

Payroll Taxes, Social Security and Informality. The 2012 Tax Reform in Colombia

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Abstract

I evaluate how the drastic reduction in payroll taxes in 2012 reduced informality in Colombia. By the end of 2012 the Colombian government implemented a tax reform that, among other things, substantially reduced payroll taxes. I evaluate the effect of this reform on informality both theoretically and empirically. Theoretically, I develop a labor market model incorporating the changes introduced by the reform. As the reduction in payroll taxes was accompanied by a change in social transfers' funding, which led to uncertain changes in profits and social benefits, straightforward predictions on informality are not possible. Empirically, I obtain difference-in-difference (DID) estimates from two household surveys—one composed by many repeated cross sections across many years and the other a much shorter panel dataset. Estimates from the repeated cross sections data indicate small, short-term effects and large long-term effects. Industry was the first sector to enjoy a reduction in informality, followed by services and agriculture. For workers earning around one minimum wage, I find large point estimates. Estimates from the household survey panel data are in line with these results.

JEL classification: D21, H24, H30, J32, J38, J46

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1 Introduction

Informality is the collection of firms, workers, and activities that operate outside the legal and regulatory framework (De Soto, 1989). Informal workers are unable to obtain formal employment, which offers higher wages and social security. But informality can be attractive if social security is undervalued and the government provides different subsidies to workers and their families who are below the poverty line. Firms can also be informal to avoid burdensome regulations and excessive taxes by choosing a smaller scale of production with restricted access to credit (Perry et al., 2007). Because of these two perspectives, informality has been a persistent problem in Latin-America. Around the year 2000, an average of 48% of wage workers held informal jobs, and 56% of all workers were employed in informal firms. By 2015, the corresponding figures were 40% and 51%—just an 8 and 5 percent point (pps) decrease in 15 years, respectively.¹

One of the main causes of informality is high taxes (Hirschman, 1970; De Soto, 1989; Lora and Fajardo-González, 2016). In Colombia, high payroll taxes, specifically, lead to informality (Clavijo et al., 2015; Merchán Álvarez, 2015; Fedesarrollo, 2014; Kugler and Kugler, 2009; Sánchez et al., 2009; Santa María et al., 2009). . In this context, would a reduction in payroll taxes lead to lesser informal employment? The Colombian tax reform of 2012 (from now on just reform) substantially reduced payroll taxes and provided an opportunity to answer this. I evaluate this reform’s impact on informal employees both theoretically and empirically.

I develop a labor market model that incorporates the main elements of the reform. The model provides a framework in which to incorporate informality—defined as lack of social security—and evaluate how it is affected by taxes. The reform reduced payroll taxes, thereby decreasing the employers’ relative cost of hiring formal workers. But the reform also partially replaced the funding of social transfers with taxes on profits, leading to uncertain changes in profits and social benefits. All these changes caused by the reform, taken in conjunction, lead to uncertain predictions of its effect on informal employment.

Empirically, I obtain difference-in-difference (DID) estimates from two household surveys with different data structures. The first one is composed by many repeated cross sections covering years 2008 to 2016. The second is a panel dataset that covers years 2010, 2013, and 2016 which, till now, has not been used to study the reform’s effects.

Estimates from the repeated cross sections data indicate small, short-term effects and large long-term effects. Before-after DID point estimates are -1.1 pps for the period January to April 2013, -2.1 pps for the period May-December 2013, and -5.4 pps for the period January 2014 and after. Monthly DID point

¹Own calculations based on the Socio-Economic Database for Latin America and the Caribbean (CEDLAS and The World Bank). Updated July 2017. In informal firm, if (s)he is a worker in a small firm, a non-professional self-employed, or a zero-income worker. In informal job, if (s)he is a salaried worker without the right to a pension when retired.

estimates rise from -5.6 in August 2013 to -9.4 pps in December 2016. When estimating the change in informality trend, total policy estimates are lower: from zero in May 2013 to -4.6 pps in December 2016. Industry sector enjoyed the re-duction in informality first and was later followed by services and agriculture. I find larger point estimates for workers earning around one minimum wage (MW) than for all workers. Estimates from the household survey panel data are in line with these results. This document is structured in seven parts, including this introduction. The following section includes a literature review divided into two parts—one on informality in labor market models and another on empirical studies on taxes and informality. The third section describes the social security system in Colombia. The fourth describes the reform. Sections five and six form the core of the study presenting the proposed labor market model and the econometric estimate results respectively. The last section concludes.

2 Literature review

Social protection and productivity are two concepts related to informality. Social protection refers to workers whose jobs do not comply with a part or all the legal requirements, tax obligations, labor contract and/or are deprived of certain labor rights like pensions or health insurance. Conversely, productivity focuses on workers in low-productivity, small-scale firms or family-based activities (Tornarolli et al., 2014)). Economic models and empirical studies have been designed with these definitions in mind.

2.1 Modeling informality

Informal labor markets have traditionally been modeled as dualistic models since Lewis (1954). In these models, workers and firms pay taxes, contribute to social security, and/or comply with the MW only in the formal market. They are characterized by higher wages in the formal market and just some workers getting access to it. The classic model by Harris and Todaro (1970) includes urban and rural sectors, where the urban sector specializes in manufactures and the rural in agriculture; wages in the urban sector are fixed at the MW while wages in the rural are free. Rauch (1991) explicitly modeled the formal-informal size dualism, where exogenous MWs are only enforced in large firms and obtains formal and informal sectors endogenously. Workers are all equal, and firms have different levels of managerial talent, which determines firm size as stated by Lucas (1978)—greater talent generating larger firm size.

More recent dualistic models have introduced taxes and other improvements. Fortin et al. (1997) incorporated both the corporate profit and payroll taxes in a model with heterogeneous firms resulting in an endogenous informal sector. If the marginal cost of tax and regulation evasion increases with firm size, their model can explain discontinuities in the firms' sizes. They obtained three forms of dualism consistent

with market segmentation: scale, wage, and evasion. Galiani and Weinschelbaum (2012) also introduced payroll taxes in a model with heterogeneous firms and, as innovation, workers with preferences over the formal/informal sector. They incorporated three stylized facts: (1) small firms tend to operate informally while large firms tend to operate formally; (2) un-skilled workers tend to be informal while skilled have formal jobs; and (3) workers other than the household head are less likely to operate formally than primary workers. Antón (2014) develop a dynamic, general equilibrium model with occupational choice and informality including value added, payroll and corporate income taxes.

In an innovative approach, Amaral and Quintin (2006) introduced informality in a competitive market. They retained heterogeneous workers and entrepreneurs. Firms face a choice between taxes and credit: formal (informal) firms (do not) pay taxes but (do not) have access to credit. In equilibrium, there is a demand for formal and informal workers, but labor supply is the same, i.e., there is only one labor market. Contrary to other models, similar workers earn the same amount in the formal and informal sectors.

Models' predictions on how taxes affect informality are generally uncertain, so simulations are used. With informality defined as a low productivity sector and taxes not translated in higher benefits for workers or firms, the models proposed by Fortin et al. (1997) and Galiani and Weinschelbaum (2012) implied that lower payroll taxes lead to lower informality. But, if a lack of social protection defines informality, informal workers receive public subsidies, and payroll taxes fund formal social benefits results are ambiguous (Antón, 2014). Lower payroll taxes make formal employees cheaper to employers, thus, decreasing informality. But if only informal employees qualify for subsidies, incentives to take formal jobs are weakened. Also, if the lower payroll taxes undermine the funding for formal social benefits or if these benefits are undervalued, formal jobs are even less attractive. For this reason, simulations are used to predict the effect tax changes has on informality. Steiner (2014) and Antón (2014) used this approach to study the Colombian reform. Steiner (2014) found that the reform should increase formal employment by 1.4% and Antón (2014) suggested that the reform would decrease informal rates by 1.4 to 1.5 pps.

2.2 Empirical background

Lora and Fajardo-González (2016) studied the effects of taxes on labor markets in Latin-America. Carried out for 15 Latin American countries, they found that payroll taxes reduce employment when workers do not value their benefits; otherwise, they increase labor participation. Vuletin (2008) used the data from 32 Latin American and Caribbean countries in the early 2000s and found high taxes to be a key factor determining the size of the informal economy. Loayza (1996) used the data from Latin American countries in the early 1990s and found that the size of the informal sector depends positively on proxies for tax burden and labor-market

restrictions.

Many studies provide support to the positive relationship between payroll taxes and informality in Colombia. Merchán Álvarez (2015) used the increase in payroll taxes between 1992 and 2006 and found a significant positive effect of payroll taxes on informality. Clavijo et al. (2015) estimated the payroll taxes that firms in Colombia faced from 1980 to 2015 and concluded that increments of 1% on payroll taxes reduced formalization by 0.4%. Mondragón-Vélez et al. (2010) showed that a 10% increase in payroll taxes increases informality by 8%. Santa María et al. (2009) analyzed the effect of the 1993 social security reform, which increased payroll taxes by 14 pps, and found a significant effect on the increase of informal employment. Sánchez et al. (2009) found that the increase in payroll taxes since the 1990s augmented informality by 5.3 pps.

