowerment has been analyzed in countries such as Peru and Guatemala. Garcia, Lensink, and Voors (2020) studied collective credit programs in Peru and concluded that access to credit generated greater aspiration and confidence among women entrepreneurs. However, Carter (2002) points out that, in Latin American contexts, the involvement of husbands in women's financial decisions can be a determining factor in the success or failure of microcredit programs.

Another relevant aspect in the literature is the relationship between credit and gender-based violence. Studies such as those by Huis *et al*. (2019) show that, in some cases, when women begin to have more financial autonomy, they may face resistance from their partners, leading to an increase in domestic violence. To mitigate this side effect, some interventions have sought to involve men in women's financial empowerment programs, promoting greater awareness of gender equality and reducing potential domestic conflicts (Bulte, Lensink, and Vu, 2017).

Despite advances, challenges remain in women's financial inclusion. In many countries, institutional barriers, such as the lack of formal documentation and the absence of public policies aimed at female credit, hinder access to financing. In addition, cultural and social norms often restrict women's economic participation, as observed by Tambunan (2017) in Indonesia and by Panda (2018) in India.

In the Brazilian case, we can cite the work of Cunha Junior *et al*. (2022), which evaluates the effect of Crediamigo in Ceará on the socioeconomic conditions of its beneficiaries, with a focus on gender differentiation. The research points out that most of the program's clients are women, many of whom are possibly single mothers, which highlights Crediamigo's role as a relevant instrument for female empowerment and productive inclusion in Northeast Brazil. In

addition, they conclude that despite more unfavorable initial conditions, financing for women had a greater impact than for men in all these dimensions.

Do Monte *et al*. (2025) assess the effects of the FNE on municipal economic indicators, with an emphasis on analyzing the heterogeneity of these effects according to the volume and profile of credit beneficiaries. The authors identify positive and growing impacts of the FNE on average income, GDP *per capita*, and total payroll in municipalities, especially when resources are directed to women and legal entities. Although lower than that of companies over the period, women's participation shows a growing trend and reveals positive effects at higher levels of resource allocation, notably on GDP per capita and total payroll. These results indicate that credit for women entrepreneurs can have a significant impact on local development, promoting economic and social inclusion, which reinforces the importance of public policies that expand women's access to productive financing.

In summary, the literature points out that access to credit can be an important tool for female empowerment, but its impacts depend on a number of contextual factors. Therefore, for credit to fulfill its transformative role, it is essential that it be accompanied by financial training, support networks, and changes in social norms that limit women's autonomy. Thus, effective public policies must integrate credit into a broader set of strategies to promote true female empowerment.

This study contributes to the literature by providing empirical evidence, in the Brazilian context, on the effects of credit directed at women on their income in the labor market, as well as investigating whether greater access to credit contributes to reducing wage inequalities between men and women.

## 3. EFFECTS OF WOMEN'S CREDIT ON THE LABOR MARKET

Based on a review of the literature, it is possible to outline some logical paths that connect women's access to credit through the FNE to changes in the local labor market. Targeted credit can influence employment, remuneration, and women's productive integration in the territories where it is applied. These effects manifest themselves through multiple channels, most of which are interdependent, involving both individual decisions and collective dynamics in the labor market (Caballero-Montes *et al*., 2023; Mayoux, 2001).

In summary, the effects of women's access to credit can be grouped according to their repercussions on the supply and demand for female labor. Greater access to credit for women

tends to alter the balance in the labor market, and the likely result of this set of interactions is an increase in the average wage paid to women. On the one hand, signaling mechanisms and general equilibrium effects tend to increase the demand for female labor. On the other hand, factors related to greater bargaining power tend to reduce the supply of female workers in the formal market, as they become more selective. Factors such as sociocultural changes and incentives for female entrepreneurship act on both sides of the market, increasing both supply and demand. These transmission channels are illustrated in Figure 1.

**Figure 1** - Transmission channels of credit supply to women on wages


Source: Prepared by the authors.

The transmission channel through signaling can be explained as follows: as women access credit in a more significant and recurrent manner, they signal to the market and financial institutions a growing presence and protagonism in the local economic circuit. This signaling can stimulate the creation of financial products and public policies more suited to this audience, such as specific lines of credit, microfinance programs, and training support. In response, these actions fuel the process of economic and productive empowerment, creating a positive feedback loop. The combined effect of greater economic presence, higher income, and greater qualifications may ultimately change labor allocation patterns in the formal market (Caballero-Montes *et al*., 2023).

From a macroeconomic perspective, there are also general equilibrium effects on the municipal labor market. The increase in women's average income directly impacts household consumption patterns, boosting specific sectors of the local economy in which the presence of female workers has historically been high. The dynamism generated in activities such as commerce, food, beauty, and care services, for example, can generate greater demand for formal work in these sectors, with the possibility of expanding the wage bill and formalizing employment relationships (Mayoux, 2006).

