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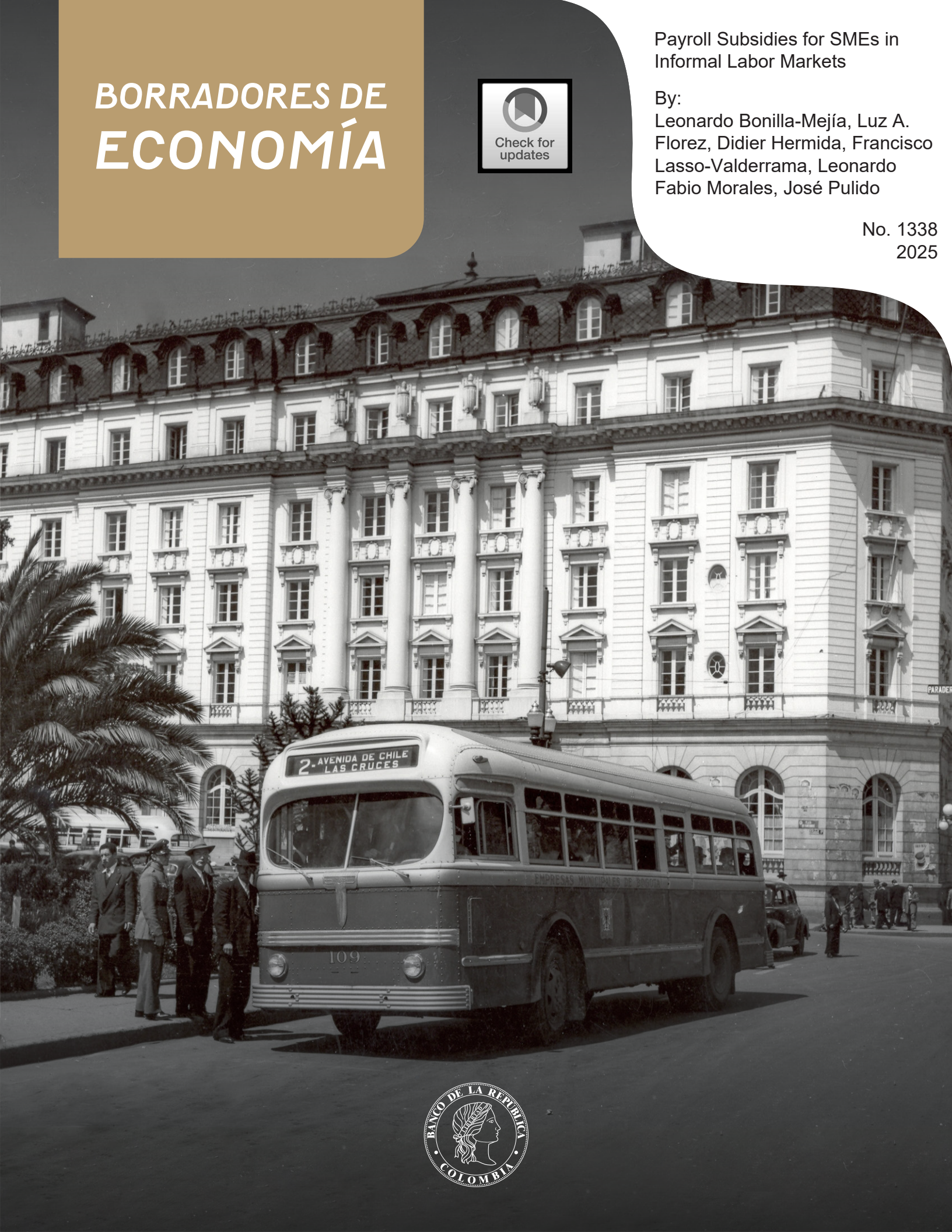

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Abstract

We study the impact of payroll subsidies targeting SMEs on labor market formalization in developing economies, where informal labor markets are prevalent. Our evidence is based on a payroll subsidy program in Colombia (PAEF-stage 2) targeting firms under 50 employees that subsidized up to 50% of the payroll. We exploit detailed administrative records, as well as the discontinuity in the eligibility threshold and the timing of the program implementation to estimate the causal effect of the program. Our findings indicate that the subsidy had a positive and persistent effect on formal employment. The impact is larger for industries receiving more subsidies but does not vary across employees' gender. Cost-benefit analysis shows that the program was financially sustainable, with internal rates of return ranging from 58% to 169%.

JEL Codes: J68, J38, J23.

Keywords: Payroll subsidies, small and medium enterprises, informality, developing economies.

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Subsidios a la nómina para las pymes en mercados laborales informales

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Resumen

En este trabajo se analiza el impacto de los subsidios a la nómina dirigidos a pequeñas y medianas empresas sobre la formalización laboral en una economía en desarrollo, donde los mercados laborales informales son predominantes. Nuestra evidencia se basa en la segunda fase del Programa de Apoyo al Empleo Formal (PAEF) en Colombia, que otorgó subsidios de hasta el 50% de la nómina a empresas con menos de 50 empleados. Se usan registros administrativos detallados, así como la discontinuidad en el umbral de elegibilidad y el momento de implementación del programa, para estimar su efecto causal. Los resultados indican que el subsidio tuvo un efecto positivo y persistente sobre el empleo formal. El impacto fue mayor en los sectores que recibieron mayores montos de subsidio, pero no presentó variaciones según el género de los trabajadores. El análisis costo-beneficio muestra que el programa fue financieramente sostenible, con tasas internas de retorno que oscilan entre el 58% y el 169%.

JEL Codes: J68, J38, J23.

Palabras clave: Subsidios a la nómina, pequeñas y medianas empresas, informalidad, economías en desarrollo.

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1. Introduction

One of the most pervasive and persistent problems of developing economies is labor market informality. Informal workers generally operate outside the reach of statutory labor protections and social insurance, facing poorer working conditions and weaker enforcement than formal workers (La Porta & Shleifer, 2014; Ulyssea, 2018). Firms may also have incentives to remain small and informal when regulations or taxes become more binding at specific size thresholds, distorting the firm-size distribution, increasing resource misallocation, and ultimately generating aggregate productivity losses (Guner et al., 2008; Garicano et al., 2016). Moreover, informality erodes the tax base, undermining state capacity and the provision of public goods over the long-run (Besley & Persson, 2014).

High labor costs are key drivers of labor informality. A large literature shows that reducing non-wage labor costs –via payroll-tax cuts or employment subsidies– can lead to significant increases in formal employment in both developed (Korkeamäki & Uusitalo, 2009; Bennmarker et al., 2009; Collischon et al., 2021) and developing economies (Kugler & Kugler, 2009; Betcherman et al., 2010; Antón, 2014; Aşık et al., 2022; Novella & Valencia, 2022; de la Parra et al. 2024). Colombia, a developing country with a large informal labor market and the focus of our study, is a well-studied case, as the effects of payroll taxes have been extensively analyzed.[3] Moreover, emergency wage-support programs during the COVID-19 pandemic provided additional evidence on the employment and firm-survival margins, though with heterogeneous cost-effectiveness across contexts (Autor et al., 2022; Watson et al., 2022; Granja et al., 2022; Harasztosi et al., 2022; Bighelli et al., 2023; Cañedo et al., 2023; Konings et al., 2023; Smart et al., 2025).

Labor costs tend to be especially binding among small and medium-sized enterprises (SMEs), where informality is more prevalent (Ulyssea, 2018). In addition, in Colombia, there is evidence that most net formal job creation is concentrated in smaller and younger firms (Flórez et al, 2021). Together, these factors make SMEs a natural target for labor cost-reduction policies.

[3] For Colombia the literature finds evidence that reductions in payroll taxes during past tax reforms have had positive effects in boosting formal employment (Kugler, et al 2017; Bernal et al., 2017; Morales & Medina, 2017; and Fernandez & Villar, 2017).

Given the fiscal cost of broad employment subsidies, targeting by firm size may enhance cost-effectiveness while reaching the firms' segment where informality is most acute.

We study such a targeted program implemented in Colombia as part of a fiscal stimulus package following the COVID-19 crisis. The Formal Employment Support Program (PAEF in Spanish), announced in September 2021, made firms with fewer than 50 employees (as of March 2021) eligible for monthly payroll subsidies between May and December 2021. The benefit amounted to 40% of the minimum wage (MW) per eligible worker, rising to 50% for women and for hard-hit sectors such as tourism, hotels, gastronomy, arts, entertainment, and recreation. Our empirical strategy, based on difference-in-differences and difference-in-discontinuity models, exploits both the discontinuity in the eligibility cutoff at 50 employees and the timing of the implementation to estimate the causal effect of the program on formal employment.

Our main findings indicate that the payroll subsidy had a positive and persistent effect on formal employment. The estimated coefficients for the average effect of the program vary between 11 percentage points (pp) and 18 pp, depending on the model specified, and are statistically significant. The dynamic responses indicate that the effects of the temporary program on formal employment were persistent, with the impact growing over time and reaching about 25 pp by the beginning of 2024, after the program had already ended. We explore the mechanisms underlying these results. The program's employment gains were driven primarily by an 8% increase in hiring and job creation, with no significant effects on separations or job destruction. Further, an estimated 2.5% reduction in firm closures (statistically significant at the 10% level) suggests that preventing market exits was an important channel, consistent with the persistence of the effects observed. Therefore, by sustaining firms that would otherwise have exited, and by boosting hiring among the targeted firms, the program preserved formal jobs and stimulated formal employment in Colombia for a considerable period after its implementation.

We next examine intensive-margin heterogeneity, assessing whether larger subsidies, granted to specific industries and women, produced larger effects. Our results indicate that the estimated effects are considerably larger for targeted tourism and art-related industries, with an estimated average effect of around 39 pp. However, we cannot reject that the impact is statistically

different from that in the other industries. In contrast, we find no differential effects by workers' gender, which implies that the differential subsidy for hiring women was ineffective.

Finally, we proceed to assess our impact evaluation results through the lens of a cost-benefit analysis. We find that the program was financially sustainable across a wide range of assumptions. Using Colombia's household survey to estimate a lower bound on benefits obtained from the formal–informal wage gap, we find that the creation of approximately 66,5K new formal jobs generated annual earnings gains of USD 98 million, rising to USD 136 million once fiscal savings from additional social security contributions are included. These employment gains also imply a 0.3 percentage point reduction in the national informality rate. Even under high annual depreciation rates of benefits (up to 50%), the program yields cost-benefit ratios between 1.3 and 3.1 and internal rates of return ranging from 58% to 169%, comparing favorably to similar labor market interventions in Colombia (Attanasio et al., 2011) and internationally (Betcherman et al., 2010; Girma et al., 2008).