Recent empirical studies have explored the effect of the reform on informality. Kugler et al. (2017) estimated a positive effect on formality of 1 to 11.1 pps depending on the data source used and treated group considered. Bernal et al. (2017) found a significant short-term increase on firms' formal employment of about 4.3%. Fernández and Villar (2016) estimated a short-term reduction in informality of 4.1 to 6.7 pps on the treated workers depending on the specification and methodology used.

3 Labor market regulations

The main Colombian labor market regulations are the MW and the social security system. All workers earning at least an MW must make contributions to social security while those earning below an MW are exempt from this obligation and are provided with subsidized social benefits.

3.1 Minimum Wage

The MW is the same for all workers in Colombia since 1983 and it is updated every year. A permanent commission is responsible for proposing the MW of the following year no later than December 15. If the commission does not reach a consensus the president decrees the new MW. The MW has also been used as an index base for many economic variables (taxes, fines, fees for services and pensions). More critically, payroll taxes regulations indicate the amount of payroll taxes to be paid by employers according to the number of MWs an employee earns.

The Ministry of Social Protection oversees the enforcement of the MW. However, there are no statistics available on the number of complaints and sanctions (or the amount of these) corresponding to non-compliance with the MW regulation (Arango et al., 2007).

The proper use of MW in empirical estimations required some additional calculations. The main frequency

of the legal MW is monthly and assumes a maximum of 48 weekly hours worked. Any worker working less than 48 weekly hours can legally earn less than the monthly MW. To incorporate this, I obtain an hourly MW by dividing the monthly MW² by 4 (weeks) and then by 48 (hours). I calculate the hourly gross wage as monthly gross wage / 4 / regular weekly hours worked in the main occupation. Finally, I define the number of hourly MWs by dividing the hourly gross wage in the hourly MW.

3.2 Social security

The social security system is composed of four parts: pensions, health, labor risks, and social services. All workers earning at least one hourly MW must contribute to social security. Employers must make health contributions for his/her employees. If the employer does not make the proper contributions, he/she faces high default interests and payment for immediate health care costs required by his/her employees.

Self-employed workers must make their own contributions, based on their actual income, to health, pensions, and occupational hazards—the latter when it applies. The same default interests to employers apply to self-employed workers who are not up-to-date with their obligations.

3.2.1 Pension system³

For workers earning at least one hourly MWs, the pension system is based mainly on a mandatory contributory pillar under two schemes: one public pay-as-you-go and one private with capitalization. In any scheme, funds must guarantee a minimum pension equal to the current monthly MW. Multiple parallel alternative schemes have been designed for workers earning less than an hourly MW and/or in poverty.

The pension system has problems that undermine its value to workers in Colombia. By 2013, only 37% of the elderly received a pension, which is low compared to the OECD average (around 90%), and 80–90% in Argentina, Brazil, Chile, and Uruguay. Coverage is also low among women, workers with low and medium incomes, workers in small businesses, or self-employed workers (Bosch et al., 2015). In rural areas, only 10% are covered, which is a product of avoided contributions or insufficient earnings to contribute. People contribute, on average, only 15 years (instead of the 25 required), as rural workers often spend their entire life not making contributions and urban workers face periods without contributions.

The requirement that pensions cannot be lower than a monthly MW is costly. Minimum pension represents around 60% of the average wage while it represents less than 20% on average in OECD countries. Many people reach retirement age without having contributed enough to qualify for benefits at all, as only around half of the working population earns more than the monthly MW (2012 figures).

²Monthly MWs obtained from the Central Bank of Colombia.

³Based on Bosch et al. (2015)

The public pay-as-you-go scheme mainly benefits high-income formal workers. More than 80% of pensions go to the highest income quintile while the two poorest quintiles receive less than 2% (Santa María et al., 2010), they are often the best educated and high-income individuals (OECD, 2013), contributions are deductible from the income tax base, the returns on pension investment are not taxable, and the benefits are largely tax exempt.

3.2.2 Health care

There are two forms of affiliation to the health care system: contributory and subsidized. All workers earning at least a monthly MW must be in the contributory scheme and contribute to the health system by paying their corresponding amount to their health promotion entity.⁴ All employees, self-employed and retired workers, must be affiliated to the contributory scheme. The responsibility of the employee's affiliation is of the employer. The contribution is 12.5% of the salary—a percentage fully assumed by independent workers; employees assume 4% and the employer 8.5% (zero for employees earning less than 10 monthly MWs after the reform).

With the subsidized scheme, the government subsidizes the population without employment, work contract, or income. Members of this scheme receive full or partial subsidies, which are financed with funds from the contributory scheme and additional public funds. Municipalities or districts manage membership using targeting mechanisms.⁵ Users of this scheme have the right to receive the same benefits as in the contributory scheme.

Workers undervalue the health care system because of its inherent issues. Despite the high coverage, 94.6% by 2015, the system suffers from quality issues with 18.3% of affiliates considering their health coverage to be bad or extremely bad by 2015.⁶ Also, certain health care services tend to be denied by insurers or providers, resulting in long wait times to obtain medical appointments and/or medical care (exams and treatment) or unexpected direct costs for affiliates when in need of health care. This has led to large legal conflicts between insurers and their affiliates, insurers and providers being under corruption charges (Vélez, 2016), and insurers going bankrupt.⁷

⁴Health promotion entities organize and ensure the provision of health services.

⁵They use Identification the Classification System of Potential Beneficiaries (*Sistema de Identificación de Potenciales Beneficiarios de Programas Sociales*, SISBEN), census listings of indigenous communities, identification of abandoned child and indigent population.

⁶Source DANE, *Encuesta de Calidad de Vida* 2015.

⁷<http://www.elpais.com.co/elpais/economia/noticias/asi-fue-como-quebraron-saludcoop>

4 Payroll taxes and the 2012 tax reform

Payroll taxes have increased systematically in recent decades in Colombia. Since the 1980s, payroll taxes were about 42–46% for 1–2 monthly MWs and 38% for those with more than 2 monthly MWs. At the end of the 1980s, payroll taxes increased even more due to higher pension contributions⁸ and parafiscals.⁹ In 1994, payroll taxes increased 8–9 pps as a product of larger contributions to health and pensions and the creation of the general system of professional risks. In 2003 and 2007, new increases were imposed on the employer’s contributions to health and pensions. In May of 2013, payroll taxes reached peak levels of 59–66% for 1–2 monthly MWs and 52% for wages above 2 monthly MWs. The 2012 tax reform drastically reduced these payroll taxes for the first time (Clavijo et al., 2015).

The 1607/2012 Act, passed on December 2012, aimed to promote formal employment. It lowered the hiring costs for firms, thus, reducing the employer’s contributions by 13.5 pps for workers earning less than 10 monthly MWs: 5 pps destined to public institutes¹⁰ and 8.5 pps to the health care system. Public institutes’ contributions took effect on May 1st, 2013 and health on January 1st, 2014. With this, the total tax on labor in Colombia was reduced from 59% to 45.5%—a 23% reduction (Fedesarrollo, 2014).

Taxes on firms’ profits were modified to make up for the lost fiscal revenue. The statutory rate was reduced from 33% to 25% and a new surtax introduced.¹¹ Revenues from this profit surtax were directed to the concerned public institutes and health care system. These funds were not part of the general public budget, and the government provided additional funding if revenues fell short of budget needs. The statutory rate of the profit surtax was established at 9% for the period 2013–2015 (OECD, 2015), which was later increased for years 2015–2018 for large firms. The tax reform of 2016 finally eliminated the profit surtax starting in 2017.

4.1 Other regulatory changes

In the period of analysis, 2008–2016, other regulatory changes might have had an impact on informality along the reform: law 1429 of 2010 (First Job Act), decree 2616 of 2013, and an increased enforcement were included in the reform.

The First Job Act, introduced in 2010, reduced taxes for certain firms. Beneficiary firms had to have less than 50 workers, or assets of less than 5,000 MWs, and opening between December 2010 and December

⁸Formal workers get a mandatory discount, determined by law, from their gross wage towards their pension fund. These are administered by a single public entity, Colpensiones, or private administrators, *Administradoras de Fondos de Pensiones* (Pension Fund Managers, AFPs). Workers choose to which of these entities to send their discounted amount.

⁹Parafiscals are all contributions (not taxes) to fund a public social service.