The literature also suggests that increased access to credit has significant effects on local social and cultural dynamics. Women's entry into more productive activities with greater economic autonomy tends to transform, albeit gradually, perceptions of women's role in the local economy. As more women assume leadership positions, social expectations regarding their presence in the labor market are reconfigured. This symbolic transformation can translate into more inclusive behavior on the part of employers and organizational policies that are more sensitive to gender equity, creating an environment more conducive to reducing wage disparities (Kabeer, 2001; Mayoux, 2001).

Although predominantly intended for the informal sector or consumption, personal credit can generate positive externalities on the formal labor market. The strengthening of the female informal sector—whether through the expansion of small businesses or the increase in women's income—creates competitive pressures on the formal sector, especially in municipalities with less diversified labor markets. In a scenario where women earn higher incomes on their own, formal companies may be forced to adjust wages or offer better working conditions to attract and retain skilled workers. This movement contributes to the valorization of women's work, both in terms of wage increases and in reducing the gender pay gap (Holvoet, 2005).

In addition, credit acts as an instrument of economic empowerment for women. By providing access to financial resources, even in the form of debt, personal credit increases women's bargaining power in the labor market. The availability of a financial reserve or an active source of credit allows for more strategic decisions regarding career paths. This gives women greater leeway to refuse unfavorable offers, seek more qualified opportunities, or even negotiate better salary and contractual conditions (Goetz and Gupta, 1996; Kabeer, 2005). This bargaining effect tends to be even more relevant in contexts marked by high informality and structural rigidity in the labor market—characteristics common in many of the municipalities served by the FNE.

Another important channel is the use of credit as a mechanism for overcoming structural barriers to women's participation in the labor market. In contexts of high informality and a lack of public policies to support family care, such as daycare centers and/or care for the elderly, and urban mobility, women face high costs to enter the labor market. In this case, credit can be used to address these practical constraints: financing transportation, paying for care services (such as daycare or domestic support), investing in professional training, or purchasing durable goods that increase productivity at work or at home. These measures, although specific, can improve the stability of women's labor market participation, increase work attendance, and expand the ability to accept more demanding occupations—factors directly associated with increased pay

and career progression (Rao and Kelleher, 2005; Mayoux, 2006).

The allocation of credit resources is also a relevant factor in this process, since it can be used to finance self-employed economic activities, such as small businesses or more structured informal occupations, especially in traditionally female sectors such as commerce, personal services, and food (Nawaz, 2010). Even if they remain in the informal sector, these activities allow for an increase in individual and family income, creating alternatives to low-skilled formal employment. This additional income can be a starting point for paths of progressive formalization, either through the regularization of the business or through improved conditions for accessing formal jobs. In addition, increased individual productivity has indirect impacts on the local labor market, raising average income and stimulating consumption in sectors that employ mostly women, contributing to a virtuous cycle of productive inclusion (Caballero-Montes *et al*., 2023).

It should also be noted that these effects are not dissociated from the rest of the local and regional economy. The magnitude of the impact on the equilibrium wage depends on the relative productivity of economic sectors, the degree of formalization of activities, and the composition of the available labor force. For example, although there is a preference for female workers in certain activities, the equilibrium wage will depend on the productivity of all sectors, as well as on the total labor supply. In addition, the different levels of formalization among economic activities constitute an obstacle to capturing the effect of credit on the wages paid to women in the formal market.

## 4. METHODOLOGY

### *4.1 Econometric Strategy*

To assess the effect of women's participation in credit granted through the FNE on average female income and the wage gap between men and women, we use the GPS methodology, originally developed by Hirano and Imbens (2004) and implemented according to models proposed by Bia and Mattei (2008) and Guardabascio and Ventura (2014). This methodology allows for continuous treatments and non-normal distributions for the treatment.

The GPS methodology is an extension of the propensity score method used for continuous treatments. In this method, municipalities are segregated according to the *quartiles* of the treatment variable, and the effects are estimated by comparing each treated group individually

with the other groups (controls). To mitigate selection bias in this comparison, the analysis is conditioned on the conditional density of the treatment given the vector of observed characteristics (GPS). Thus, under the hypothesis of weak ignorability, this approach allows us to obtain the average effect for each treatment level, since adjusting for prior differences solves the problem of making causal inferences[1].

In this study, the treatment level of municipality $i$ ($T_i$) is defined as the proportion of the total volume of credit to individuals granted to women under the FNE financing lines in that municipality. Therefore, $T_i$ is a fractional variable belonging to the interval [0,1], where values closer to 1 indicate a greater participation of women among borrowers granted credit by the FNE. As an outcome variable ($Y_i$), variables such as the average salary paid to women and the salary difference between women and men were used, in addition to a set of observable characteristics ($X_i$).