Our study contributes to at least three strands of the literature. First, we add evidence to the aforementioned body of research examining the effects of policies aiming at reducing non-wage labor costs –via payroll-tax cuts or employment subsidies– on employment, in the context of a labor market such as Colombia's, where informality is widespread. Our findings suggest that a program targeting segments of firms where informality is prevalent can be highly cost-effective in addressing labor informality. This is particularly relevant in the context of developing countries, where most formal job creation relies on the survival of SMEs (Florez et al., 2021) and where policy interventions may be justified to correct market or regulatory distortions that misallocate employment between formal and informal jobs (Álvarez & Ruane, 2024; Machado Parente, 2024; Otero-Cortés et al., 2025).

Second, our study contributes to the prior Colombian evidence, which extensively examines only economy-wide and permanent payroll-tax cuts followed after tax reforms (Kugler et al 2017; Bernal et al., 2017; Fernández & Villar, 2017; Morales & Medina, 2017). We complement this body of work by showing that tight targeting of SMEs —where informality is concentrated— can generate equally sizable employment effects but at potentially lower fiscal cost per job than broad-based reductions. Moreover, by evaluating dynamic effects and tracking outcomes well beyond

the subsidy window, we can evaluate the persistence of employment gains after the program ended; suggesting that even temporary cost reliefs can place firms on a sustained formal hiring trajectory.

Finally, our study also contributes to the growing body of literature evaluating worldwide policy interventions designed to mitigate the labor market impacts of the COVID-19 pandemic, focusing on the Colombian case. Given the reduction in fiscal space caused by these interventions —together with the costs of other public health measures— which, in Colombia's case, contributed to a significant increase in the debt-to-GDP ratio, we deliberately examine not only the program's impact on formal employment but also its fiscal viability through our cost-benefit analysis. Hence, our evaluation aligns with recent literature assessing both the effectiveness and the cost-efficiency of crisis-response labor policies (e.g., Autor et al., 2022; Smart et al, 2025).

The rest of the paper is structured as follows. Section 2 briefly describes the Colombian labor market and the payroll subsidy program. Section 3 outlines the data and the empirical strategy. Section 4 presents the main results, explores the mechanisms and examines intensive-margin heterogeneity. Section 5 presents the cost-benefit analysis. Finally, Section 6 concludes.

2. Context

2.1. Colombian labor market

Colombia is a developing country with a labor market characterized by high levels of informality and unemployment, a rigid formal sector with wages heavily influenced by the legal MW, and remarkable regional and demographic disparities in the labor market outcomes, among other structural issues (Pulido et al., 2024). Although informality has trended downward in recent years –from 62% in 2021 to 56% in 2025 – its incidence remains above the regional average, even after conditioning on GDP per capita (Otero-Cortés et al., 2025). A key driver of this high informality is the relatively elevated cost of labor. On the wage side, Colombia's MW, relative to the median wage, has been the highest in a sample of OECD advanced and emerging economies over the past decade (Pulido et al., 2024), and it is highly binding: more than 40% of formal workers earn exactly the MW (Becerra & Morales, 2025). On the non-wage side, Colombia faces payroll surcharges and hiring/firing costs that exceed the OECD average, even after a 2012 reform that substantially reduced payroll taxes (Florez et al., 2021).

Another salient feature of the Colombian labor market is the predominance of SMEs. In a comparative study of labor market dynamics in Colombia and the United States, Florez et al. (2021) show that Colombia's labor market has a higher share of employment in SMEs and an overrepresentation of these firms in the business ecosystem. Firms with 2-19 and 20-49 employees account for 19.2% and 10.4% of total employment, and 85.5% and 8.1% of total firms, respectively. SMEs are the largest job creators in Colombia, with job creation rates of 15.4% and 12.5%, respectively; together, they accounted for nearly 50% of all jobs created between 2009 and 2017. This evidence underscores the central role of SMEs in Colombia's labor market –particularly in formal job creation– suggesting that firm size could be a relevant criterion for targeting employment subsidies aimed at boosting employment in a highly rigid and distorted formal sector, such as Colombia's.[4]

2.2. Formal Employment Support Programs (PAEF)

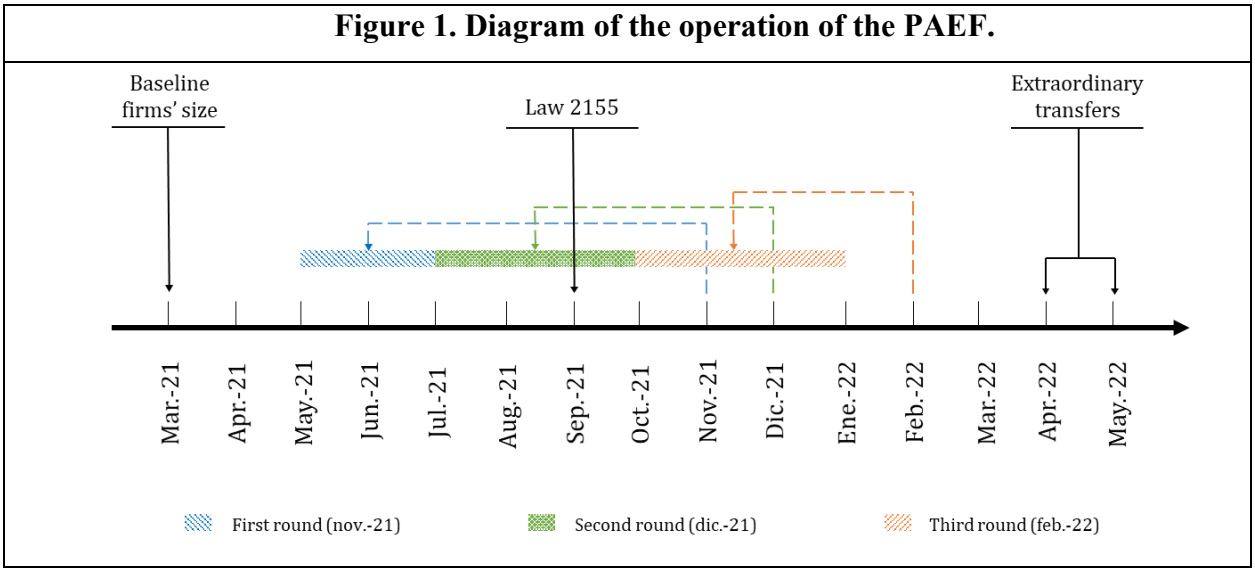
Governments tend to expand fiscal budgets during recessions to mitigate the impact of the crisis on employment and poverty. This is the case of the program evaluated in this paper, PAEF, launched under Law 2155 of September 2021 and applied to payrolls from May to December 2021. The nature of the program was subsidizing firms, through payroll subsidies, in exchange for maintaining or creating employment during the crisis. The key novelty of this program was its targeting mechanism: subsidies were only granted to SMEs, up to 50 workers. To prevent potential manipulation of the eligibility criteria, the company's size was measured by the number of workers contributing to PILA in March 2021, six months before the subsidy was announced. In addition to the firm size criteria, eligible firms also needed to prove a reduction in income of at least 20% during the pandemic. [5] Of the 349,873 firms under 50 workers registered in the PILA in March 2021, this policy benefited 49,989 (14.3%), with a total cost of COP 0.72 billion.

[4] While there is widespread evidence of the aggregate productivity costs of size-dependent distortions in market structures without policy interventions (Guner et al, 2008; Restuccia & Rogerson, 2008; Hopenhayn, 2014), in a regulatory environment such as the Colombian formal sector described above —where, for instance, a high MW potentially distorts employment allocation between formal and informal jobs (see Machado Parente, 2004, for the mechanism tested in Brazil)— a size-dependent policy could serve as an intervention to mitigate the effects of regulatory constraints, moving the allocation of resources toward its "second-best."

[5] The reduction in income is calculated comparing income in any month in 2021 to the same month in 2019 or the average in January and February in 2020. Other eligibility criteria included: 1. Being legally constituted and having a commercial registry renewed or completed before May 6, 2020. 2. Being up to date in the payment of salaries and

Figure 1 presents the timeline of the PAEF. Law 2155 was enacted in September 2021. To avoid manipulation in the firm's eligibility, the Lawmakers determined that the first reference date for the workers' headcount would be March 2021. The first round of transfers began in November 2021, which reimbursed firms for the payroll costs of May and June 2021. In December 2021, a second tranche was disbursed to cover payrolls incurred between July and September 2021, and in February 2022, a third tranche was paid to offset payroll expenses for October - December 2021. Finally, between March and April 2022, a set of extraordinary transfers was issued to those approved firms that had not yet claimed their initial subsidies.

Figure 1. Diagram of the operation of the PAEF.



Subsidies varied by industry and gender. Firms in industries that were most affected by the pandemic, such as tourism, hospitality, and gastronomy, as well as the arts and entertainment activities, received a 50% subsidy of MW for each worker, whereas all other firms received a 40% subsidy. Subsidies were also slightly higher for women and for some sectors most affected by the pandemic. Specifically, the support for women amounted to a subsidy equivalent to 50% of a MW, while for men it was 40%.

social security contributions of workers for whom they receive the subsidy and not have the participation of the nation or its decentralized entities greater than 50% of its capital. 3. Eligible employees needed to earn monthly wages of at least one MW, and have no registers of unpaid leave or temporary contract suspension.

A previous version of the PAEF, created under the Emergency Decree 637 of May 2020, was set in place to support and protect formal employment in the country through a direct payroll subsidy for firms that were particularly hit by the pandemic, regardless of their size. This program benefited firms that experienced a reduction of at least 20% in income during the first months of the pandemic, and covered 40% of the MW per worker. The program was later extended until March 2021, increasing the number of transfers over a maximum of 11 months and raising the benefit to 50% of a MW for companies that hired women or operated in the tourism, hospitality, gastronomy, or the arts, entertainment, and recreation sectors. During these months, the first version of PAEF distributed approximately 6.8 billion Colombian pesos (COP) to 142,999 companies.

