The Missing Response to Taxes: Informality
[INCOMPLETE, DO NOT CITE]

Francisco Cabezon*

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Abstract

This paper estimates taxable income responses using a natural experiment of variation in the net-of-tax rate generated by the Chilean pension system. The nature of the variation, together with rich monthly administrative data, allows estimation of heterogeneous responses. Only low-income people that are less attached to the formal sector respond to the variation in tax rate. This finding is contrary to previous results of studies using data from the developed world that find low-income people do not respond to tax rate variation. The mechanism behind the the new result is the informal economy, which is lacking in the developed world. The tax response is driven exclusively by people changing their extensive participation in the formal economy.

Introduction

The modern literature on behavioral responses to taxes is focused on the elasticity of taxable income (ETI). Under certain conditions the distortionary effect of taxes are capture by this elasticity and therefore accurate measurement is crucial to guide tax policy. Even though every country needs tax policy, to date most of the empirical literature is based on data from developed countries, with the only exception of Pakistan.[1][2] The magnitude of and factors driving ETI in developing countries may be very different from those in develop ones. In particular, the existence of the informal (shadow) economy may significantly effect the ETI.

Informal economy is prevalent in the world and more relevant for developing countries. In developing countries an average of 54% of the labor force works informally. For the countries with recent ETI studies, the rate of informal labor work is more than five times lower. Among these countries, the one with the larger number of studies is the United States, where a 18% of it's labor force works in the informal sector. More than 95% of the world's population lives in countries with an informality larger than the United States.[3]

The informal economy provides a channel for tax avoidance, and therefore it's presence is relevant for the estimation of the elasticity of taxable income and the design of taxes. Theoretical work and anecdotal surveys have linked informality and tax systems. The presence of a big informal economy influences optimal tax policies

*Princeton University. email: jfcabezon@princeton.edu I am grateful to Owen Zidar for his support in this project. I thanks Henrik Kleven for his lectures. This project is the result of directly applying his graduated public finance lectures to my data. I am also thankful to Alex Kaufam for his ideas, discussion, common sense, and grammatical correcting, which were fundamental to the writing of this draft.

[1] See Saez, Slemrod and Giertz (2012) and Chetty, Guren, Manoli and Weber (2014) for reviews.

[2] Countries with recent studies are USA, United Kingdom, Sweden, Denmark, Finland, and Canada. Kleven and Waseem (2014) studies the ETI in Pakistan.

[3] "Women and Men in the Informal Economy: A Statistical Picture", ILO (2018)

and taxes are one of the main reason for workers to be in the informal economy.[4]. There is also a strong empirical correlation between the informality of a country and it's income tax system. In figure 1, we can see a strong negative correlation between the share of labor force working in the informal sector and both, the share of tax revenue that comes from income taxes and the tax rate in the lowest bracket of taxable income. Despite the theoretical relationship, anecdote survey evidence and observed cross-country relationship between informality and income taxes, I am not aware of any micro empirical evidence on the effect of informality on the elasticity of taxable income (Kleven and Waseem (2013)).[5]

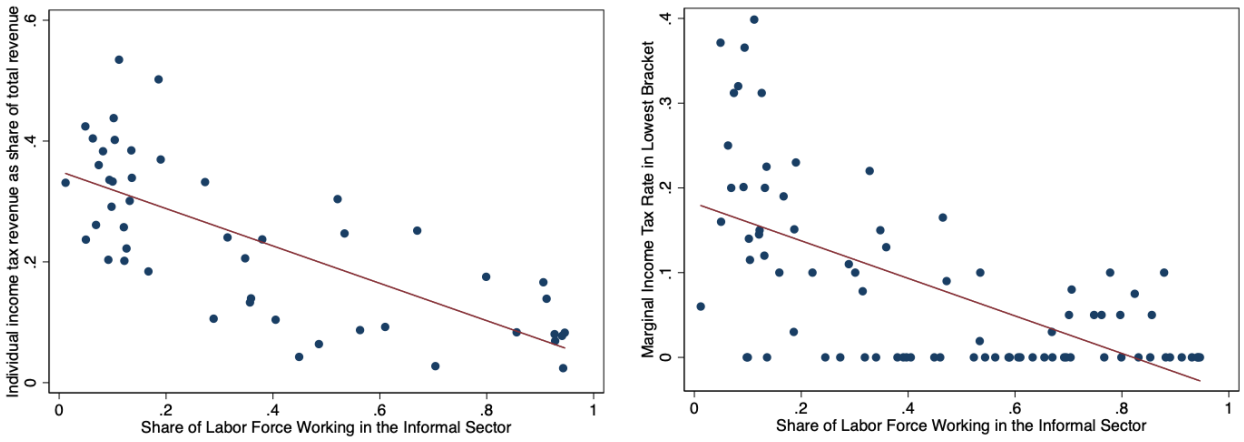


Figure 1: Cross-country relation between income tax and the size of informal economy.