The objective is to estimate the expected value of the dependent variable for different proportions of credit granted to women, the so-called dose-response function. Based on the potential outcomes model $Y_i(t)$ is defined as the set of outcomes for each treatment level $t$, so that the dose-response function can be expressed as $\mu(t)=E[Y_i(t)|X]$.

The first step in the process is to estimate the GPS, $R_i(t,x)$, which represents the conditional density of the treatment given the vector of covariates. The distribution parameters can be estimated using a generalized linear model, which maximizes a logarithmic version of a Bernoulli quasi-maximum likelihood (Bernoulli QML) function[2].

After estimating the GPS, the balancing property is verified, which ensures that, within strata with similar GPS values, the control covariates are independent of the treatment. This procedure is essential to ensure that the results are attributed to the variation in women's participation in the fund's total credit volume, rather than to differences in the observable characteristics of the municipalities. The verification procedure involves testing the balance of covariates between treatment groups within blocks defined by the GPS.

In the next step, the expected value of the dependent variable is estimated by modeling women's average wages—and the wage differential between men and women—as a flexible function of the treatment level and GPS. A polynomial model of up to third order is used, including interaction terms between treatment and GPS, which allows for capturing nonlinear relationships and interactive effects between these variables. The general specification of the

1 For further information, see Imbens (2000)
2 For further information, see Papke e Wooldridge (1996)

model is given by:

$$\varphi\{E(Y_i|T_i,R_i)\} = \alpha_0 + \alpha_1 T_i + \alpha_2 T_i^2 + \alpha_3 T_i^3 + \alpha_4 R_i + \alpha_5 R_i^2 + \alpha_6 R_i^3 + \alpha_7 T_i R_i \quad [1]$$

where the coefficients are estimated for the type of outcome variable. $\varphi(\,.\,)$ is a *link* function that relates the predictor and the conditional expectation, $E(Y_i|T_i,R_i)$. In order to avoid *ad hoc* specifications, second- and third-order polynomials are tested for treatment and GPS, and the functional form with the best fit is chosen based on the estimated confidence intervals (CIs). Thus, the results in which the dose-response function has a better fit in the CIs for the second or third order approximation will be reported.

Finally, the average dose-response function is estimated by calculating the conditional expectation mean of the response variable for each treatment level, evaluating the model on the estimated GPS. Formally, the function is expressed as:

$$\hat{\mu}(t) = \frac{1}{N}\sum_{i=1}^{N} \varphi E\left(T_i = t, \hat{R}_i = \hat{r}(t, X_i)\right) \quad [2]$$

To ensure the robustness of the inferences, the standard errors of the estimated dose-response function will be obtained using *bootstrap* procedures, which consider both the uncertainty in the GPS estimation and the parameters of the outcome model.

### *4.2 Database*

To implement the econometric strategy, data from FNE credit operations carried out in 2022 were used, obtained from the Ministry of Integration and Regional Development (MIDR). These operations were aggregated by municipality. The geographic sample includes all municipalities in the states of the Northeast region that recorded at least one FNE financing operation for women in that year. The original database allows the gender of the borrower to be identified in operations intended for individuals, in different FNE financing lines.

As variables related to the municipal labor market, information from the Annual Social Information Report (RAIS) was used, aggregated by gender and municipality. In addition to the average salary, data on the age and education of workers and the average length of employment were considered.

Additionally, in order to capture the inclination toward female entrepreneurship, the ave-

rage proportion of women in the corporate structure of companies in the municipality was used, information obtained from the Federal Revenue Service's partner database. To infer the gender of the partners from their names, the "GenderBR" algorithm (Meireles, 2023) was used, which specializes in gender identification based on first names in the Brazilian context. The table below summarizes the variables used in the study.

**Table 1** - Description of variables used

| Variable | Description | Source |
|---|---|---|
| Remuneration | Average remuneration of formal workers. | RAIS |
| Women's participation | Proportion of the total value of FNE credit to individuals allocated to women. | MIDR |
| Education | Average education level of formal workers in years of study. | RAIS |
| Age | Average age of formal workers in years. | RAIS |
| Employment duration | Average duration of formal employment in months. | RAIS |
| Proportion of Female Partners | Average proportion of women in the corporate structure of companies in the municipality. | RFB* |

Source: Prepared by the authors. Note: * Brazilian Federal Revenue Service.

It is important to note that, for estimates considering wage differences between men and women as a response variable, differences in education, age, and length of employment are used as covariates in the GPS calculation, in addition to the proportion of female partners. Finally, in addition to the variables described above, state *dummies* were included in the GPS estimates, considering the state of Ceará as a reference. The inclusion of these binary variables aims to control for structural characteristics of the economic environment and labor market specific to the northeastern states that may affect the probability of the municipality receiving a greater share of credit.