In addition to the PAEF programs, the government implemented other policies to protect employment and boost job creation. First, it supported the payment of payrolls in June and December 2020, when extra-salary benefits are typically paid. Second, it assisted companies affected by national strikes and protests in May and June 2021, providing 20% of the monthly MW per worker earning that salary. Third, for payroll applications from August 2021 to August 2023, it introduced programs to encourage job creation, such as the 'Shake It Up Strategy,' which offered a 25% subsidy of an MW for each additional young person between the ages of 18 and 28 hired, and the 'New Employment' program, which extended the subsidy to 15% and 10% of an MW, respectively, for each additional woman and man over 28 years of age hired for a salary of less than three MW.

3. Data and empirical strategy

3.1. Data

In the analysis of the effects of PAEF, we use administrative records from the social security system in Colombia. Specifically, we use employer-employee linked data from the Unified Social Security Contribution Form (PILA, by its acronym in Spanish). All contributions made by firms and formal self-employed workers are registered in PILA; with this information, we construct a monthly panel of all formal firms in Colombia. We can collect information on wages, employment

levels, payroll-tax payments, economic sector, and some employees' characteristics, among other variables. We also observe workers' transitions between employers across firms, and in and out of PILA. Therefore, we can also measure for each firm, labor market flows in the standard way that macroeconomic labor literature defines them (Davis et al., 1996; Davis et al., 2006; Morales & Medina, 2019).

As mentioned before, the PAEF subsidies were designed as a firm protection mechanism in recessions, specifically, it took place during the pandemic crisis. During this period, firms in sectors affected by the lockdowns reduced their labor demand intensively (Morales et al., 2022). Since one of the prerequisites for eligibility was a significant reduction in their income, we excluded firms belonging to the economic sectors declared essential and unaffected by lockdowns in the pandemic from the sample.[6] More specifically, we exclude firms from the following sectors: public administration, finance, agriculture and public utilities.

3.2. Empirical strategy

Our main empirical analysis is based on Difference-in-Discontinuity (D-Disc) design, which extends the Difference-in-Differences (DD) setup to model the discontinuity in the eligibility criteria explicitly (Grembi et al., 2016; Takahashi, 2024; and Tramontin, et al., 2024). The main advantage of this approach with respect to DD is that it places greater weight on firms that are close to the cut-off, effectively reducing the observed and unobserved differences between the treated and control groups.

In the baseline DD model, we compare the employment levels of eligible firms –under 50 employees in March 2021- with non-eligible firms, before and after August 2021:

$$y_{i,t} = \alpha_0 + \beta_0 Treat_i + \gamma_0 Post_t + \varphi_0 (Treat_i \times Post_t) + \delta_i + \gamma_t + \varepsilon_{i,t} \qquad (1)$$

Where **y** is the number of formal workers of firm i in period t, **Treat** is a dummy variable that takes the value 1 for eligible firms and 0 for control firms, and **Post** is a dummy variable that

[6] With a high probability, the firms in the sectors declared essential did not register significant decreases in their income, so companies with less than 50 employees could not be eligible to receive the subsidy. Thus, firms in these sectors are excluded from the treatment and control groups. For the definition of essential sectors and the consequences of mobility restriction on employment, see Morales et al. (2022).

takes the value 1 after August 2021, the month in which the program is implemented. The model includes firm (δ_i) and time (γ_t) fixed effects, which account for observable and unobservable invariant characteristics of the firms and common shocks. The errors are clustered at the firms' level.

The (D-Disc) model extends the DD setup by interacting all terms with the normalized distance to the cut-off ($Norm_i$):

$$y_{i,t} = \alpha_0 + \alpha_1 Norm_i + (\beta_0 + \beta_1 Norm_i) Treat_i + [(\gamma_0 + \gamma_1 Norm_i) Post_t + (\varphi_0 + \varphi_1 Norm_i) Treat_i] \times Post_t + \delta_i + \gamma_t + \varepsilon_{i,t} \quad (2)$$

As in equation (1), the **Treat x Post** coefficient is our parameter of interest, measuring the effect on the intended-to-treat group compared to the control group, while controlling for the distance from the threshold.

We assess the dynamic impacts of the program with event study specifications, in which the treatment variables are interacted with a set of temporary dummy variables (D_τ), taking as a reference value the month of August 2021. In the DD setup, the event study is estimated as follows:

$$y_{i,t} = \alpha_0 + \sum_{\tau=1}^{T} \beta_\tau \, Treat_i \times D_\tau + \delta_i + \gamma_t + \varepsilon_{i,t} \quad (3)$$

In the D-Disc model, the dynamic estimation also includes all the interaction with the distance to the cut-off variable:

$$y_{i,t} = \alpha_0 + \sum_{\tau=1}^{T} \beta_\tau \, Treat_i \times D_\tau + \sum_{\tau=1}^{T} \beta_\tau \, Treat_i \times D_\tau \times Norm_i + \delta_i + \gamma_t + \varepsilon_{i,t} \quad (4)$$

The baseline estimation sample includes firms with between 42 and 59 workers in March 2021. This choice is based on the fact that the average optimal Calonico et al. (2014) bandwidth, estimated period by period, is 9 (Appendix Figure A1). As a robustness check, we vary the bandwidth from 2 to 38 workers, finding overall similar results (Appendix Figure A4). The baseline sample includes 5,028 firms, of which 2,915 are in the treated group and 2,113 are in the control. Table 1 presents some descriptive statistics of the sample, showing that the average employment for firms in the treatment group is around 39.1, while in the control group, the average is 59.4. Furthermore, the gender composition of firms is quite similar between the two groups,

with women accounting for 37.2% of employment in the treatment group and 37.7% in the control group. In the same way, the share of young employees is similar for the treatment (10,8%) and control (10,6%) group. Additionally, firms in the tourism, hospitality, and arts-related sectors make up around 5.6% of the treatment group and 5.2% of the control group.

Table 1. Descriptive statistics

	Treatment group (between 42 and 50 employees)			Control group (between 51 and 59 employees)		
	Mean	Std. Dev.	Number of firms	Mean	Std. Dev.	Number of firms
Total	45.7	2.6	2915	54.7	2.6	2113
Share of Men	62.2	24.1	2915	62.7	23.8	2113
Share of young people	10.8	8.4	2915	10.6	8.6	2113
Share of employment in Tourism, hotels, and art related activities	5.0	21.9	2915	4.8	21.4	2113

Notes: summary as of March 2021. Source: PILA, calculations by the authors. The share of young people stands for the percentage of employees up to 25 years old.

The validity of the regression discontinuity design also relies on the similarity between treated and control firms. We test for balance in observed characteristics following Cattaneo et al., (2020) in Appendix Figure A2. Our results indicate that, prior to treatment, the treated and control groups are similar overall.

4. Results

4.1. Main results

We begin our analysis with the D-D (columns 1 to 4) and D-Disc estimations (columns 5 to 8) in Table 2. Columns 4 and 8 present the OLS estimations described in Equations 1 and 2, which control for both time and firm fixed effects. Results are particularly robust across specifications, with an estimated impact of 0.113 in the D-D models and 0.181 in the D-Disc designs.

Table 2. Difference-in-Differences and Difference-in-Discontinuity effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treat x Post	0.113***	0.113***	0.113***	0.113***	0.181***	0.181***	0.181***	0.181***
	(0.0296)	(0.0296)	(0.0296)	(0.0296)	(0.0607)	(0.0607)	(0.0607)	(0.0607)
Treat	-0.174***		-0.174***		0.0237		0.0237	
	(0.0136)		(0.0136)		(0.0278)		(0.0278)	
Post	-0.482***	-0.482***			-0.551***	-0.551***		
	(0.0236)	(0.0236)			(0.0489)	(0.0489)		
Norm					0.0175***		0.0175***	
					(0.00424)		(0.00424)	
Treat X Norm					0.00897*		0.00897*	
					(0.00539)		(0.00539)	
Post X Norm					0.0147	0.0147	0.0147	0.0147
					(0.00899)	(0.00899)	(0.00899)	(0.00899)
Treat X Post X Norm					-0.0148	-0.0148	-0.0148	-0.0148
					(0.0115)	(0.0115)	(0.0115)	(0.0115)
Constant	3.840***	3.740***	3.493***	3.392***	3.758***	3.740***	3.361***	3.343***
	(0.0103)	(0.0104)	(0.0203)	(0.0124)	(0.0223)	(0.0104)	(0.0427)	(0.0331)
Adjusted R-squared	0.024	0.536	0.052	0.566	0.027	0.536	0.056	0.566
Firm fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Time fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Observations	216,204	216,204	216,204	216,204	216,204	216,204	216,204	216,204

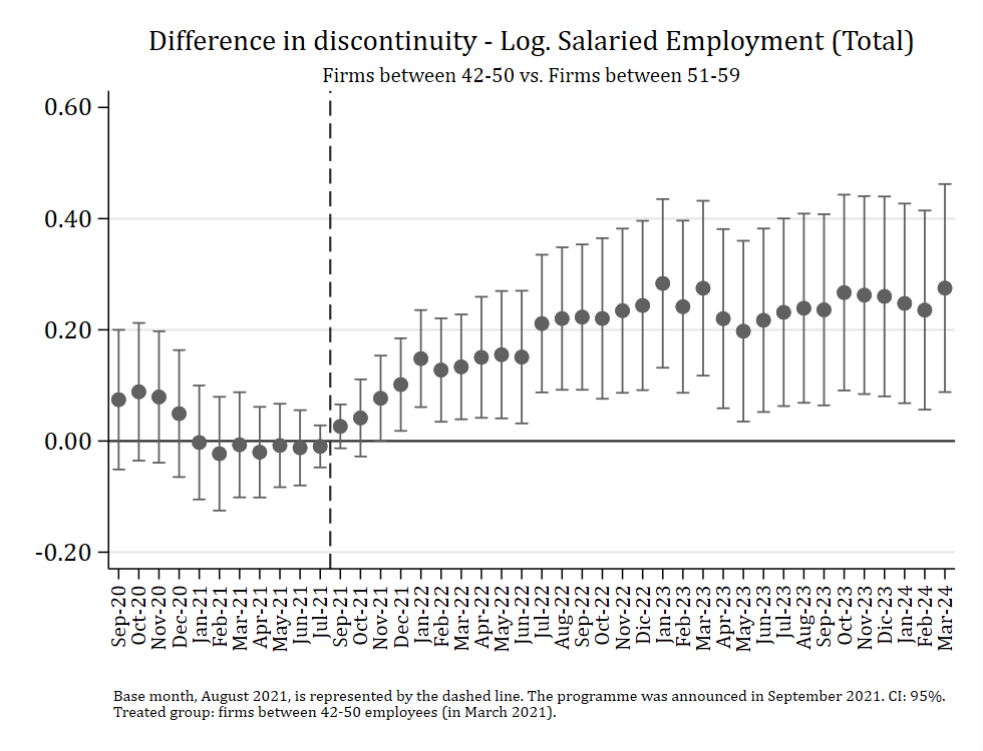
*Notes: standard errors in parentheses and clustered at the firm level. Significance codes: *** p<0.01, ** p<0.05, * p<0.1*

The D-Disc dynamic effects, estimated with equation (4), are presented in Figure 2. The first thing to be noticed is that the treated and control firms behave similarly before the program was implemented, suggesting that the parallel trends assumption holds. This is consistent with the Rambachan and Roth (2023) test, which overall shows the robustness of our estimates to deviations in the parallel trends assumption. In Appendix Figure A9, we present confidence sets that vary with the magnitude of the deviation (M). The results indicate that our main findings are robust to violations of the parallel trends assumption up to 1.5 times the maximum difference between two periods in pre-treatment trends.