¹⁰The *Servicio Nacional de Aprendizaje* (National Service of Learning, SENA), a public institution focused in the development of professional education programs, and the *Instituto Colombiano de Bienestar Familiar* (Colombian Institute of Family Welfare, ICBF), a public institution in charge of the development and protection of children and families.

¹¹The *Impuesto sobre la renta para la equidad* (Corporate Income Contributions to Equity, CREE)

2014. Under this law, firms enjoyed no income tax or payroll taxes for the first two years of operation. Benefits were conditional on new hires of certain types of workers: (i) less than 28 years of age, (ii) heads of households in poverty, (iii) victims of the armed conflict, (iv) disabled, (v) women older than 40 years of age, and (vi) workers earning less than 1.5 monthly MWs. Given the limited scope of beneficiary firms, it is likely that this policy had a small effect on the overall informality of the economy, but any significant estimate before the reform could be the product of this regulation.

The decree 2616 of 2013 allowed, since January 2014, weekly contributions to social security. Previously, the system only allowed monthly contributions. For example, for an employee working for a single week earning less than a monthly MW, the employer had to pay the contributions corresponding to a monthly MW. Weekly contributions apply to all workers with labor contracts working less than 30 days—independent of the hours worked.¹² If the worker works between 1 and 7 days in a month, the minimum contribution is one week (1/4 of a monthly MW). For 8–14 days, 2 weeks (1/2 monthly MW), for 15–21 days, 3 weeks (3/4 monthly MW), and for more than 21 days, an entire monthly MW. This additional flexibility might have allowed these workers to become formal. But it is not possible to control for this regulatory change as the data limitations do not allow to identify how many weeks an employee has worked in a month.

Finally, the reform also improved the enforcement capabilities of the public entity that supervises workers' contributions to social security. This increased enforcement might explain part of the reduction in informality. Unfortunately, there is no way to disentangle this from the effect of the lower payroll taxes.

5 Labor market model

The reform introduced not only a reduction in payroll taxes but also a change in the funding of social benefits using a new tax on profits. I develop a labor market model that incorporates these changes and investigate the final effect of these on informality. The following is a modified version of the model proposed by Antón (2014). The main characteristics of the model are: a) static, b) single good sold in a perfectly competitive market, c) individuals characterized by different managerial ability (Lucas, 1978), d) taxes on payroll and profits, e) imperfect enforcement of payroll tax, f) employees' formal/informal status defined by employers' compliance with payroll tax, g) informal employees, self-employed, and employers receive Non-Contributory Social Benefits (NCSB), h) formal employees receive Contributory Social Benefits (CSB), i) Social Benefits are not fully valued (Levy, 2008), and j) Government collects taxes and makes social benefits transfers keeping a balanced budget.

The model has one period with a single representative household composed by a continuum of individuals

¹²These workers still qualify for the health subsidized scheme.

of mass one. Each individual is endowed with a managerial ability z that has a probability density function $g(z)$ with support $[\underline{z}, \bar{z}]$; $G(\cdot)$ denotes the cumulative distribution function. Individuals can choose to be employees, self-employed, or employers according to their managerial ability.

5.1 Profits

Employers produce a single product y using labor l and managerial ability z . The product is sold in a perfectly competitive market at price p , which is used as numeraire. Technology is characterized by a Cobb-Douglas production function $y = z^{1-\gamma} (l_I + l_F)^\gamma$. Employers are required to pay τ_l for each unit of labor hired but imperfect enforcement of payroll tax allows hiring formal employees, paying τ_l and a wage w_F , or informal employees, paying only wage w_I . Employers face a probability of audit θ_l and, if audited, they pay a fine $\sigma_l \tau_l w_I l_I$ where $\sigma_l \in [0, 1]$ measures the severeness of the fine and l_I is the level of informal employment used by the firm. Government also raises a fraction τ_π of firms' profits.¹³ Employer's problem is

$$\pi(w_I, w_F, z, \tau_l, \tau_\pi) = \max_{l_I, l_F} (1 - \tau_\pi) \{ z^{1-\gamma} (l_I + l_F)^\gamma - (1 + \tau_l) w_F l_F - (1 + \theta_l \sigma_l \tau_l) w_I l_I \} \quad (1)$$

There will be labor tax evasion as long as $(1 + \theta_l \sigma_l \tau_l) w_I \leq (1 + \tau_l) w_F$. To obtain a non-degenerated distribution of informal labor across firms in equilibrium, it is assumed that θ_l is not constant but an increasing function of l_I and z , this is, $\theta_l(l_I, z)$ with $\frac{\partial \theta_l}{\partial l_I} > 0$ and $\frac{\partial \theta_l}{\partial z} > 0$. From $\pi(w_I, w_F, z, \tau_l, \tau_\pi)$ we obtain factor demands $l_I(w_I, w_F, z, \tau_l)$ and $l_F(w_I, w_F, z, \tau_l)$. Notice how τ_π play no direct role in firms' labor demands. For any level of τ_π the level of labor employment chosen by firms does not change. Also, observe how formal and informal workers have equal productivity making firms hire informal workers as long as they are cheaper than formal ones.

Self-employed, on the other hand, are informal employees and part-time entrepreneurs whose profits are given by

$$\pi^{SE}(w_I, z) = \max_{l_o} \{ z^{1-\gamma} l_o^\gamma + w_I (\kappa - l_o) \} \quad (2)$$

Where $(1 - \kappa)$ is the fraction of labor self-employed lose as consequence of commitment to managerial activities (Gollin, 2008). With $0 \leq l_o \leq \kappa \leq 1$, $(\kappa - l_o)$ is the fraction of time offered to the market. Self-employed have labor demands $l_o(w_I, z)$.

¹³I assume perfect enforcement of this tax.

5.2 Households

The representative household has a concave utility function $u(C)$ where C is the total consumption of goods. Household income come from labor, if employee, profits from self-employment and profits from firms, if employer. The non-decreasing nature of the distribution $g(z)$ guarantees two critical levels of managerial ability z_1 and z_2 such that for $z < z_1$ the individual chooses to be an employee, for $z_1 \leq z < z_2$ the individual chooses to be self-employed and for $z \geq z_2$ the individual chooses to be an employer. This means that a mass $[\underline{z}, z_1)$ will be employees, a mass $[z_1, z_2)$ will be self-employed and a mass $[z_2, \bar{z}]$ will be employers. The household also must choose the fraction η of formal employees. Informal employees, self-employed and employers receive a NCSB transfer T_I and formal employees receive a CSB transfer T_F . The household problem is given by

$$\max_C u(C) = \max_{\eta, z_1, z_2} u \left(\int_{\underline{z}}^{z_1} WN g(z) dz + \int_{z_1}^{z_2} [\pi^{SE}(\cdot, z) + T_I] g(z) dz + \int_{z_2}^{\bar{z}} [\pi(\cdot, z) + T_I] g(z) dz \right)$$

where $WN = \eta(w_F + T_F) + (1 - \eta)(w_I + T_I)$. Household's first order condition for η is given by

$$w_F + T_F = w_I + T_I \quad (3)$$

Eq. (3) can be interpreted as indifference between formal and informal employment. At z_1 individual has to be indifferent between being employee or self-employed then

$$\eta(w_F + T_F) + (1 - \eta)(w_I + T_I) = \pi^{SE}(\cdot, z_1) + T_I$$

And given (3) we have the final condition for z_1

$$w_I = \pi^{SE}(\cdot, z_1) \quad (4)$$

which, as π^{SE} is strictly increasing in z , it uniquely determines z_1 .

Individuals at z_2 will also be indifferent between self-employment and being employer then

$$\pi^{SE}(\cdot, z_2) = \pi(\cdot, z_2) \quad (5)$$

In addition, Government must keep a balanced budget, this is, total revenues must equal total expenses.