## 5. ANALYSIS AND DISCUSSION OF RESULTS

### *5.1 Descriptive Analysis*

Table 1 shows the distribution of FNE-financed operations for individuals in 2022, segregated by gender and economic sectors. In that year, more than 650,000 operations were carried out in this modality, 49% of which were destined for women. Despite this apparent balance in terms of the number of operations between borrowers of both sexes, the total amount contracted by men was three times higher than that contracted by women. While men contracted an avera-

ge of R$ 29,000, women contracted R$ 10,000.

In sectoral terms, the distribution of the amount contracted shows that women seem to be more active than men in urban activities linked to the industrial and service sectors, while men participate proportionally more in sectors linked to agriculture and livestock. Even so, the service sector was the only one in which the average value of transactions was higher for women.

Within these sectors, the activities predominantly carried out by women were related to food, poultry farming, retail trade, education, and personal services. Among men, the predominant activities were related to beekeeping, beverages and tobacco, hunting and fishing, fruit growing, grains, and repair and maintenance.

**Table 1** - FNE transactions in 2022, by gender and sector - Individuals

| | Men | % | Women | % | Total |
|---|---|---|---|---|---|
| No. of Operations | 334,950 | 51.0 | 321,309 | 49 | 656,259 |
| *Agricultural* | 60,251 | 18.0 | 558.72 | 17.4 | 116,123 |
| *Industrial* | 13,549 | 4.0 | 18,549 | 5.8 | 32,098 |
| *Livestock* | 260,847 | 77.9 | 24,6212 | 76.6 | 507,059 |
| *Services* | 303 | 0.1 | 676 | 0.2 | 979 |
| Contract Value (millions) | 9,710 | 75.2 | 3,210 | 24.8 | 12,920 |
| *Agricultural* | 5,270.0 | 54.3 | 955.0 | 29.8 | 6,225.0 |
| *Industrial* | 276.0 | 2.8 | 322.0 | 10.0 | 598.0 |
| *Livestock* | 4,150.0 | 42.7 | 1,920.0 | 59.8 | 6,070.0 |
| *Services* | 9.4 | 0.1 | 21.7 | 0.7 | 31.1 |
| Average Transaction Value | $29,003.80 | - | 10,004.67 | - | 19,701.69 |
| *Agricultural* | 87,547.33 | - | 17,090.99 | - | 53,647.62 |
| *Industrial* | 20,382.76 | - | 17,375.14 | - | 18,644.7 |
| *Livestock* | 15,926.82 | - | 7,781 | - | 11,971.24 |

Source: Prepared by the authors.

The distribution of formal employment in municipalities in the Northeast Region in 2022, broken down by gender and economic sector, is shown in Table 2. In that year, approximately 43% of formal jobs in the region were held by women, mainly in the service sector, which was also the only sector with a predominance of female workers. In terms of average remuneration,

women received 6% less than men, with this difference reaching 24% in the industrial sector, where there was the greatest discrepancy. The commerce sector was the one with the smallest average wage difference, at approximately 5%.

Among the professions predominantly occupied by women during this period, the most notable were teacher, administrative assistant, receptionist, health worker, telemarketing operator, nurse, and cook. Among men, the most common professions were security guard, construction worker, driver, warehouse worker, mechanic, police officer, among others.

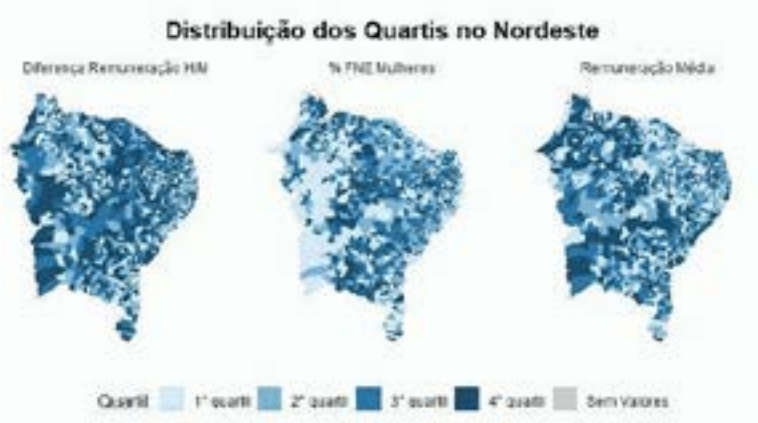
**Table 2** - Formal Employment in the Northeast in 2022, by Gender and Sector

| IBGE Gr Sector | Men | % | Women | % | Total |
|---|---|---|---|---|---|
| No. of contracts | 5,547,619 | 56.7 | 4,229,377 | 43.3 | 9,777,008 |
| *Industry* | 903,334 | 16.3 | 327,550 | 7.7 | 1,230,885 |
| *Civil Construction* | 352,550 | 6.4 | 39,442 | 0.9 | 391,992 |
| *Trade* | 1,056,057 | 19.0 | 715,715 | 16.9 | 1,771,772 |
| *Services* | 2,863,483 | 51.6 | 3,098,349 | 73.3 | 5,961,843 |
| *Agriculture and livestock* | 258,779 | 4.7 | 43,986 | 1.0 | 302,765 |
| Average Compensation | 3,155.23 | - | 2,956.16 | - | 3,069.11 |
| *Industry* | 2,967.51 | - | 2,252.66 | - | 2,777.28 |
| *Civil Construction* | 2,759.99 | - | 2,531.41 | - | 2,736.99 |
| *Trade* | 2,113.57 | - | 2,001.71 | - | 2,068.38 |
| *Services* | 3,730.61 | - | 3,271.79 | - | 3,492.16 |

Source: Prepared by the authors.