Following the implementation of the program, we find that the employment differences between eligible and non-eligible firms are economically large and persistent. The estimated coefficients are positive and significant effects from the third trimester of 2021 until the end of the study period. Moreover, the impact tends to grow over time, with average estimated coefficients of almost 0.25 in 2023 and 2024. The persistence of these effects, observed even four years after

the policy's implementation, may be attributed to the tendency of formal salaried workers to remain in such occupational positions. This phenomenon has been documented in the Colombian labor market literature. For instance, Lasso-Valderrama (2012) finds that the highest annual transition probability in a Markov chain model of occupational states is remaining in a formal job (78%), which increases to 84% for workers over the age of 25.

Figure 2. Dynamic Effects



Notes: The figure represents the estimated coefficients and the 95% confidence intervals of the interactions of the treatment variable with dummy variables for each month (Equation 1). Standard errors are clustered at the firm level. The red line represents the start month of the policy: August 2021; The immediately preceding month is used as the reference period.

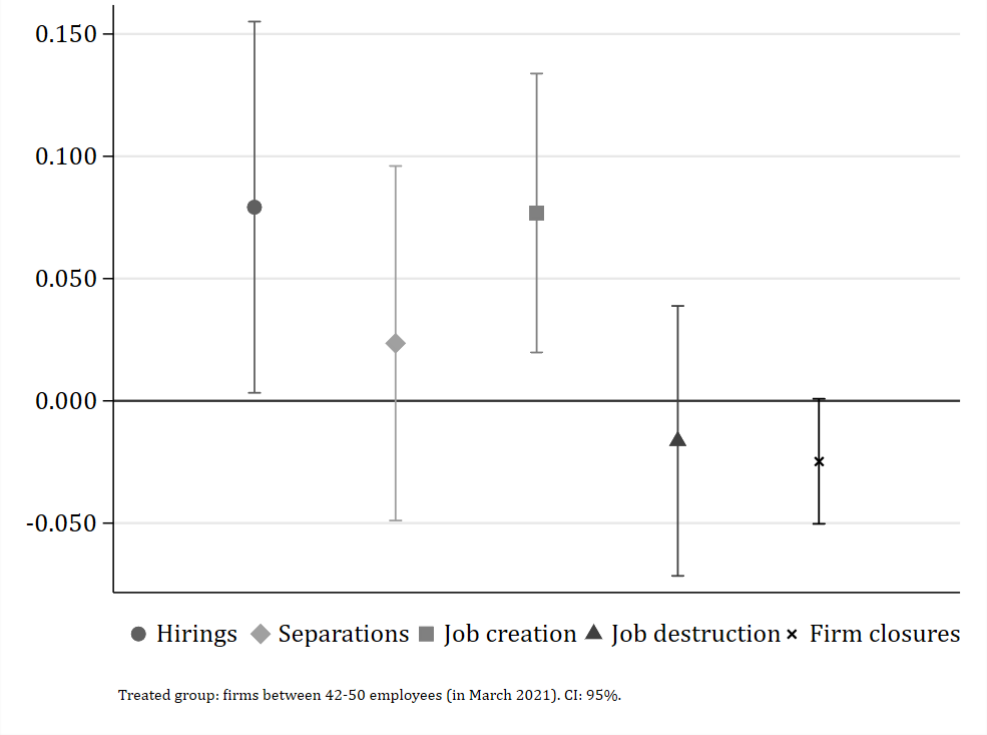
Results are overall similar with the DD dynamic model, with positive and persistent estimated effects (Appendix Figure A3). However, the DD does exhibit small differences in employment in the pre-treatment period. This would suggest that the D-Disc specification does a better job than the DD at controlling for unobserved differences between treatment and control firms. Our results are also robust to alternative bandwidth selection. We estimate the D-Disc with bandwidths oscillating between 2 and 38 in Appendix Figure A3. The estimated coefficients are significant in all cases, although smaller for larger bandwidths. Finally, we run placebo tests for

the treatment assignment, altering the threshold from 50 to 30 and 70 employees, respectively (Appendix Figure A5). The estimated coefficients are small and statistically insignificant in both cases, as expected.

4.2. Mechanisms

We begin our mechanism analysis by estimating the impact of the program on firm closures and labor market flows in Figure 3, with the corresponding dynamic estimates presented in Appendix Figure A8. There are two key takeaways from these estimations. First, the program significantly reduced firm closures, suggesting that part of the observed employment effect is explained by adjustments along the extensive margin. Second, the expansion in employment is primarily driven by increased hiring and job creation, while separations and job destruction remained unchanged. The estimated effect on firm closures is -0.025 and is statistically significant at the 10% level. This finding suggests that one mechanism through which the PAEF program influenced employment was by preventing firm closures. Moreover, this may also help explain the persistent nature of the program's employment effects: in the absence of the program, jobs in firms that would have exited the market would have been permanently lost. Finally, the program does not appear to have a significant effect on the intensive margins of separations or job destruction rates. The employment effect is instead explained by an increase of nearly 8% in hiring and job creation, which—given the path dependency of formal employment in Colombia discussed earlier—is consistent with the lasting impact of the program.

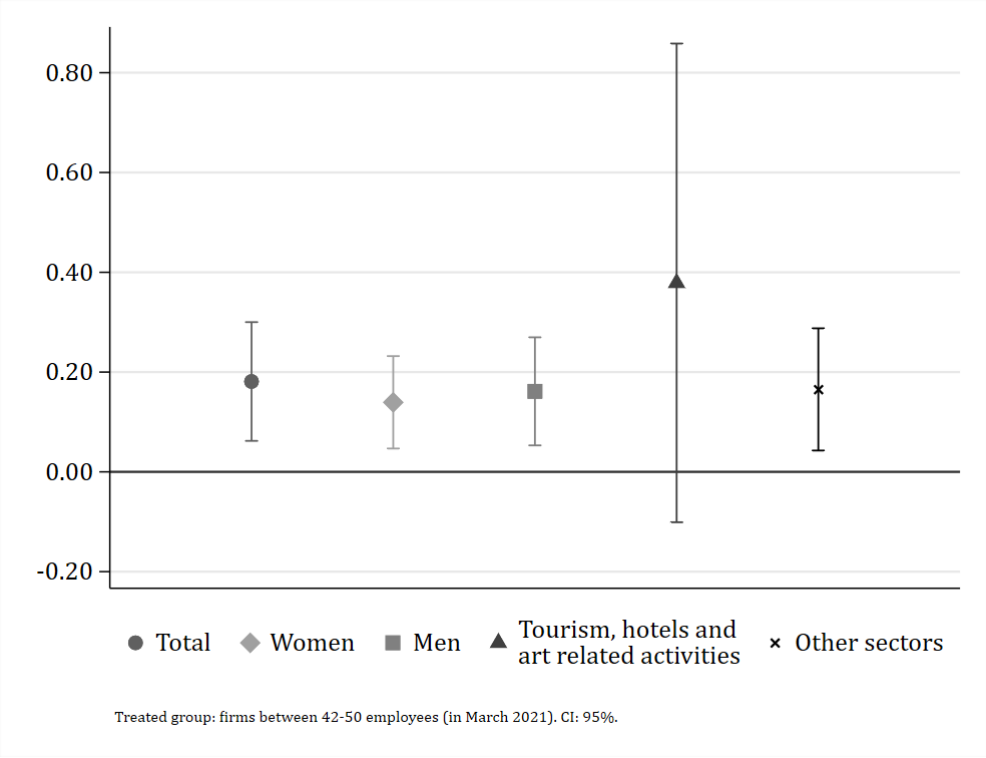
Figure 3. Effects on firm closures and job flows



Notes: The Figure represents the estimated coefficients and the 95% confidence intervals. Standard errors are clustered at the firm level.

We then assess the intensive margin effects. The program provided slightly higher subsidies for women and firms in some industries that were particularly affected by the pandemic, such as tourism, hotels, and art-related activities. We explore the heterogeneity of the effects of the program across these dimensions in Figure 4. Results indicate that the impact does not vary by gender, as the estimated coefficients are similar for women and men. The pandemic affected industries do have a considerably higher point estimate, of 0.39; however, given the small sample size and the large variance, we cannot reject that the impact is statistically larger than in the other industries. This is likely the result of a lack of power given the sample reduction. The dynamic effects, presented in Appendix Figures A6, tend to confirm these findings.