Before the reform total revenues from payroll tax equal CSB expenses

$$\tau_l w_F \eta \int_{\underline{z}}^{z_1} g(z) dz = \tau_{CSB} \eta \int_{\underline{z}}^{z_1} g(z) dz \quad (6)$$

After the reform revenues from the new tax on profits, τ_π^{TR} , are added to the left-hand side of the equation

$$\tau_l w_F \eta \int_{\underline{z}}^{z_1} g(z) dz + \tau_\pi^{TR} \int_{z_2}^{\bar{z}} \pi(\cdot, z) g(z) dz = \tau_{CSB} \eta \int_{\underline{z}}^{z_1} g(z) dz \quad (7)$$

Before and after the reform total revenues from profit tax equal NCSB expenses

$$\tau_\pi \int_{z_2}^{\bar{z}} \pi(\cdot, z) g(z) dz = \tau_{NCSB} \left[(1 - \eta) \int_{\underline{z}}^{z_1} g(z) dz + \kappa \int_{z_1}^{z_2} g(z) dz + \int_{z_2}^{\bar{z}} g(z) dz \right] \quad (8)$$

where $\tau_\pi = \tau_\pi^0$ before the reform and $\tau_\pi = \tau_\pi^0 + \tau_\pi^{TR}$ after the reform where τ_π^{TR} is the part of the tax on profit used to fund CSB. On the other hand, every formal employee receives w_F and CSB transfers T_F . From (6) we have before the reform $\tau_{CSB} = \tau_l w_F$ while after $\tau_{CSB} = \tau_l w_F + \tau_\pi^{TR} \frac{\int_{z_2}^{\bar{z}} \pi(\cdot, z) g(z) dz}{\eta \int_{\underline{z}}^{z_1} g(z) dz}$. Following Levy (2008), formal workers value these benefits by a fraction $\beta_F \in [0, 1]$ then $T_F = \beta_F \tau_l w_F$ before the reform and $T_F = \beta_F \left(\tau_l w_F + \tau_\pi^{TR} \frac{\int_{z_2}^{\bar{z}} \pi(\cdot, z) g(z) dz}{\eta \int_{\underline{z}}^{z_1} g(z) dz} \right)$ after the reform. Likewise, informal employees receive w_F and NCSB transfers¹⁴ by τ_{NCSB} but value these benefits by $\beta_I \in [0, 1]$. These assumptions mean that the first order condition for η before the reform can be written as

$$w_F + \beta_F \tau_l w_F = w_I + \beta_I \tau_{NCSB} \quad (9)$$

and after the reform as

$$w_F + \beta_F \left(\tau_l w_F + \tau_\pi^{TR} \frac{\int_{z_2}^{\bar{z}} \pi(\cdot, z) g(z) dz}{\eta \int_{\underline{z}}^{z_1} g(z) dz} \right) = w_I + \beta_I \tau_{NCSB} \quad (10)$$

Eq. (9) mean that for any given β_F, β_I, τ_l and τ_{NCSB} then w_I is determined by w_F before the reform and also τ_π after (Eq. (10)).

Eqs. (9) and (10) represent the fact that the reform changed the funding of CSB transfers using the new tax on profits. This means that even if τ_π does not affect firms' labor demand directly, the new amount of CSB transfers could be different from before the reform and household choose a different level of η . This is a departure from Antón (2014) who only considers the change in level of payroll taxes and not the change in funding of CSB.

¹⁴For simplicity I assume these benefits do not change after the Tax reform.

5.3 Equilibrium

All individuals such that $z \in [z, z_1)$ are employees and $z \in [z_1, z_2)$ are self-employed then supply of labor in the economy is

$$N \equiv G(z_1) + \kappa \int_{z_1}^{z_2} g(z) dz \quad (11)$$

On the other hand, individuals with $z \in [z_1, z_2)$ are self-employed with equilibrium labor demands given by $l_o(w_F^*, z)$ and those with $z \in [z_2, \bar{z}]$ are employers with equilibrium labor demands $l(w_F^*, z, \tau_l) = l_I(w_F^*, z, \tau_l) + l_F(w_F^*, z, \tau_l)$. The equilibrium in the labor market is given by

$$N = \kappa \int_{z_1}^{z_2} l_o(w_F^*, z) g(z) dz + \int_{z_2}^{\bar{z}} l(w_F^*, z, \tau_l) g(z) dz \quad (12)$$

Finally, the resource constraint yields the equilibrium in the goods market

$$C = Y(\tau_l, \tau_\pi, w_F^*) = \int_{z_1}^{z_2} y_o(\cdot, z) g(z) dz + \int_{z_2}^{\bar{z}} y(\cdot, z) g(z) dz \quad (13)$$

In equilibrium we obtain (w_F^*) given $(\tau_l, \tau_\pi, T_F, T_I)$. Equilibrium informal wage w_I^* is obtained from eq. (9) before the Tax reform and Eq. (10) after the Tax reform.

5.4 Reform and informality

The multiplicity of changes introduced by the reform makes straightforward comparative statics not possible. First and foremost, the reform changed the funding of CSB, which is represented by (9) and (10). Before the reform, CSB depended only on payroll taxes; after the reform, resources also come from the new tax on profits. This changes the government budgetary constraints and makes uncertain if the new level of contributory social benefits will be higher or lower than before the reform.

Second, lower payroll taxes not only increase labor demand from the employers and pushes z_1 up (Eq. (12)) but also increased the firms' profits, thus, attracting more self-employed to become employers, i.e., a decrease in z_2 . Therefore, the final directions of z_1 and z_2 are uncertain.

Third, the increased labor demand and lower labor supply will lead to an increase in w_F , alongside w_I as indicated by Eq. (9).

Finally, comparing (9) and (10), CSB transfers can go up or down after the reform leading to an uncertain new level of η chosen by households. These effects in conjunction lead to an uncertain final effect on the informality rate in the economy.

6 Econometric estimates

Econometric estimations are based on two types of household microdata. The first is composed by repeated cross sections coming from the *Gran Encuesta Integrada de Hogares* (Major Integrated Household Survey, GEIH) while the second is the panel data *Encuesta Longitudinal Colombiana* (Longitudinal Colombian Survey, ELCA).

The GEIH is carried out by the National Statistics Department of Colombia and has been in place since 2006, including a section on informality since 2007. The survey currently specializes in the measurement of the labor market structure and households' incomes. It has an annual size of approximately 240,000 households (800,000 observations) making it the major one at the national level. It covers 24 capital cities and their metropolitan areas (DANE, 2013). For my analysis, I use all microdata from 2008 to 2016.¹⁵

The ELCA is carried out by the University of Los Andes. It was designed from 2007 to 2010 to follow about 10,000 households for 12 years, ending with about 21,000 individuals per year. It covers a multiplicity of topics ranging from childhood growth dynamics to social capital. The sample is probabilistic, stratified, multistage, and on conglomerates with municipalities selection based on demographic and socioeconomic variables. Questionnaires differ for urban and rural areas and, due to consistency problems across time, I use only data for households in urban areas.¹⁶ This urban sample is representative of the five geographic regions (Bogota, Central, Oriental, Atlántica, and Pacífica). For my analysis, I use all the microdata for 2010, 2013, and 2016.

Each data source provides different benefits and problems. GEIH is highly frequent (monthly) and spans over several years (before and after the reform) with high sample size and very similar questionnaires across the period. ELCA covers only three years with much smaller sample sizes. ELCA provides the critical benefit of observing the same individuals across time which, as explained below, might address bias concerns on econometric estimations based solely on GEIH.

As the reform reduced the payroll taxes attached to social services, I use a social security definition of informality. I classify informal as (i) an employee not making health or pension contributions to subsidized health schemes or earning under 1 hourly MW¹⁷ or (ii) self-employed not contributing to a pension fund

¹⁵The survey questionnaires for 2006 and 2007 suffered many changes rendering the data for these years not comparable with 2008 to 2015.

¹⁶For example, firm size is unavailable for rural areas.

¹⁷Two adjustments were needed when using MWs. First, when using the MW of each year from January to December a high peak of informality was present in January. This is the product of slow adjustment of labor contracts to the new monthly MW. To avoid this the monthly MW of each year is used from February to January of next year. For example, the monthly MW of 2013 is valid from February 2013 until January 2014, the monthly MW of 2014 is valid from February 2014 until January 2015 and so on.

Second, measurement error was detected on hourly wages close to the minimum in year 2016 resulting in a sudden peak in informality rates. To adjust for this a 99% of the MW was used as cutoff. This has almost no effect in informality rates for other years.

without health coverage or to subsidized health schemes. I consider formal as (i) an employee making pension contributions to contributory health schemes and earning above 1 hourly MW or (ii) self-employed making pension contributions to contributory health schemes.

The reform excluded specific groups from the reduction in payroll taxes: (i) all workers earning 10 monthly MW or more, (ii) all non-profit firms, (iii) any natural person employer of one employee, and (iv) government workers. Employers could not deduct the payroll taxes derived from employees earning more than 10 monthly MWs for the new profit surtax, implying a different tax burden for employers. For this reason, employees earning more than 10 monthly MWs are discarded from the analysis. Employers and government workers are also excluded. Employers act more as firms, and government workers belong to a non-optimizing employer.

The remaining workers that are part of the analysis are private employees, domestic, laborer or farmhand,¹⁸ and self-employed. I classify private, domestic and laborer or farmhand as treated and self-employed as control. Self-employed have a different tax legal framework than employees and are not subject to payroll taxes. But, as characterized by the model above, self-employed might still be indirectly affected by the reform due to the change in the funding of social benefits and the new labor demand from employers.

An additional concern regards workers' control-treated transitions. Workers might move from self-employment to salaried work after the reform, thereby contaminating the estimates of its impact on informality. ELCA data allows to control for this with fixed effects estimates on the treated dummy, which captures control-treated transitions within individuals. In addition, fixed effects estimate control for individuals' unobserved heterogeneity. This type of estimate has not been used before to study the reform.