These data show that access to credit is more limited in terms of volume among women, which may be linked to the lower availability of collateral or other social aspects that discourage this segment of the population from taking out productive credit. Although, like men, they are mainly engaged in agricultural activities, they are also more frequently engaged in urban activities, mainly in the service sector.

**Figure 2** - Spatial Distribution of the Wage Gap, Women's Participation in the FNE, and Average Female Wage, Northeast (2022)




Source: Prepared by the authors.

Figure 2 shows the spatial distribution of the treatment and outcome variables, average remuneration of female workers, and the wage gap between men and women. Visual inspection reveals no striking pattern of spatial concentration of the treatment across most of the territory. The exception appears to be the south of the states of Maranhão and Piauí and the west of Bahia, in the region known as MATOPIBA, where a new frontier of agricultural production is being established and which also has a low share of credit granted to women. In terms of correlation, the data seem to corroborate the research hypothesis, suggesting that in municipalities with lower participation of women in FNE credit, there also appears to be a greater wage gap.

Along the same lines, Table 3 presents descriptive statistics for the variables used, according to gender and the proportion of total FNE credit taken out by women. In terms of average remuneration, it can be seen that the wage gap between men and women appears to be directly proportional to the level of treatment. For example, while the difference in the first quartile was R$56.08 in favor of men, in the fourth and last quartile, women received, on average, R$118.72 more than male workers. This may indicate a positive effect of the treatment on wage inequality.

**Table 3** - Descriptive statistics of the variables used, by treatment level

| % FNE credit for women | [0.0000 - 0.1401] | | [0.1401 - 0.2621] | | [0.2627 - 0.3711] | | [0.3714 - 0.0404] | |
|---|---|---|---|---|---|---|---|---|
| | Men | Women | Men | Women | Men | Women | Men | Women |
| Remuneration | 2374.63 | 2318.55 | 2269.92 | 2276.24 | 2294.81 | 2288.09 | 2238.45 | 2357.18 |
| Women | (770.45) | (437.07) | (703.41) | (510.66) | (609.05) | (425.91) | (613.12) | (437.90) |
| Industry | 3000.28 | 2034.63 | 2505.31 | 1780.26 | 3097.64 | 1715.18 | 2725.37 | 1906.50 |
| | (4234.78) | (1548.61) | (2857.20) | (1,789.44) | (6007.94) | (1,401.34) | (2,966.22) | (2370.98) |
| Civil | 2607.14 | 2395.70 | 2970.94 | 2424.05 | 2046.66 | 2020.12 | 3156.01 | 2328.91 |
| Construction | (2,210.70) | (2726.38) | (3,245.05) | (2,722.90) | (2869.00) | (3,444.96) | (4143.54) | (3658.48) |
| Trade | 1712.00 | 1000.00 | 1544.45 | 1472.29 | 1520.70 | 1499.29 | 1493.93 | 1520.74 |
| | (712.69) | (102.64) | (393.06) | (270.18) | (598.05) | (418.67) | (624.61) | (898.89) |
| Services | 2729.33 | 2711.46 | 2542.77 | 2652.53 | 2542.99 | 2607.30 | 2391.95 | 2629.58 |
| | (747.81) | (514.41) | (642.15) | (495.58) | (955.01) | (579.28) | (627.58) | (534.07) |
| Agriculture | 1720.01 | 1832.11 | 1402.57 | 1551.47 | 1344.48 | 1508.13 | 1338.11 | 1510.76 |
| | (1083.65) | (2480.06) | (634.25) | (736.04) | (567.53) | (1000.33) | (360.51) | (860.32) |
| Remuneration difference | 56.08 | | -0.32 | | 0.72 | | -118.72 | |
| | (620.72) | | (500.65) | | (626.31) | | (596.61) | |
| Industry | 1120.16 | | 041.06 | | 1674.68 | | 1341.13 | |
| | (4074.60) | | (2,453.50) | | (5772.93) | | (3445.95) | |
| Civil | 012.77 | | 1521.44 | | 1730.30 | | 2239.50 | |
| Construction | (3100.20) | | (3507.55) | | (3562.30) | | (4772.12) | |
| Trade | 453.01 | | 75.30 | | 44.33 | | -9.36 | |
| | (529.47) | | (435.00) | | (671.61) | | (719.11) | |
| Services | 17.86 | | -109.77 | | -64.31 | | -237.63 | |
| | (575.66) | | (649.10) | | (1344.48) | | (610.22) | |
| Agriculture | 119.67 | | 414.92 | | 515.13 | | 620.13 | |
| | (2228.33) | | (871.77) | | (873.14) | | (921.47) | |
| Education | 10.83 | 7.70 | 11.09 | 7.29 | 11.30 | 7.01 | 11.43 | 6.58 |
| | (1.19) | (1.36) | (1.09) | (1.60) | (1.00) | (1.62) | (1.05) | (1.77) |
| Age | 37.72 | 38.90 | 38.16 | 39.54 | 38.79 | 40.10 | 39.71 | 41.18 |
| | (2.15) | (2.63) | (2.36) | (2.83) | (2.10) | (2.77) | (2.32) | (2.96) |
| Time Employment | 55.74 | 05.54 | 68.97 | 101.27 | 75.00 | 111.37 | 05.14 | 125.19 |
| | (20.37) | (34.13) | (25.10) | (36.28) | (26.71) | (37.11) | (33.01) | (43.69) |
| Percentage of Female Partners | 0.35 | | 0.35 | | 0.34 | | 0.35 | |
| | (0.04) | | (0.04) | | (0.05) | | (0.06) | |