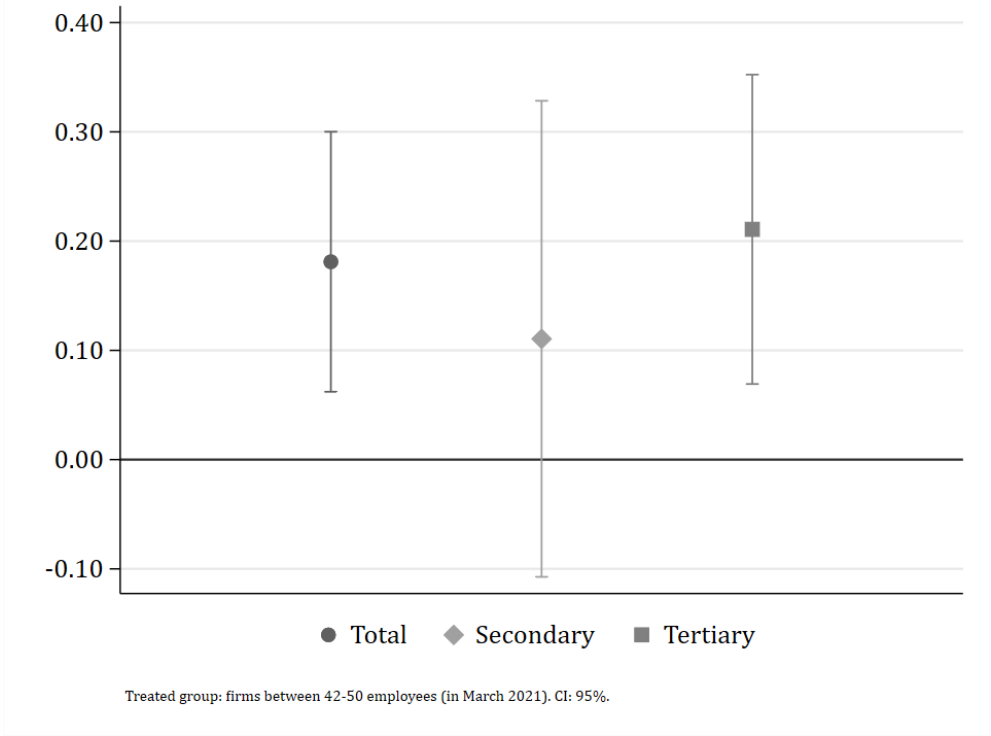
Figure 4. Effects by Subsidy Intensity



Notes: The Figure represents the estimated coefficients and the 95% confidence intervals. Standard errors are clustered at the firm level.

Finally, we assess the heterogeneous impact by economic sector in Figure 5 (The dynamic estimates by economic sector are presented in Appendix Figures A7). The impact is particularly larger in the tertiary sector than in the secondary one. These findings align with the observation that during the economic crisis associated with the COVID-19 pandemic, the sectors most affected were those related to services. Most service-related industries experienced disruptions due to lockdowns or more subtle mobility restrictions (Morales et al., 2022). Consequently, it is reasonable to expect that firms in this sector were more likely to take advantage of the eligibility policy to apply for the PAEF program, which in turn supported their recovery from the crisis.

Figure 5. Heterogeneous Effects by Economic Sector



Notes: The Figure represents the estimated coefficients and the 95% confidence intervals. Standard errors are clustered at the firm level. For presentation purposes the primary sector has been removed, nevertheless in Appendix Figure A7 the Event Study for all the economic sector is shown.

5. Cost-Benefit Analysis

In the last section of the paper, we discuss the program's cost-efficiency and compare it with similar estimations in the literature. The valuation of the benefits of the program is based on the difference between average wages in the formal sector and labor income in the informal sector in Colombia. This is a lower bound of the possible benefits because we assume that in the absence of the program, the workers in the new jobs generated by the policy would be in informal employment with lower labor income, but not unemployed. Using information from the official household survey in Colombia (GEIH, by its Spanish acronym), we found that in 2021, the formality wage premium was USD $129 per month. In additional exercises, we include as benefits fiscal savings coming from the fact that every new formal job implies contributions from

employers and employees to the social security system that otherwise would need to be compensated by government transfers to the system; such additional benefits add up to USD 51 per month.[7]

A key issue in measuring benefits is whether they are permanent; in this regard, we compute cost-efficiency indexes for several scenarios depending upon the rate at which the benefits are allowed to depreciate (15%, 25%, 40% and 50%). In Appendix Tables A1 and A2, we present the results of the Cost benefits analysis, and the flow of benefits and costs, discounted at a 10% annual rate, in a time horizon of 21 years; this is because the average worker on the treated firm is 39 years old, and we assume a retirement age of 60 years. We compute the program cost based on the official information of the Colombian Ministry of Economics. In the second stage of the PAEF, authorities declared that 49.989 firms were treated with a total cost of USD 179 million (COP 0.72 billion). We compute the total benefits of the programs by applying the employment semi-elasticity (0.18) found in section four to the employment level of the 49.989 beneficiary firms without the treatment. For this purpose, we use the average size before the policy of firms between 2 and 50 employees. The employment effect of the policy in the treated firms implies an increase of 66,556 new employments; based on these new employments, the earnings benefits are equivalent to USD 98 million, which increases to USD 136 million if the fiscal savings from contributions of these new formal employees are considered. Moreover, the creation of these 66,556 jobs translates into a 0.3 pp reduction in the overall informality rate.

The cost-benefit analysis results describe the PAEF as a financially sustainable program across all depreciation scenarios. The cost-benefit ratios of 3.1, 2.2, 1.6 and 1.3, and internal rate of returns (IRR) of 169%, 138%, 90%, and 58% for the exercises with benefits depreciation rates of 15%, 25%, 40%, and 50%, respectively, are a testament to the program's financial prudence (see Appendix Tables A1 and A2). According to this evidence, the second stage of the PAEF program is cost-efficient, even in scenarios where benefits depreciate annually at very high depreciation rates. Once fiscal savings are incorporated, we find an IRR of around 58%, even in the highest depreciation of benefits scenario, which reflects a public policy that could be considered appealing from the financial point of view. This index not only stands on its own but

[7] By law, the contribution to the pension system is 16% of the wage, and 4% of the wage to the health insurance system.

also compares favorably with other policy financial assessments in the literature. In Colombia, for example, Attanasio et al., (2011) found that a short job-training program for disadvantaged youth introduced in Colombia in 2005 had an IRR of 21.6% for women participants using a discount rate of 10% for the benefits.[8] The second stage of the PAEF programs compares well with labor market policies and reforms internationally. For instance, just to mention a subset of the literature, Betcherman et al. (2010) find an IRR of 35% of a subsidy scheme in Turkey implemented to boost formal employment. Girma et al. (2008) find benefit-cost ratios between 1.2 and 1.9 for public programs of government grants on labor demand in Ireland.

6. Conclusions

This study assesses the impact on formal employment of a job protection program in Colombia (PAEF second version) created by the government to mitigate the effects of the COVID-19 pandemic on the labor market. The program offered subsidies aimed at protecting formal jobs in SMEs with fewer than 50 workers that experienced a 20% drop in income due to the health crisis. It involved paying 40% of one MW per male worker on the payroll registered in the official Social Security records between May 2020 and December 2021, and 50% of the MW per female worker. For workers in the tourism, hotel, gastronomy, arts, entertainment, and recreation sectors, the subsidy was 50% of a MW, regardless of gender.

The empirical strategy uses both a D-Disc and a DD design, with dynamic effects estimated with event study specifications. To identify the causal intended-to-treat effect (IIT) of the policy, firms close to the threshold of 50 workers established by law for subsidy eligibility were selected. Additionally, firms in economic sectors declared essential and unaffected by the lockdowns were excluded from the sample, ensuring that the treated and control firms are as comparable as possible. Our results show a significant positive effect on formal employment after implementing the policy for eligible firms with up to 50 workers compared to larger firms. The aggregate results obtained from the D-Disc (DD) estimates show that, as a result of the policy, eligible firms increased their employment by 0.11 lp. (0.18 lp.) relative to firms in the control group. This result

[8] For the same program Attanasio et al., (2017), in the long run, find IRR of 20%, with depreciation rates up to 6%.

is robust to changes in the definition of treated versus control firms in the analyzed sample, allowing for different windows in firm size to compare treated and control groups. We believe that our strategy allows us to capture the causal local ITT effect of the program, given that the eligibility criteria based on firm size were not affected by the policy (the information used to calculate firm size corresponds to PILA records from March 2021, six months before the policy was implemented). Moreover, we provide evidence that there was no manipulation at the cut-off of 50 employees.

Additionally, the results show a high persistence effect. Even though the policy was applied only until December 2021's payroll, the effect remains positive and significant until 2024. No differential effects were found by gender, but a larger impact is observed in tourism, hotel, gastronomy, artistic activities, entertainment, and recreation, which received a subsidy of 50% of the MW per worker. Finally, the cost-benefit analysis results describe the PAEF as a financially sustainable program across all depreciation scenarios. Once fiscal savings are incorporated, we find an IRR ranging from 58% to 169%, depending on the depreciation of benefits scenario, which reflects a public policy that could be considered appealing from the fiscal point of view.

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Appendix

Figure A1. Density of the optimal bandwidth in each period of the sample

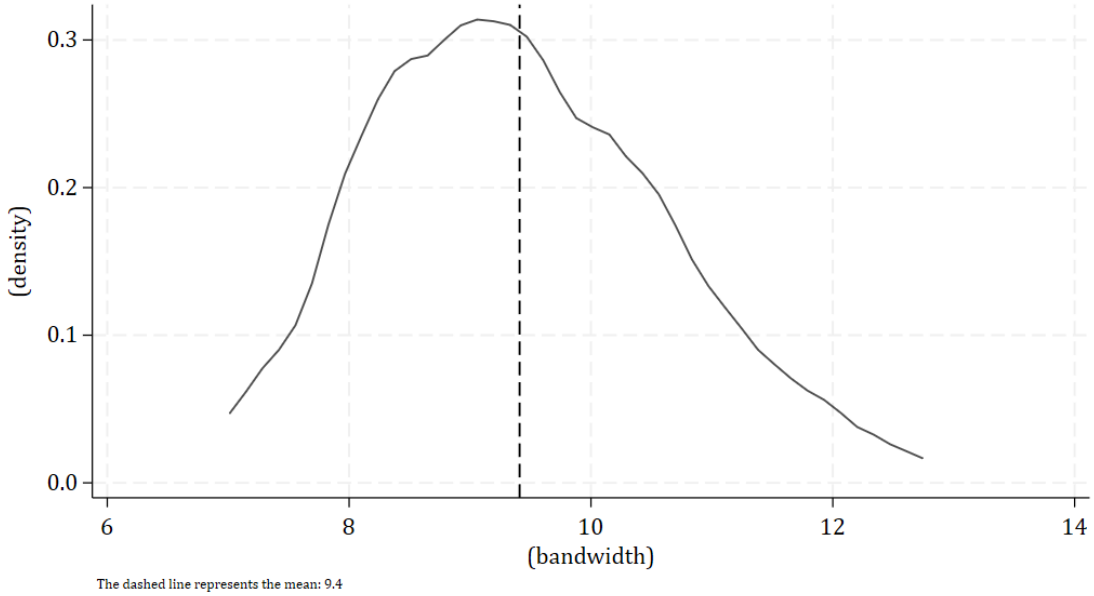
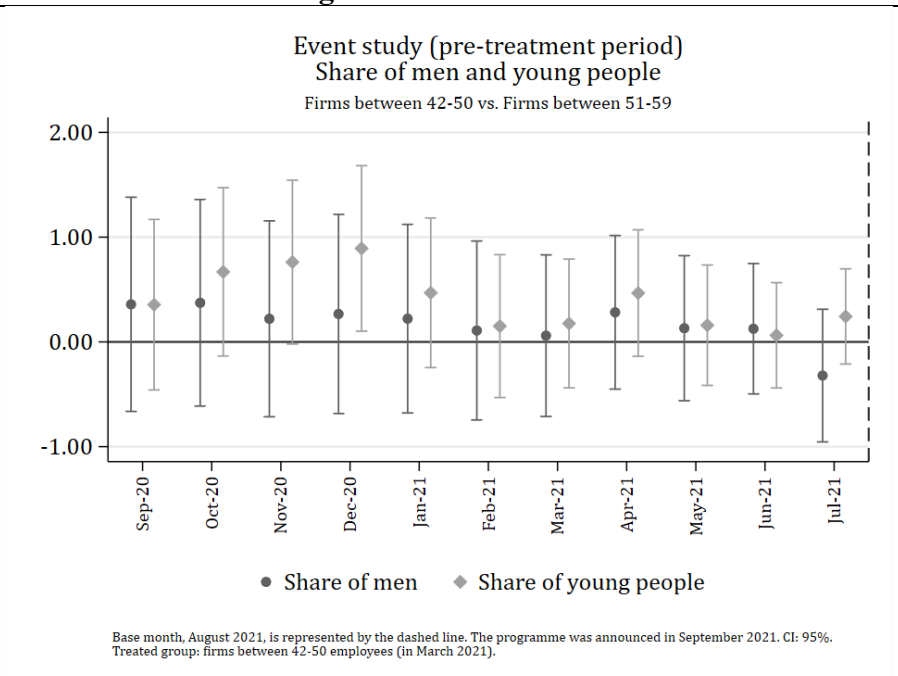