6.1 Results based on repeated cross sections

6.1.1 Informality before and after the reform

Figure 1 presents monthly informality rates from 2008 to 2016. We can observe how 2013 is a transition year where just part of the reform was implemented. On figure 1a, we see how the informality rate for the treated group had a sudden decrease in January 2014, when all parts of the reform were in place. At the same time, we observe almost no change for the control group. But a seasonal component is clear on the informality rate for the treated group, with a permanent decrease at mid and peaks at the end of each year. To control for this, figure 1b presents seasonally adjusted averages making the change in informality after the reform clearer. Small decreases are present after the law and the first tax waiver were passed, but the

¹⁸As any natural person, employer with one employee was excluded from the reform, and survey data does not allow to observe if the employer is a natural person; only domestic and laborer in firms with more than one employee are included in the analysis.

largest drop is still present since January 2014. Again, we see almost no change for the control group.

Informality trends require some care. On figure 1b we see that trends of treated and control groups are not parallel, thus, violating a critical assumption for the DID approach. In addition, the decreasing trend for the treated group is more pronounced after the final tax waiver. This could be indicating that there was a change in both the level and trends of informality. I implement multiple econometric strategies to evaluate this series' behavior.

6.1.2 Regression models and estimates

I estimate different DID specifications to capture changes in informality levels and trends. The simplest one is

$$\begin{aligned} P(I_{it}) = & \alpha_0 + \alpha_1 \textit{treated} + \alpha_2 \textit{treated} * \textit{Jan13} + \\ & \alpha_3 \textit{treated} * \textit{May13} + \alpha_4 \textit{treated} * \textit{Jan14} + \boldsymbol{\alpha} \mathbf{X}_{it} + \varepsilon_{it} \end{aligned} \quad (14)$$

Where $P(I_{it})$ indicates the probability that a worker i has an informal job at time t , $\textit{treated}$ a dummy of treatment group, $\textit{Jan13}$ a dummy equal to one if January to April 2013, $\textit{May13}$ a dummy equal to one if May to December 2013, $\textit{Jan14}$ a dummy equal to one if January 2014 or later, \mathbf{X}_{it} includes all controls and ε_{it} is the random error term. In this specification α_2 measures the effect of the reform passing, α_3 the effect of the first tax waiver and α_4 the effect of the last tax waiver.

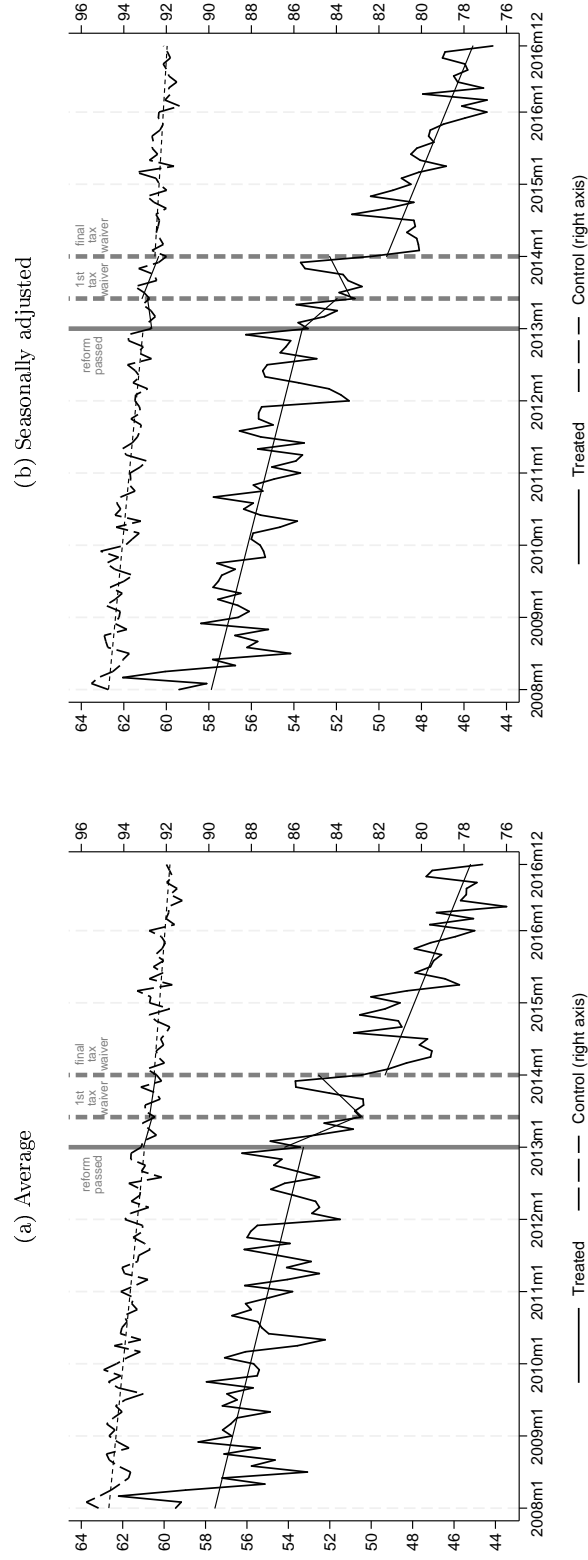
The second specification uses year-month interactions

$$\begin{aligned} P(I_{it}) = & \beta_0 + \beta_1 \textit{treated} + \beta_2 \textit{treated} * \mathbf{ym}_{08-12} + \\ & \beta_3 \textit{treated} * \mathbf{ym}_{13-16} + \beta_4 \mathbf{ym}_{08-16} + \boldsymbol{\beta} \mathbf{X}_{it} + \varepsilon_{it} \end{aligned} \quad (15)$$

Where \mathbf{ym}_{08-16} is a vector of year-month dummies for 2008 to 2016, \mathbf{ym}_{08-12} is a vector of year-month dummies for 2008 to 2012, \mathbf{ym}_{13-16} is a vector of year-month dummies for 2013 to 2016. Here, β_3 is the vector of treatment effects of interest while β_2 acts as a parallel trend test. In this specification, I use December 2012 as the baseline.

Specifications (14) and (15) impose no time structure. Parameter estimates on $\textit{treated} * \textit{time}$ measure the change in the time series level, including the part due to a change in informality trend. To restrict to a linear trend and separate changes in levels and trend I use an additional specification

Figure 1: Monthly informality rate, % of wage workers



Source: Author calculations based on GEIH household survey data. Notes: Private employees as treated, self-employed as control. Informality definition in main text. Straight lines indicate linear OLS fits. Seasonally adjusted product of regressing informality dummy in month dummies and adding average informality to residuals. Workage if age 12 or more in urban areas, age 10 or more for rural areas.

$$\begin{aligned}
P(I_{it}) = & \delta_0 + \delta_1(t - c) + \delta_2 after + \delta_3 treated + \\
& \delta_4(t - c) * treated + \delta_5 after * treated + \\
& \delta_6(t - c) * after * treated + \\
& \delta_7 \mathbf{X}_{it} + \delta_8 \mathbf{X}_{it} * treated + \varepsilon_{it}
\end{aligned} \tag{16}$$

Where t is the year-month time variable, c the time baseline (December 2012) and *after* a dummy equal to one if January 2013 or after. Here δ_5 captures the change in informality level while and δ_6 the change in trend. The total estimated effect of the reform equals $\delta_5 + \delta_6 t$, with t for January 2013 or after.

For all specifications, I take the same estimation approach. I use seasonality adjusted residuals, as shown in figure 1b, as the dependent variable. To avoid the problems of using non-linear estimators in a DID context (Greene, 2010; Blundell and Dias, 2009; Ai and Norton, 2003), I assume a Linear Probability Model (LPM) with estimates obtained using Ordinary Least Squares (OLS) with robust standard errors clustered by the industry. LPM allows DID estimates to be readily interpretable and is much faster, given the large sample size of 2,302,575 observations in the GEIH data.¹⁹ Controls by age, gender, education, and department are included in all regressions.²⁰ I use main sectors and workers above 1 hourly MW for differential impact analysis.

In Table 1, we can see that treated and control are different in terms of the control variables used in the regression specifications. In terms of the sample size per year, the control group is larger the treated one—by about 28% before the reform and 16% after. Differences in workers’ characteristics remain relatively the same before and after the reform. Control workers remain more female, older, less educated, less urban, earning lower wages, more concentrated in agriculture and services, and in small firm sizes than treated workers.

Simple DID estimates show an increasing reduction in informality after the reform (Table 2). The DID estimate for the approval of the reform (DID1) is -1.5, which indicates a larger reduction of 1.5 pps for treated workers than controls between January and April 2013. The estimated reduction for the first tax waiver (DID2) is bigger at 2.5 pps; after the second tax waiver, we obtain an even larger reduction of 6.5 pps.