Source: Prepared by the authors. Note: Standard errors in parentheses.

In sectoral terms, it should be noted that this difference originates mainly in the commerce and services sectors, where women earn more than men in municipalities with greater female participation in FNE loans. On the other hand, the industrial and civil construction sectors showed the largest wage discrepancies to the detriment of women, which, like agriculture, seem to be less sensitive to variations in treatment levels.

In terms of the average characteristics of the municipalities, there are no major differences between the treatment groups, as they all have similar levels of education, age, and propor-

tion of women among company partners. The biggest difference in this regard was the average length of employment, which appears to be significantly shorter in municipalities with lower proportions of women in the workforce. This result highlights the need to use a methodology that adequately considers these differences, such as GPS.

### *5.2 Empirical analysis, dose-response effect*

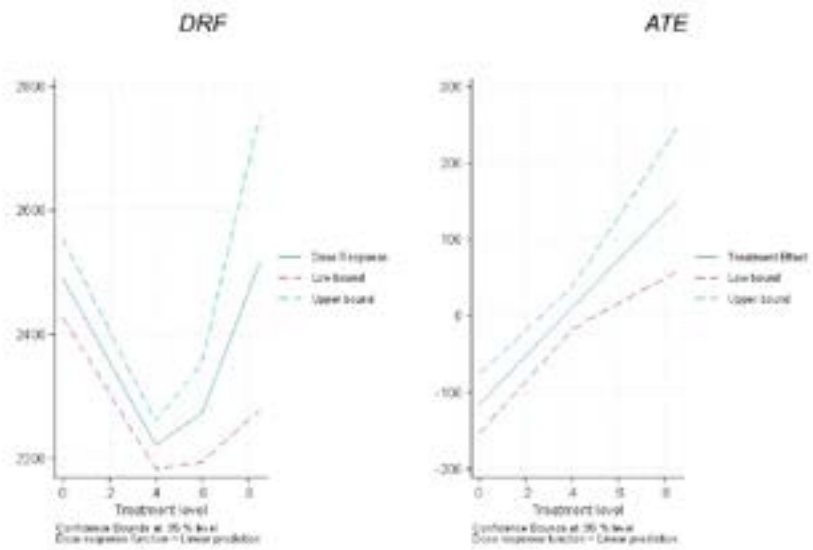
In order to ensure causal interpretation, it is first necessary to verify compliance with the ignorability hypothesis. To this end, GPS-conditioned balancing tests were performed between the characteristics of the groups for the different treatment levels. The results, available in Tables A1 and A2 in the appendix, reveal that in most cases there were no statistically significant differences between the groups in terms of observed characteristics, suggesting that the method was effective in mitigating possible selection bias.

Furthermore, the estimated coefficients for the dose-response function, also available in the Appendix, were statistically significant and had the expected sign, indicating that both treatment and GPS contribute to explaining the average wage of female workers, as well as the wage gap between men and women. Thus, the procedures attest to the validity of the interpretation of the estimation in terms of causality of the variation in women's access to credit on the outcome indicators.

Figures 3 and 4 present the estimates of the dose-response functions for the effect of women's share of total credit granted by the FNE on the average income of female workers and the wage gap between men and women, respectively. The graphs on the right, with the average effect of the treatment, can be seen as the marginal effect for each different level of treatment.

In Figure 3, the results indicate a positive relationship between credit directed to female borrowers under the FNE and the wages of female workers in the formal market. This is particularly evident when the proportion of credit granted to women reaches about 60% of the total value of operations. This result suggests that, above this threshold, an increase in female participation in total loans leads to an increase in wages for female workers in these municipalities.