Figure A2. Balance test



Notes: Share of young people represets the percentage of employees up to 25 years old.

Figure A3. Dynamic Difference-in-Differences results

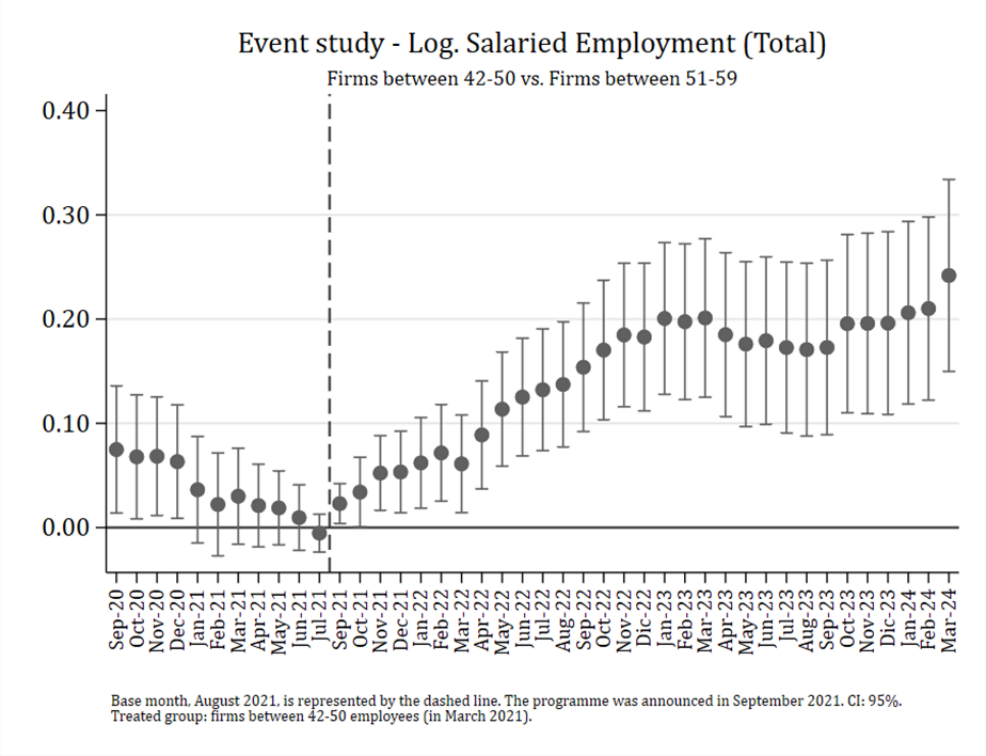


Figure A4. Sensibility to bandwidth selection

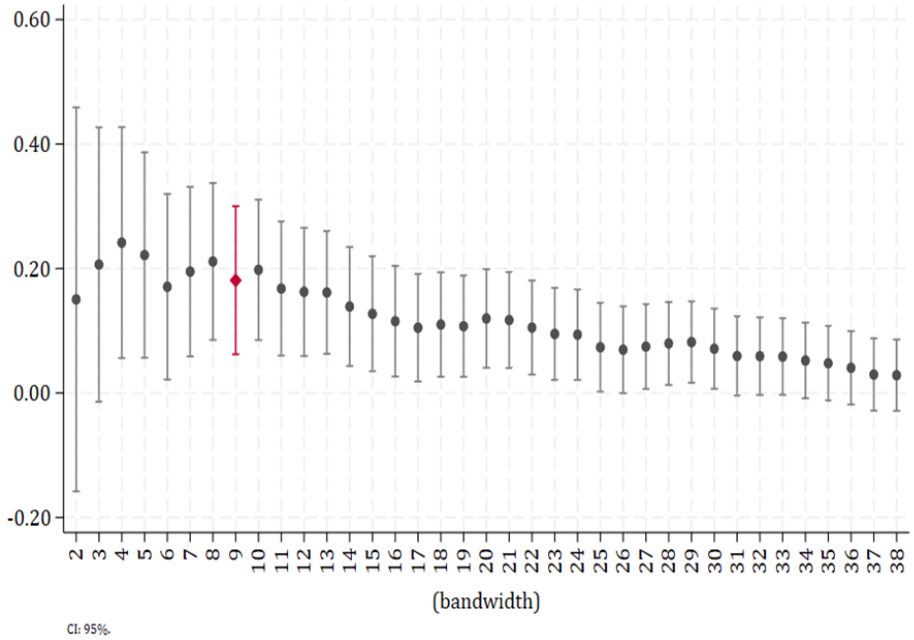
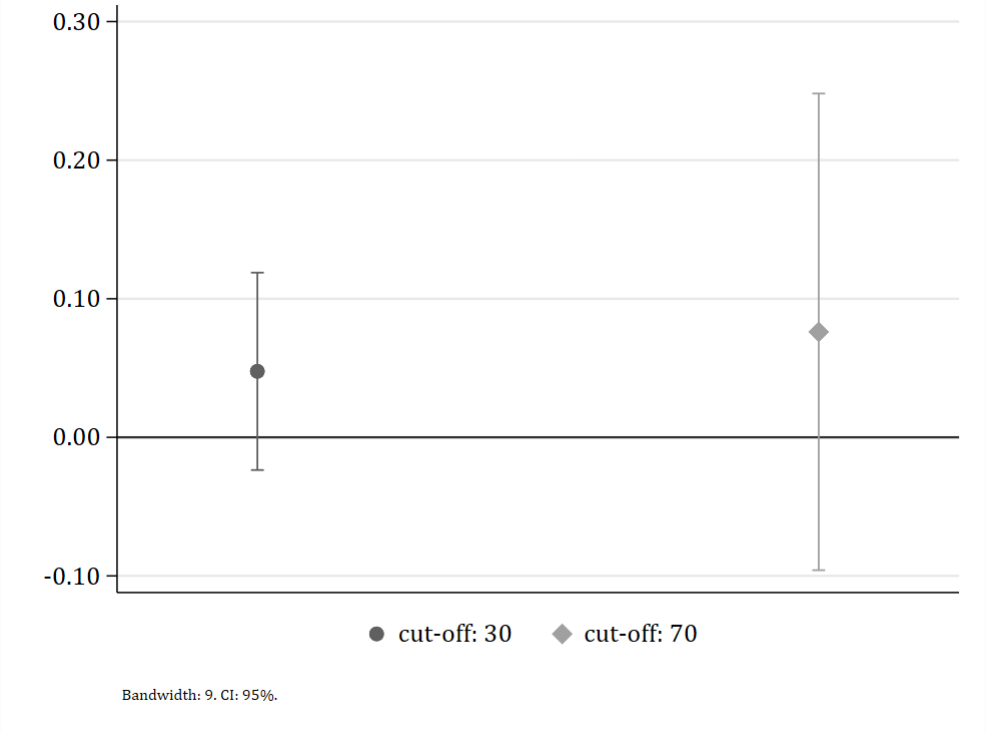


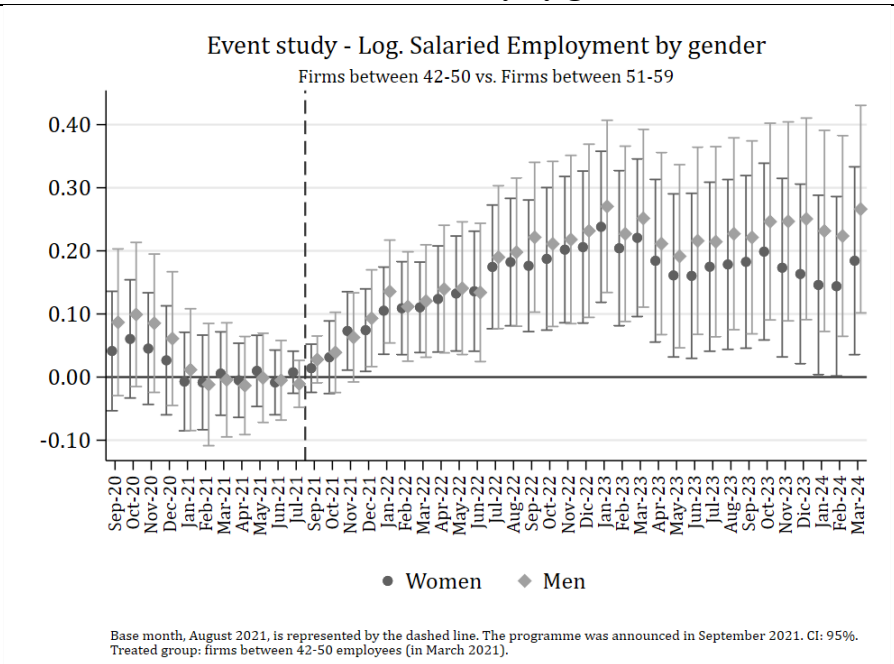
Figure A5. Placebo tests for treatment definition.