Before-after DID estimates go in line with the simple estimates (Table 3). In column (1), I obtain similar point estimates to those obtained in the simple calculation. Using controls, column (2), the point estimate for January to April 2013 becomes marginally significant at -1.1 pps, for May to December 2013, highly

¹⁹LPM limitations like predicted probabilities outside (0,1) interval or heteroskedasticity are not of much concern in a diff-in-diff context. I am not interested in predicted probabilities and heteroskedasticity is easily adjusted for.

²⁰Sector and firm size are highly correlated with informality but using them as controls raises concerns of endogeneity. For example, a firm could change their size and its composition of informal workers after the decrease in payroll taxes.

Table 1: Workers characteristics

		Control		Treated	
		[2008-2012]	[2013-2016]	[2008-2012]	[2013-2016]
Freq. workage workers		741,369	577,816	577,280	496,325
Male (%)		60.8	59.8	64.2	61.4
Age (avg. years)		41.6	42.5	34.2	34.7
Years of education (avg.)		7.2	7.6	9.4	10.1
Urban (%)		73.5	72.6	80.7	82.9
Wages (avg. # hourly MWs)		1.05	1.06	1.32	1.37
Sector (%)	Agriculture	20.6	20.6	17.0	13.1
	Industry	17.6	16.5	27.0	26.3
	Services	61.8	62.9	56.0	60.5
Firm size (%)	Alone	75.3	76.3	0.7	1.5
	[2-5]	17.8	16.9	34.4	29.7
	[6-10]	1.5	1.4	11.1	10.6
	[11-19]	0.8	0.8	6.6	6.5
	[20-49]	1.0	1.0	10.7	10.4
	[50+]	3.6	3.6	36.6	41.3

Author calculations based on GEIH microdata. Notes: Employees as treated, self-employed as control.

Table 2: Simple DID estimates

Group	[2008-2012]	Jan-Apr 2013	May-Dec 2013	[2014-2015]	DID1	DID2	DID3
Control	93.8	92.9	92.7	92.2	-0.9	-1.1	-1.6
Treated	55.4	53.0	51.7	47.3	-2.4	-3.7	-8.1
Difference	-38.4	-39.9	-41.0	-44.9	-1.5	-2.5	-6.5

Source: Author calculations based on GEIH household survey data. Notes: Employees as treated, self-employed as control. Informality definition in main text.

Table 3: Before-after DID estimates

Variable	All employees		Sector			[0.5-1.5]
	(1)	(2)	Agriculture	Industry	Services	MW
			(3)	(4)	(5)	(6)
treated*Jan-Apr13	-0.016** (0.007)	-0.011* (0.006)	-0.019 (0.021)	-0.017** (0.008)	-0.003 (0.008)	-0.009 (0.007)
treated*May-Dec13	-0.025*** (0.008)	-0.021*** (0.006)	-0.011 (0.016)	-0.026*** (0.009)	-0.017** (0.007)	-0.017** (0.007)
treated*2014-2016	-0.065*** (0.011)	-0.054*** (0.008)	-0.053** (0.018)	-0.047*** (0.006)	-0.048*** (0.011)	-0.066*** (0.010)
Controls	No	Yes	Yes	Yes	Yes	Yes
Observations	2302498	2302118	200489	503430	1597352	1416825

Source: Author calculations based on GEIH household survey microdata. Notes: Results from OLS regressions with robust standard errors clustered by industry. Residuals of OLS regression of informality on month dummies as dependent variable. Standard errors in parentheses. Number of observations in brackets.* p<0.1 ** p<0.05 *** p<0.01. Employees as treated, self-employed as control. Informality definition in main text. Controls include age, gender, education and department.

significant at -2.1 pps as well as for January 2014 and after where the point estimate is -5.4 pps.

The reform impact was unequally distributed among sectors in the short term and almost evenly in the long term. For January to April 2013, only industry had a significant estimate of -1.7 pps; for May to December 2013, both industry and services have significant estimates of -2.6 and -1.7 respectively. For January 2014 and later, point estimates are significant for all three sectors at about -5 pps.

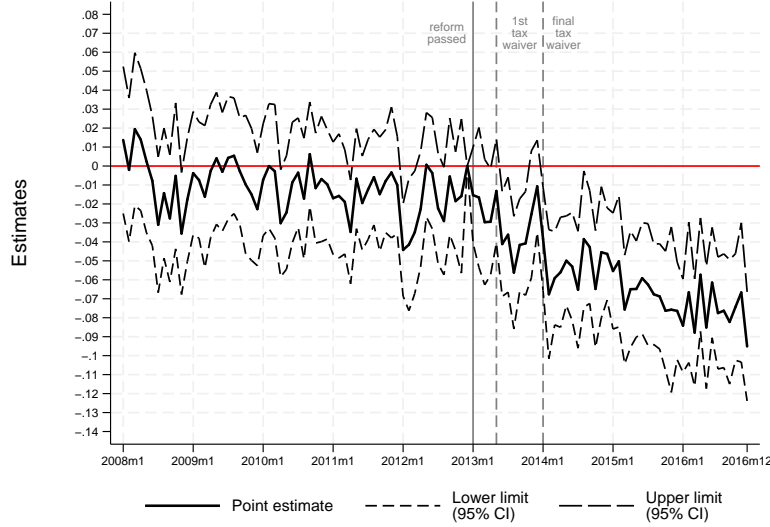
Employers' compliance with MW is critical for formality; for employees around 1 hourly MW, the DID estimate was larger than for all workers for Jan 2014 and after. For workers with wages equal to half to one and a half hourly MW, [0.5-1.5] MW, DID estimate is not significant for January to April 2013. For May to December 2013, the point estimate is significant at -1.7 pps, lower than for all workers at -2.1 pps. But for January 2014 and later, the point estimate is larger at 6.6 pps compared with 5.4 for all workers. This could be indicating that the reform had a larger impact for workers around MW than for all workers.

The increasing size of point estimates after the reform is even more pronounced on treated*year-month interactions (Figure 2). We see that, with or without controls, confidence intervals for point estimates before January 2013 include zero in almost all months. In addition, the Wald test of statistical significance of treated*months point estimates for months before January 2013 cannot reject the hypotheses of all equal to zero for 40 out of 48 months without controls, 38 months with controls, at 10% or less. Thus, although parallel trends are slightly not parallel, the difference is not statistically significant.

With controls, from January to May 2013, we see that confidence intervals also include zero. From June to October 2013, all point estimates do not include zero and go up to -5.6 pps for August. Starting January 2014, all point estimates become significant with confidence intervals not including zero. Point estimates indicate larger reductions in informality starting in January 2014 at -3.8 and getting largest by December 2016 with -9.4.

Estimation of the change in level and trend in informality also indicates significant but smaller impact

Figure 2: Diff-in-diff treated*year-month estimates



Source: Author calculations based on GEIH household survey microdata. Notes: Results from OLS regressions with robust standard errors clustered by industry. Residuals of OLS regression of informality on month dummies as dependent variable. Employees as treated, self-employed as control. Informality definition in main text. Controls include age, gender, education and department.

(Figure 3). Using the estimates from specification (16) figure 3 presents the total estimated effect $\hat{\delta}_5 + \hat{\delta}_6 t$. We see that, as before, for January to April 2013 estimates are not significant. From May to December 2013 the total effect estimate go from almost zero to -1.4 pps. By December 2014 the estimated total effect goes up to -2.5 pps, -3.5 for December 2015 and a maximum of -4.6 pps by December 2016.

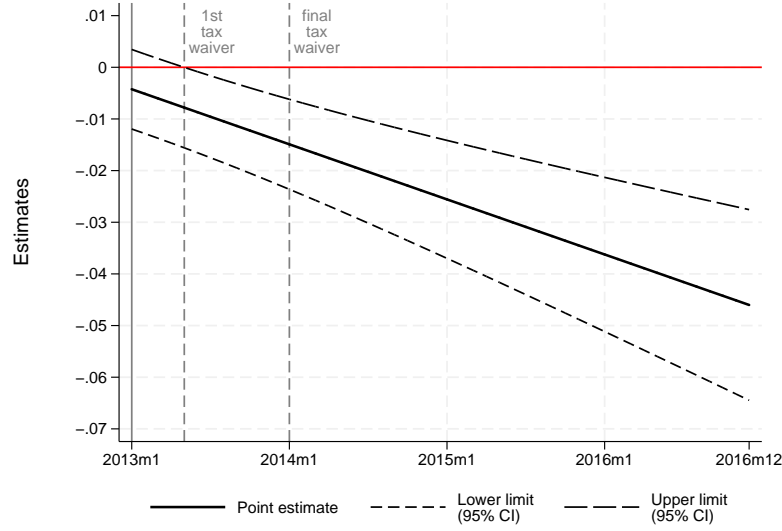
Finally, results are robust to the use of alternative definitions of informality (Table 4). No pension or no health, columns (1) and (2), are both significantly reduced by the reform passing, January–April 2013, and its first tax waiver, May–December 2013. Reduction in the share of workers earning under 1 MW takes until after the second tax waiver with a significant point estimate for [2014–2016] and for January 2015 and January 2016.