**Figure 3** - Dose-Response Function and Treatment Effect on Women's Average Labor Income




Source: Prepared by the authors.

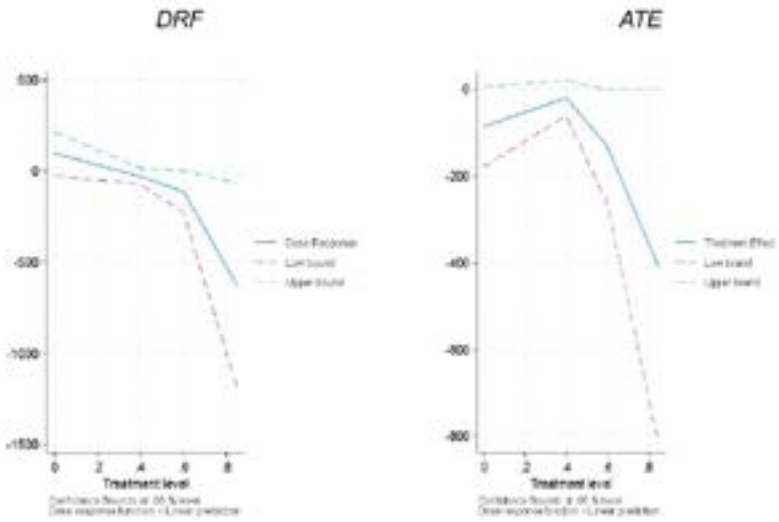
Note: 1. The balancing property is satisfied at a level lower than 0.01. 2. The lower and upper dashed lines indicate the 95% confidence interval (CI) constructed from 1,000 *bootstrap* replications.

Figure 4, in turn, shows the results of the dose-response function and the average effect of the FNE treatment on the wage gap between men and women. Corroborating the previous analysis, the results indicate a negative relationship between credit granted and the gender wage gap. Similar to what was observed previously, the result was significant above the threshold of 60% of the volume of credit granted to women.

Thus, it can be said that greater female participation in the credit market contributes to an increase in this group's labor income and also helps to reduce the wage gap between them and male workers. These results confirm the role of credit as a mediator for women's financial autonomy (Hashemi, Schuler, and Riley, 1996; Ali and Hatta, 2012; Esmaeil Zaei *et al*., 2018; Amankwa *et al*., 2021; Ekpe, Mat, and Che Razak, 2010; Garcia, Lensink, and Voors, 2020; Do Monte *et al*., 2025).

The non-linearity between the level of treatment and the outcome variables suggests the need to combine access to credit with other complementary policies, such as training, support networks, and care services, as advocated by authors such as Kabeer (2005) and Seguino (2021), in order to ensure that credit effectively translates into improvements in women's well-being and economic inclusion.

**Figure 4** - Dose-Response Function and Treatment Effect on the Wage Gap between Men and Women




Source: Prepared by the authors.

Note: 1. The balancing property is satisfied at a level of less than 0.01. 2. The lower and upper dashed lines indicate the 95% confidence interval (CI) constructed from 1,000 *bootstrap* replications.

## 6. FINAL CONSIDERATIONS

This study investigated the effects of productive financing granted to women on the labor market in municipalities in the Northeast. More specifically, it studied the impact of women's participation in resource transfers from all FNE credit lines on average wages and gender wage inequality.

To this end, data on total fund transfers were used, as well as the portion of the fund allocated to women. In addition, information was collected on variables that are commonly considered relevant to explaining wage returns. Based on this data, and using the GPS methodology and dose-response function, it was possible to identify the impact of women's participation in total transfers from the fund on average female income and the wage gap between men and women in northeastern municipalities in 2022.

The results point to a statistically significant causal association between the increase in female participation in FNE credit operations and the growth in the average wage of employed women. In addition, credit seems to reduce the gap between the average wages received by men and women. However, these effects proved to be heterogeneous according to the level of treatment, being relevant only when female participation in total credit reaches 60%.

This suggests that productive credit directed at women can function as a vector for economic empowerment by promoting entrepreneurship opportunities and stimulating income and job creation at the local level. Specifically, the positive effects on women's average wages suggest that such investments not only benefit direct borrowers. They also generate positive externalities in the labor market more broadly, possibly by increasing the demand for female labor, strengthening local productive arrangements, and increasing wage competition in the segments in which they operate.

In terms of public policy implications, the results of this study reinforce the strategic role of the FNE in promoting more inclusive development that is sensitive to gender and territorial inequalities. Among the alternatives for enhancing the positive effects identified, it would be possible to expand specific programs that primarily serve women, as well as provide technical assistance to activities in which women seem to have advantages in terms of remuneration, such as in the service sector.