Notes: The Figure represents the estimated coefficients and the 95% confidence intervals. Standard errors are clustered at the firm level.

Figure A6. Heterogenous Event Studies with discontinuity

Panel A. Event Study by gender.



Panel B. Event Study by economics sector (tourism and others)

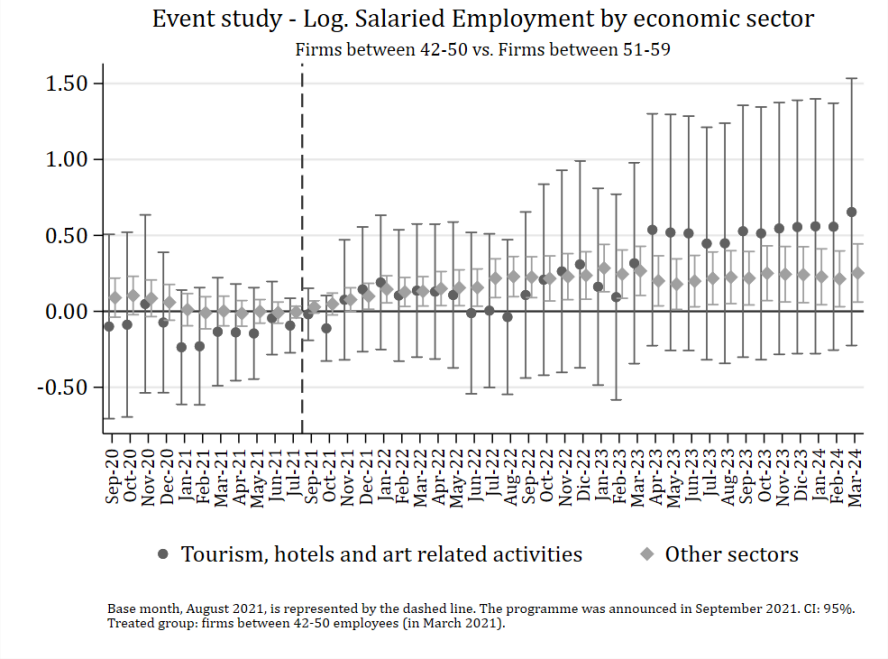
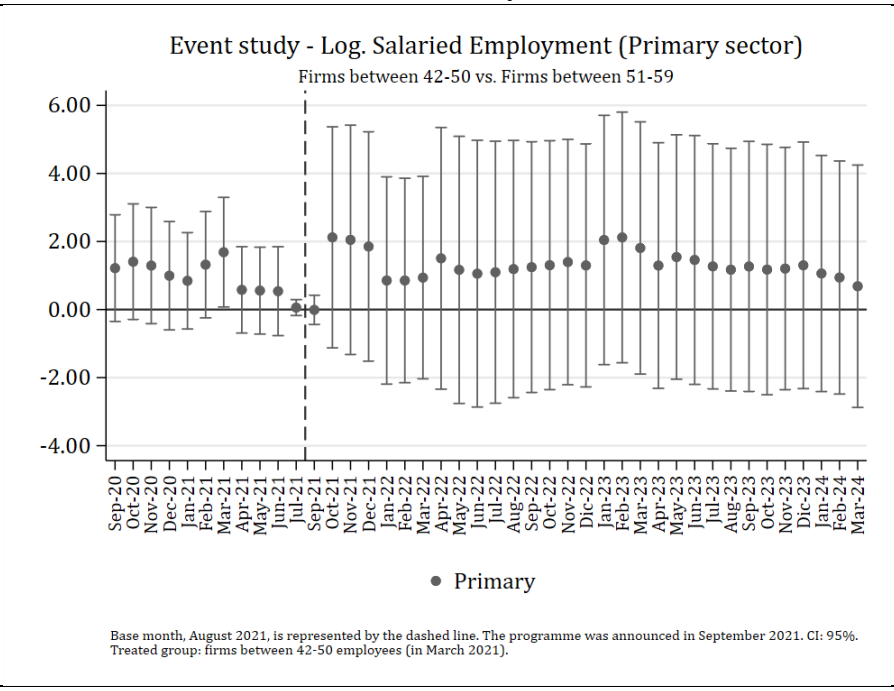
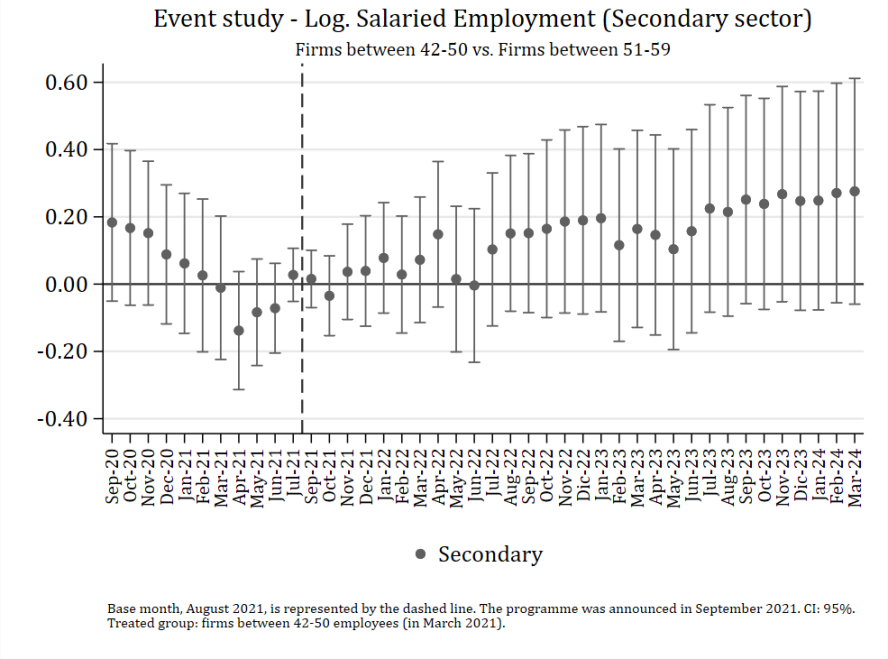


Figure A7. Heterogenous Event Studies with discontinuity by three economic sectors

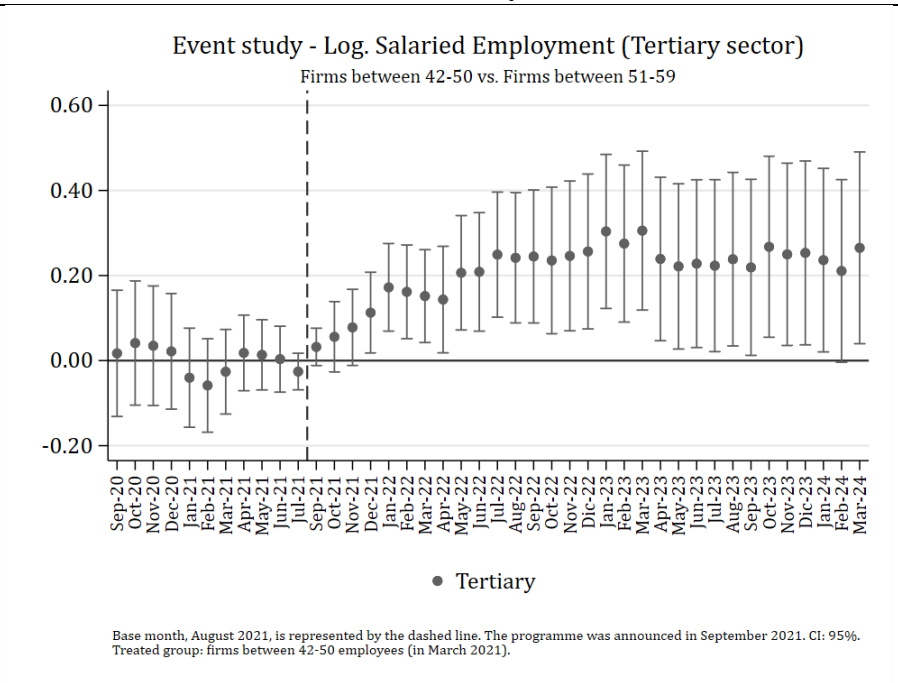
Panel A. Primary sector



Panel B. Secondary sector.