6.2 Results based on panel data

6.2.1 Informality before and after the reform

The results in this section are based on a balanced panel subset from the ELCA panel data, which is not significantly different from the total panel data (see Tables 8 and 9). In Table 5, we can see that simple DID calculations are negative for years 2013 and 2016 compared with 2010. As expected, the control group has a high informality starting at 93% in 2010 and ending in 92% in 2016, but the treated group has a much lower level of informality at 63% in 2010 and ending in 52% in 2016. This implies DID simple calculations of -9% for 2013 and -9.7% for 2016.

Figure 3: Treated*after + treated*after*year-month estimates



Source: Author calculations based on GEIH household survey microdata. Notes: Results from OLS regressions with robust standard errors clustered by industry. Residuals of OLS regression of informality on month dummies as dependent variable. Employees as treated, self-employed as control. Informality definition in main text. Controls include age, gender, education and department.

Table 4: DID estimates by different informality definitions

Specification	%	No pension	No health	Under 1 MW
		(1)	(2)	(3)
before-after	treated*Jan-Apr13	-0.020*** (0.007)	-0.023*** (0.007)	-0.018 (0.026)
	treated*May-Dec13	-0.023*** (0.006)	-0.026*** (0.006)	-0.018 (0.017)
	treated*[2014-2016]	-0.047*** (0.008)	-0.052*** (0.009)	-0.067*** (0.010)
year-month	treated*2013m1	-0.004 (0.014)	0.017 (0.012)	-0.019 (0.013)
	treated*2014m1	-0.039*** (0.014)	-0.022* (0.012)	-0.013 (0.015)
	treated*2015m1	-0.041** (0.017)	-0.029* (0.017)	-0.074*** (0.015)
	treated*2016m1	-0.063*** (0.014)	-0.045*** (0.014)	-0.077*** (0.016)

Source: Author calculations based on GEIH household survey microdata. Notes: Results from OLS regressions with robust standard errors clustered by industry. Residuals of OLS regression of informality on month dummies as dependent variable. Standard errors in parentheses. Number of observations in brackets. * $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$. Employees as treated, self-employed as control. Informality definition in main text. Controls include age, gender, education and department.

Before-after DID estimates indicate significant reductions in informality with the exception of workers in agriculture or earning above 1 MW (Table 6). For all workers including control-treated transitions, we have a DID estimate of -9.6 pps, similar figures for workers in industry and services, and higher estimates for workers around 1 MW, in line with the results from GEIH data.

Per-year DID estimates are in line with results from before-after DID (Table 7). We obtain significant point estimates of -9.2 pps for 2013 and -10 pps for 2016 for all workers, point estimates slightly higher in workers at services and lower for workers at industry. Interestingly we obtain a marginally significant point estimate for 2016 in agriculture. We obtain larger estimates for workers around 1 MW.

Table 5: Simple diff-in-diff estimates, balanced panel

<i>Group</i>	<i>Informality rate (%)</i>			<i>Diff-in-diff</i>	
	2010	2013	2016	2013	2016
<i>Control</i>	93.2	93.8	92.0	0.6	-1.2
<i>Treated</i>	62.7	54.3	51.8	-8.4	-10.9
<i>Difference</i>				-9.0	-9.7

Source: Author calculations based on ELCA household survey microdata. Notes: Informal if: (i) Employee not making health or pension contributions, in subsidized health scheme or earning under 1 hourly MW, (ii) Self-employed not contributing to a pension fund, without health coverage or in subsidized health scheme.

Table 6: Before-after fixed effects estimates, balanced panel

	All employees		Sector			[0.5-1.5]
	(1)	(2)	Agriculture	Industry	Services	MW
<i>After</i>	-0.019** (0.008)	0.006 (0.013)	0.112* (0.058)	-0.028 (0.036)	0.018 (0.016)	0.014 (0.025)
<i>Treated</i>	-0.089*** (0.017)	-0.091*** (0.017)	0.048 (0.056)	-0.124*** (0.048)	-0.080*** (0.022)	-0.013 (0.027)
<i>Treated*After</i>	-0.099*** (0.015)	-0.096*** (0.015)	-0.054 (0.053)	-0.095*** (0.035)	-0.094*** (0.020)	-0.123*** (0.025)
<i>Controls</i>	No	Yes	Yes	Yes	Yes	Yes
<i>N</i>	10716	10679	799	2482	7379	6024

Source: Author calculations based on ELCA household survey microdata. Notes: Controls include age, gender, education and department. Informal if: (i) employee not making health or pension contributions, in subsidized health scheme or earning under 1 hourly MW, (ii) self-employed not making health or pension contributions, in subsidized health scheme. * p<0.1 ** p<0.05 *** p<0.01

Table 7: Treated*year fixed effects regressions, balanced panel

	All employees		Sector			[0.5-1.5]
	(1)	(2)	Agriculture	Industry	Services	MW
<i>Treated*2013</i>	-0.094*** (0.016)	-0.090*** (0.017)	0.027 (0.052)	-0.094*** (0.036)	-0.101*** (0.021)	-0.109*** (0.028)
<i>Treated*2016</i>	-0.106*** (0.018)	-0.101*** (0.018)	-0.100* (0.059)	-0.081** (0.040)	-0.113*** (0.023)	-0.133*** (0.029)
<i>Controls</i>	No	Yes	Yes	Yes	Yes	Yes
<i>N</i>	10716	10679	989	3202	9393	6024

Source: Author calculations based on ELCA household survey microdata. Notes: Controls include age, gender, education and department. Informal if: (i) employee not making health or pension contributions, in subsidized health scheme or earning under 1 hourly MW, (ii) self-employed not making health or pension contributions, in subsidized health scheme. * p<0.1 ** p<0.05 *** p<0.01

7 Conclusions

Current studies provide mixed guidance to policymakers on the effects of payroll taxes on informality. Predictions from economic theory depend on how informality is defined, workers' preferences for informal employment, and the specific economic model chosen (Antón, 2014; Galiani and Weinschelbaum, 2012). Empirical evidence points to a positive relationship between payroll taxes and informality (Merchán Álvarez, 2015; Clavijo et al., 2015; Mondragón-Vélez et al., 2010; Santa María et al., 2009; Sánchez et al., 2009). The large reduction of payroll taxes in Colombia in 2012 provides a great opportunity to evaluate this both theoretical and empirically.

My labor market model incorporates the reduction in payroll taxes and the structural change in the funding of social benefits introduced by the reform. Due to the structural change in the funding of social benefits and multiple general equilibrium changes, the model is unable to provide clear comparative statics resulting from the reform. The result depends on how employees, self-employed, and employers react to the new economic conditions.

Econometric estimates indicate significant reductions in informality derived from the reform. From repeated cross-section household survey, DID estimates are marginally significant after the first tax waiver in May 2013 and increasingly larger after the second one in January 2014. The industry sector was the first one to enjoy a reduction in informality after the reform was passed, then services joined the list after the first tax waiver, and also agriculture after the second. For workers with wages around 1 MW, estimates are also significant after the first tax waiver; after the second tax waiver, point estimates are even larger than for all workers.

The informality rate in December 2012 for the treated group was 56.2%. Then, simple DID before-after indicates that the reform passing had a small effect of 2% (1.1/56.2); the first tax waiver a slightly bigger one of 3.7%, and the largest effect of 9.6% came after the second tax waiver. Monthly DID estimates also reflect this same pattern; for example, I estimate reductions of 10% for August 2013 and up to 16.7% for December 2016. When restricting informality to have a linear trend, I obtain smaller but more stable point estimates from almost zero in May 2013 to 8.2% in December 2016.

The informality rate on the panel sample for 2010 for the treated group was 62.7%, and the DID point estimates indicate a treatment effect of 14.7% (9.2/62.7) for 2013 and 15.9% (10/62.7) for 2016. These are in line with the results obtained from the repeated cross-sections. DID estimates also indicate significant reductions for those in industry or services (marginally significant for those in agriculture in 2016). We still obtain no significant point estimates for workers earning 1 hourly MW or more. Also, the difference in point estimates including control-treated transitions or not indicate a mild bias introduced by this. It is still

pending estimations based on repeated cross sections that replicate, as close as possible, the characteristics of the panel sample.