From a literature perspective, this study contributes by providing empirical evidence on the territorial impacts of gender-specific productive credit, a topic that has been little explored at the interface between regional economics and gender economics. By using administrative data and impact assessment techniques, the study offers a replicable methodological approach and a valuable empirical basis for future analyses.

In methodological terms, future research could expand the analysis to cover other years, which would possibly help to improve the adjustment of the confidence intervals of the estimates and, consequently, reduce the uncertainties of the results found. Future work may also address alternative effects of credit expansion for women, such as on the formalization of work, job creation, or other indicators of gender inequality. In addition, there is room for further study of other social aspects, such as the issue of race. Furthermore, it is possible to extend the analysis to other sources of financing and regional segments.

In short, this study provides evidence that strengthening productive financing for women in Northeast Brazil can be an important tool for promoting a more inclusive, innovative, and sustainable economy, contributing both to the PNDR objectives and to the reduction of gender and regional inequalities.

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# APPENDIX

Table A1 - GPS balancing for women's average labor income

| Covariates | Treatment Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | [0.0008 - 0.1401] | | [0.1401 - 0.2621] | | [0.2627 - 0.3711] | | [0.3714 - 0.8404] | |
| | Mean Diff. | t | Average Diff. | t | Average Diff. | t | Average Diff. | t |
| Education | -0.0474 (0.0865) | -0.5479 | -0.0002 (0.0761) | -0.0030 | -0.0424 (0.0759) | -0.5595 | 0.0928 (0.0823) | 1.1279 |
| Age | 0.0836 (0.1418) | 0.5895 | 0.0812 (0.1260) | 0.6446 | 0.1913 (0.1273) | 1.5027 | -0.4566 (0.1402) | -3.2564 |
| Employment Duration | 5.2648 (1.7748) | 2.9664 | -1.1891 (1.4611) | -0.8138 | -0.2841 (1.3524) | -0.2101 | -3.2616 (1.4825) | -2.2001 |
| Female Partner Prop. | -0.0003 (0.0030) | -0.1032 | 0.0015 (0.0027) | 0.5716 | 0.0051 (0.0026) | 1.9359 | -0.0038 (0.0028) | -1.3342 |

Source: prepared by the authors. Note: The values in parentheses are standard deviations.

Table A2 - Balancing given the GPS for the Wage Gap between Men and Women

| Covariates | Treatment Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | [0.0008 - 0.1401] | | [0.1401 - 0.2621] | | [0.2627 - 0.3711] | | [0.3714 - 0.8404] | |
| | Mean Diff. | t | Average Diff. | t | Average Diff. | t | Average Diff. | t |
| Dif. Education | 0.2939 (0.0966) | 3.0437 | -0.0745 (0.0893) | -0.8343 | -0.1222 (0.0874) | -1.3989 | -0.0518 (0.0948) | -0.5456 |
| Age Diff. | -0.8251 (1.4499) | -0.5691 | 0.9261 (1.3295) | 0.6966 | -0.3540 (1.3368) | -0.2649 | 0.2424 (1.4288) | 0.1696 |
| Difference in length of employment | 0.0178 (0.1179) | 0.1511 | 0.1054 (0.1090) | 0.9675 | -0.0861 (0.1102) | -0.7814 | -0.0385 (0.1181) | -0.3263 |
| Female Partner Prop. | -0.0026 (0.0029) | -0.8908 | 0.0015 (0.0027) | 0.5401 | 0.0048 (0.0027) | 1.7900 | -0.0031 (0.0028) | -1.0963 |

Source: prepared by the authors. Note: Values in parentheses are standard deviations.

Table A3 - Estimated Coefficients of the Dose-Response Function

| | Average Labor Income | | | Gender Wage Gap | | |
|---|---|---|---|---|---|---|
| | Coeff. | Standard Deviation | p-value | Coeff. | Standard deviation | p-value |
| $T$ | -2338.6100 | 332.5519 | 0.0000 | -706.4712 | 670.0399 | 0.2920 |
| $T^2$ | 1561.7620 | 382.5136 | 0.0000 | 3857.9080 | 2203.4680 | 0.0800 |
| $T^3$ | | | | -4043.6280 | 2211.5610 | 0.0680 |
| $GPS$ | 3240.4790 | 1132.2420 | 0.0040 | 19091.2400 | 6966.6760 | 0.0060 |
| $GPS^2$ | -2437.8630 | 2206.2660 | 0.2690 | -67568.4200 | 24503.57 | 0.0060 |
| $GPS^3$ | | | | 74503.49 | 27656.49 | 0.0070 |
| $T \times GPS$ | 3994.8380 | 1250.3380 | 0.0010 | -1921.5760 | 1899.4230 | 0.3120 |
| $\alpha_0$ | 1821.9320 | 149.5639 | 0.0000 | -1587.9450 | 637.8360 | 0.0130 |

Source: Prepared by the authors. Note: *, **, *** Significant at 1%, 5%, and 10%, respectively.