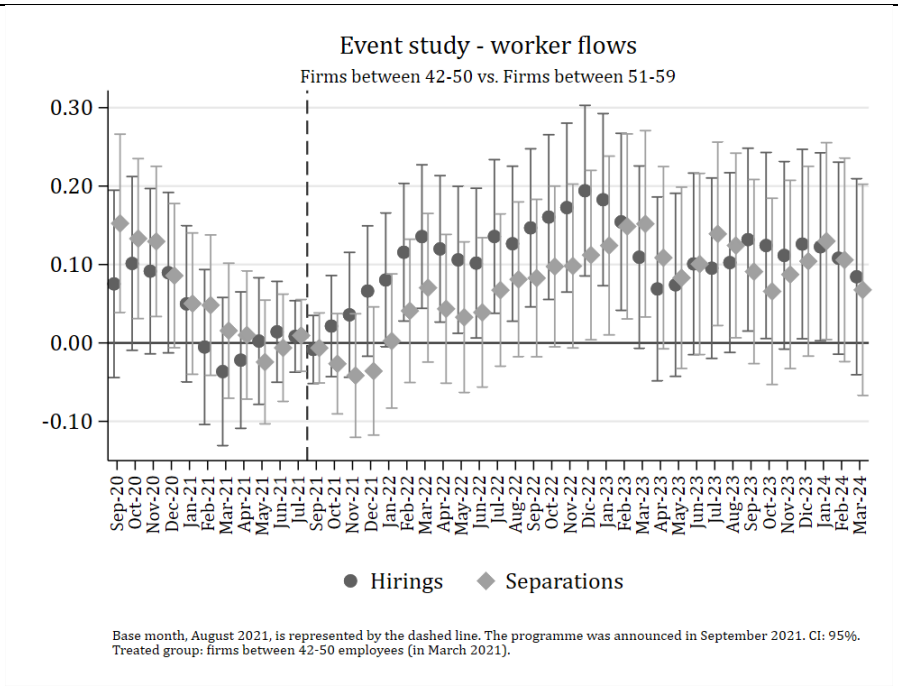
Panel C. Tertiary sector



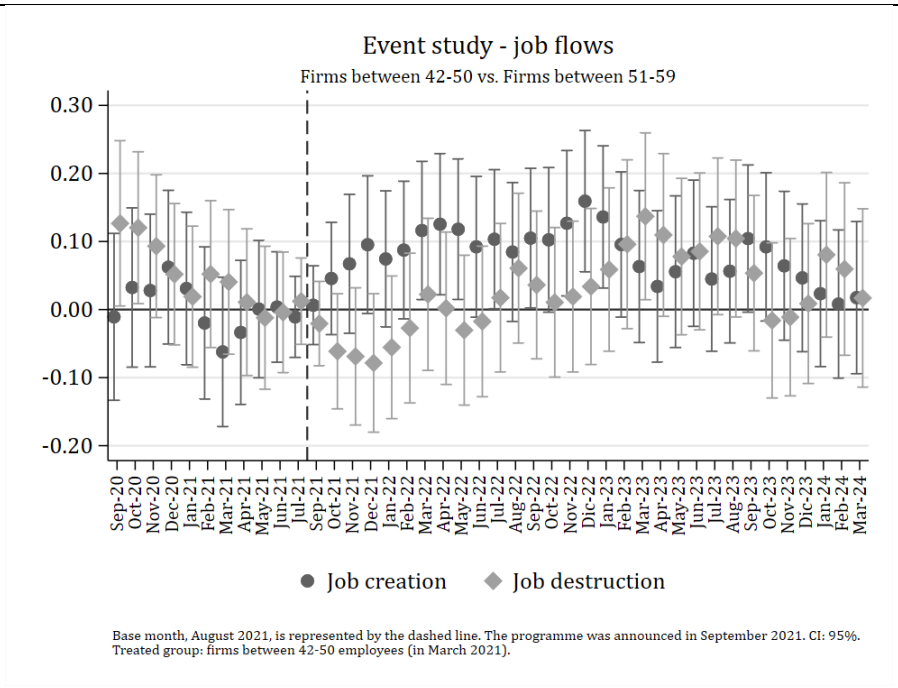
Base month, August 2021, is represented by the dashed line. The programme was announced in September 2021. CI: 95%.
Treated group: firms between 42-50 employees (in March 2021).

Figure A8. Event Studies with discontinuity for worker flows, job flows, and firm closures

Panel A. Worker flows



Panel B. Job flows



Panel C. Firm closures

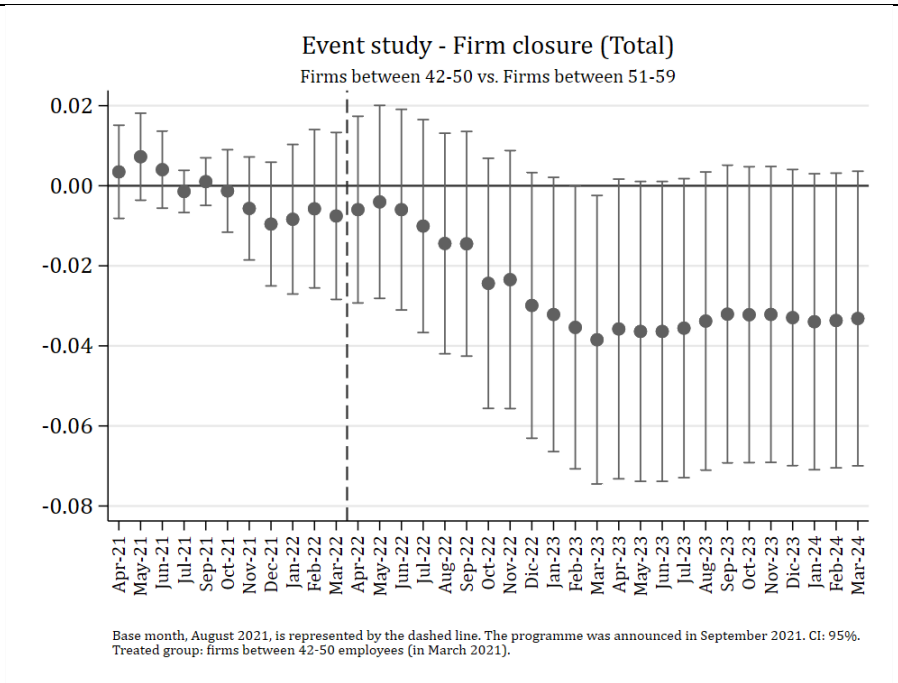


Figure A9. Rambachan and Roth (2023) test

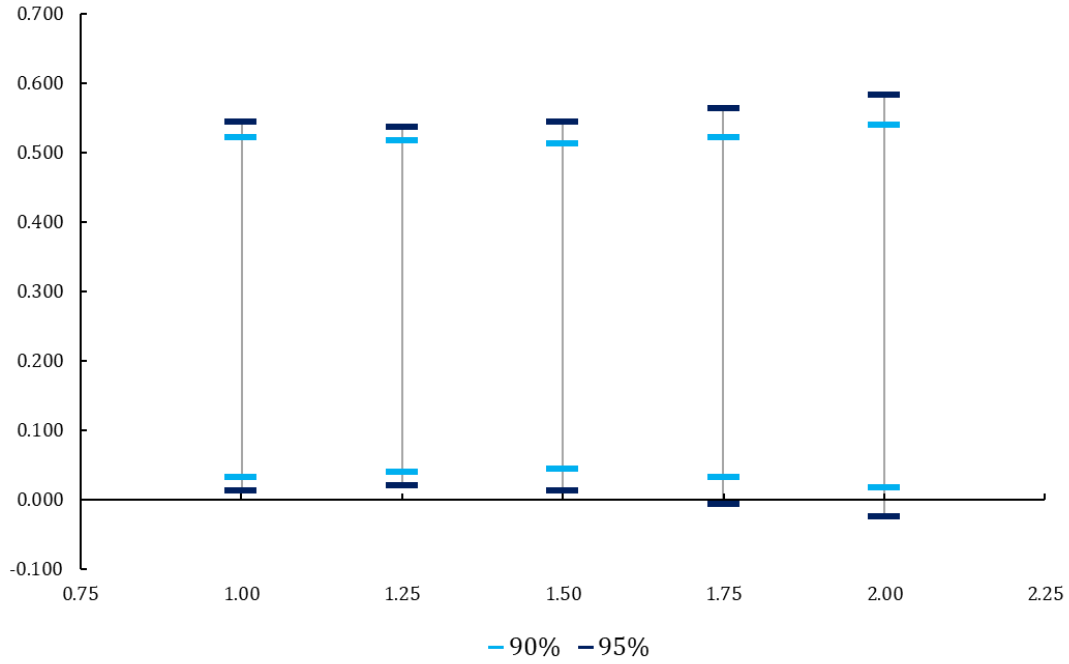


Table A1: Results Cost Benefits Analysis

NPV OF FLOWS (21 YEARS)				
	DEPRECIATION SCENARIOS			
	15%	25%	40%	50%
Benefit	558.0	400.2	280.3	233.6
Cost	178.7	178.7	178.7	178.7
Profits	379	222	102	186
Ratio B/C	3.1	2.2	1.6	1.3
IRR	169%	138%	90%	58%

Notes: In this table, we present the ratio benefits cost (Ratio B/C) and the Internal Return Rates (IRR) of an analysis of present value cost and benefits discounted at an annual rate of 10% over 21 years. The benefits are depreciated at a rate of 15%, 25%, 40% and 50%. Cost declared by authorities were USD 179 million. The employment effect of the policy in the treated firms implies an increase of 66.556 new employments; based on these new employments, the earning benefits are equivalent to USD 98 million, which increase to USD 136 million if fiscal savings from contributions of these new formal employees are considered.

Table A2: Flow of Present Value Benefits and Costs

FLOW OF 21 YEARS: PrivateBenefits Plus Fiscal Savings																					
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
A. Benefits dep=15%	140.1	119.1	101.2	86.1	73.1	62.2	52.9	44.9	38.2	32.5	27.6	23.4	19.9	16.9	14.4	12.2	10.4	8.8	7.5	6.4	5.4
NPV Benefits dep=15%	127.4	98.4	76.1	58.8	45.4	35.1	27.1	21.0	16.2	12.5	9.7	7.5	5.8	4.5	3.4	2.7	2.1	1.6	1.2	0.9	0.7
NPV Cost	178.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NPV Profits	-51.3	98.4	76.1	58.8	45.4	35.1	27.1	21.0	16.2	12.5	9.7	7.5	5.8	4.5	3.4	2.7	2.1	1.6	1.2	0.9	0.7
B. Benefits dep=25%	140.1	105.1	78.8	59.1	44.3	33.3	24.9	18.7	14.0	10.5	7.9	5.9	4.4	3.3	2.5	1.9	1.4	1.1	0.8	0.6	0.4
NPV Benefits dep=25%	127.4	86.9	59.2	40.4	27.5	18.8	12.8	8.7	5.9	4.1	2.8	1.9	1.3	0.9	0.6	0.4	0.3	0.2	0.1	0.1	0.1
NPV Cost	178.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NPV Profits	-51.3	86.9	59.2	40.4	27.5	18.8	12.8	8.7	5.9	4.1	2.8	1.9	1.3	0.9	0.6	0.4	0.3	0.2	0.1	0.1	0.1
C. Benefits dep=40%	140.1	84.1	50.4	30.3	18.2	10.9	6.5	3.9	2.4	1.4	0.8	0.5	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0
NPV Benefits dep=40%	127.4	69.5	37.9	20.7	11.3	6.2	3.4	1.8	1.0	0.5	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NPV Cost	178.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NPV Profits	-51.3	69.5	37.9	20.7	11.3	6.2	3.4	1.8	1.0	0.5	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. Benefits dep=50%	140.1	70.1	35.0	17.5	8.8	4.4	2.2	1.1	0.5	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NPV Benefits dep=50%	127.4	57.9	26.3	12.0	5.4	2.5	1.1	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NPV Cost	178.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NPV Profits	-51.3	57.9	26.3	12.0	5.4	2.5	1.1	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes: In this table, we present the flow of present value benefits and costs discounted at an annual rate of 10% over 21 years. The benefits are depreciated at a rate of 15%, 25%, 40% and 50%. Cost declared by authorities were USD 179 million. The employment effect of the policy in the treated firms implies an increase of 66.556 new employments; based on these new employments, the earning benefits are equivalent to USD 98 million, which increase to USD 136 million if fiscal savings from contributions of these new formal employees are considered.