These results are consistent with those in Fernández and Villar (2016) but very different from Kugler et al. (2017). I successfully replicate Fernández and Villar (2016), with similar point estimates, sample sizes, controls, and econometric methodology. Treated and control groups are similar, with 80% of workers identified on the same groups in this study and in Fernández and Villar (2016). Differences in estimations are due to the longer period and estimation methodology in this study. In the case of Kugler et al. (2017), despite attempts to emulate same formality measures and treated and control groups, the large differences in sample sizes between the original study and those in the replication render the comparison of point estimates not appropriate.²¹

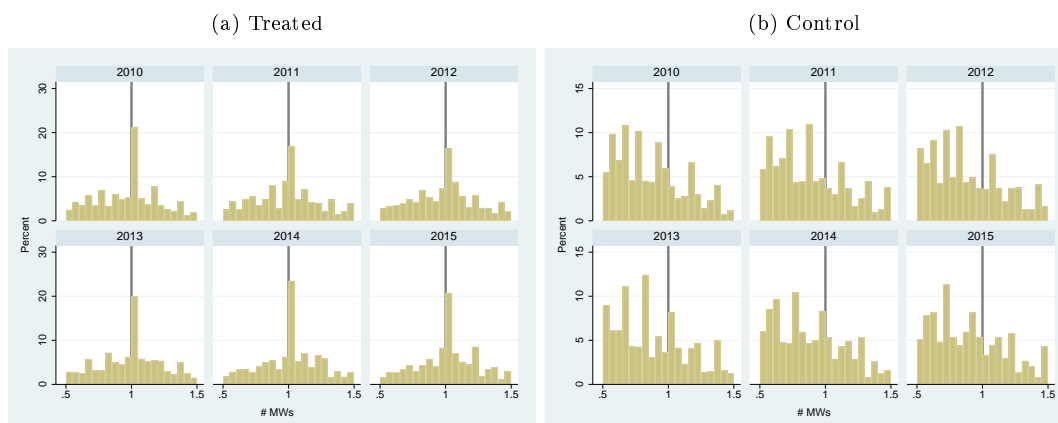
An important limitation of this study is the use of self-employed as the control group as they might still be indirectly affected by a decrease in payroll taxes. In the context of the Colombian reform, firms could increase their labor demand and hire from the pool of self-employed workers and self-employed could decide to formalize if the contributory social benefits are improved or if their wages are increased. This could lead to biased estimates of the reform effect on informality.

For policy implications, it is important to highlight that the estimates' connection with payroll taxes is indirect and replications might not lead to the same results. Multiple regulatory changes—increased flexibility to make contributions to social security, a change in social benefits funding, and increased enforcement—took place at the same time as the reduction in payroll taxes. The reform also implemented new taxes on firms' profits to fund social benefits as well as changes in value-added taxes. It is possible that some or all these factors explain part of the reduction in informality. Also, this study is limited to employees, those most directly affected by changes in payroll taxes but also a small fraction of workers in developing countries. If the reduction in payroll taxes reduces informality only among these types of workers, informality reduction in the country could be small. Accordingly, replications in other contexts should be done with care.

Future research agenda could aim to unveil the effects of the reform on the distribution of wages. As observed above, one of the reform effects was the lower share of treated workers earning under 1 MW. Looking more closely to the distribution of wages around 1 MW (Figure 4), we see a sudden jump since 2013 on the share of workers at exactly 1 MW without any significant change in the control group. Further exploration of the phenomena could look across all the income distribution of treated (employees) workers compared with controls (self-employed). One possible unintended consequence of the reform could be the reduction of wages for employees above 1 MW with excluded workers getting increasingly self-employed. A likely instrument to explore this could be the discontinuous tax rates present in the Colombian tax code

²¹Further details on the replication exercise can be seen in annex table 21.

Figure 4: Histograms of hourly wages



Source: Author calculations based on GEIH microdata. Notes: Employees as treated, self-employed as control. Informality definition in main text.

according to the different number of minimum wages a worker earns.

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A Annex

Table 8: Panel urban population characteristics, all panel vs. balanced

		<i>All panel</i>			<i>Balanced panel</i>		
		2010	2013	2016	2010	2013	2016
<i>Frequencies</i>		22,179	20,574	19,298	12,506	12,506	12,506
<i>Male (%)</i>		47.1	46.9	46.8	45.7	45.7	45.7
<i>Age (Ave. years)</i>		28.6	30.0	31.7	28.8	31.8	34.8
<i>Education</i>	No study	3.4	3.2	2.9	4.0	2.9	2.8
	Prim. inc.	29.8	21.2	19.0	30.8	22.4	18.4
	Prim. comp.	13.3	11.1	10.9	13.2	11.2	10.7
	Sec. inc.	16.4	24.1	25.1	16.4	24.1	24.8
	Sec. comp.	19.1	18.7	17.5	18.9	18.1	17.7
	Ter. inc.	6.1	10.0	11.9	5.5	9.4	12.2
	Ter. inc.	11.9	11.7	12.7	11.1	11.9	13.5
<i>Region</i>	Orinoquia-Amazonia		0.0			0.0	
	Atlantica	24.0	24.6	25.1	26.7	26.7	26.8
	Oriental	20.0	18.6	18.1	20.4	20.3	20.5
	Central	19.9	18.3	16.5	18.6	18.6	18.7
	Pacifica	19.9	19.2	17.4	20.0	20.0	19.9
	Bogota	16.3	13.8	12.1	14.3	14.4	14.1
	Atlantica media		0.7	2.6			
	Cundi-Boyacense		1.7	2.4			
	Eje Cafetero		2.8	3.7			
	Centro-Oriente		0.3	2.1			

Notes: Controls include age, gender, education and department.

Table 9: Labor statistics, all panel vs. balanced

		<i>All panel</i>			<i>Balanced panel</i>		
		2010	2013	2016	2010	2013	2016
<i># employed workage</i>		6,107	9,021	8,665	4,000	5,732	6,063
<i>Sector</i>	Agriculture, cattle and fishing	6.5	7.2	7.0	6.8	6.5	5.6
	Manufacture and mining	17.4	15.7	10.7	17.4	16.0	11.0
	Electricity, gas and water	0.6	1.1	0.8	0.6	1.2	0.7
	Construction	5.3	5.9	6.9	5.3	5.3	6.3
	Retail, restaurant and hotels	29.0	29.8	29.5	29.0	30.4	30.0
	Transport and communication	9.4	8.0	8.3	8.8	7.4	8.4
	Finance and real state	2.5	1.2	1.4	2.4	1.2	1.4
	Govt/public administration	3.1	2.6	2.0	2.8	2.4	2.0
	Other services	26.2	28.4	33.6	26.8	29.7	34.6
<i>Firm size</i>	Alone	34.1	35.3	37.9	36.2	36.5	38.4
	[2-5]	24.7	23.6	22.5	24.2	23.2	21.8
	[6-10]	6.4	6.5	6.4	6.5	6.1	6.0
	[11-19]	3.8	4.3	4.1	3.8	4.4	3.9
	[20-49]	5.7	6.9	6.2	5.6	6.6	6.2
	[50+)	25.3	23.4	22.8	23.8	23.1	23.6

Notes: Controls include age, gender, education and department.

Table 10: Replication exercise

Dependent variable	Before-after diff-in-diff				Kugler et al. (2017)		Fernandez and Villar (2016)	
	Estimate				diff-in-diff		diff-in-diff	
	(1)				Original	Replication	Original	Replication
	[2008-2012] vs [2008-2012] vs [2008-2012] vs	Jan-Apr13	May-Dec13	[2014-2016]	[2010-2012] vs 2013		2012 vs 2014	2012 vs 2014
=1 if no pension or health	-0.011* (0.006)	-0.021*** (0.006)	-0.054*** (0.008)				-0.041*** [-23.7]	-0.052*** (0.002)
Treated * after								
Less than 10 MWs *								
after								
Self-employed with more								
than 3 workers * after								
Observations	2,302,195				377,669	1,242,677	590,286	597,605
Standard errors	Clustered by industry				Clustered by department		No information	
Weighted	Yes				No information		No	
Controls	x				x		x	
Age	x				x		x	
Age squared	x				x		x	
Gender	x				x		x	
Marital status	%				x		x	
Years of education	x				x		x	
Years of education squared	x				x		x	
Education level	%				x		x	
# monthly MWs	%				x		x	
Labor state	x				x		x	
Firm size	x				x		x	
Firm size * Labor state	x				x		x	
Sector	x				x		x	
Urban dummy	x				x		x	
City group	x				x		x	
Department dummy	x				x		x	
Year dummy	x				x		x	
Weight	x				x		x	
January, February and	x				x		x	
December dummies	x				x		x	

Source: Author calculations based on GEIH microdata. Notes: Standard errors in parentheses. * p<0.1 ** p<0.05 *** p<0.01