Notes: The tax information comes from IMF. The informality data comes from International Labor Organization. The plot is done with raw data for all the countries with available data.

In this paper I estimate the elasticity of taxable income for a country with a large informal economy. I use a unique administrative data set and a quasi-natural experiment from Chile, where the pension system generated exogenous variation of net-of-tax rate for some workers. I decompose the workers' response by their income level and attachment to the formal sector, finding strong heterogeneity of responses. Using this heterogeneity of response and the predictions of a model, I test whether the response of taxable income is driven by the presence of the informal sector.

The **main contribution** of my paper is the following. I find an elasticity of taxable income that is similar in magnitude to other studies, but this response is driven by workers with low income and low attachment to the formal sector who move from the informal economy to the formal one. This finding is in clear opposition with findings of the literature in the developed world, where the income response is driven mostly by the use of tax deductions and tax base shifts, and therefore low income workers barely respond to taxes.[6] The response of taxable income of low income workers has implications for the prescription of tax and social security policy. Given that 78% of world's population lives in countries with larger informality than Chile and being the informality the driver of my findings, my results are likely relevant for a big share of world's population.

The first part of the paper describes a model of tax avoidance that guides the empirical work through reduce-form predictions. In the model, workers in the formal economy receive periodic jobs offers from the informal

[4]See Gordon and Li (2009), Besley and Persson (2014) and Lemieux, Fortin and Fréchette (1994)

[5]In the words of Kleven and Waseem (2013): "Empirically, we are not aware of any previous study showing compelling evidence of large evasion responses to tax rates even in samples featuring large evasion levels (Kleven et al. 2011: Saez, Slemrod, and Giertz (2012))."

[6]Gruber and Saez (2002); Kleven and Schultz (2014); Saez, Slemrod and Giertz (2012); Kopczuk (2005)

economy which they compare to their net income in the formal sector. They can avoid taxes by participating in the formal economy and hiding part of their income or by switching to the informal sector where they pay zero taxes. Workers can hide taxes in the formal sector by paying a variable cost of hiding, and must also pay a switching cost to adjust the share of their income hidden.[7] The model predicts that in the presence of a small tax change, high income workers taxable income do not respond and low-income worker's taxable income respond through changes in formal labor participation. These predictions are in line with previous empirical and theoretical results of the literature.[8]

For my estimation I rely on administrative data from the Chilean pension system and exploit variation in income deductions, which is equivalent to a variation in tax rate. The Chilean pension system is a private system where every worker is required to save a 10% of her income in a personal account, which is invested until the workers retires. The investment service is provided by a Pension Fund Administrator (PFA) chosen by each worker. The PFAs collect management fees as a share of each worker's income. The fee rate is independent set by each PFA, but is the same for all the workers affiliated to that administrator. In August of 2014, one of the PFA lowered its administration fee by 1.96pp increasing the adjusted gross income (AGI) of it's workers by 2.6pp, while all the other PFA maintained theirs fee unchanged. Because this was the only relevant fee change in the period between 2010 and 2018, workers affiliated with other PFAs are a natural control group. Within the workers treated by the shift in PFA fees, every worker faces a treatment of similar magnitude. This set up allows me to employ a difference-in-difference specification.

The key threat to this design is that time-varying PFA shocks may coincide with the fee reduction event. This risk is limited for five reasons. First, I provide graphical evidence of parallel trends between treated and control groups. Using the pre-treatment period I also conduct a placebo test and find a null treatment effect for periods before the actual treatment event. Second, the estimates are stable across many specifications including controls for income, attachment to formal sector, demographics characteristics, pension fund administrator specific trends and time fixed effects. Third, I show that there is no evidence of worker selection into the PFA that reduced it's fee, and I provide qualitative and quantitative evidence that the change in fee is not related to the characteristics of the affected workers. Fourth, I explain the results with a specific mechanism, provide robust sub-sample analysis and do placebo tests. To be confounders the drivers of my findings, the confounders must have unique characteristics: they must be specific to pension fund administrator, also to workers' characteristics like income, presence in the formal market and retirement, and a specific timing that coincides with the change in management fee. Fifth, because the treatment intensity is independent of worker's income and the data are a monthly-panel I can rule out two issues that are common in the ETI estimation literature: income mean reversion and time-income confounders.[9]

The empirical results of the my paper are the following. The difference-in-difference estimation of the elasticity of taxable income is around 0.4. This response is driven by workers working more in the formal economy after a tax reduction. The elasticity varies widely by heterogeneous of workers' income and proximity to the formal sector. Workers below the 25th percentile of income have a ETI above 1 and those above the 55th percentile display no response. There is also heterogeneity with respect to the attachment to the formal sector. Workers below the median attachment display larger responses, with elasticity close to 1, while workers above the median show no response. The heterogeneity in the size of the elasticity is given by the exposition to the informal economy and these results provide an explanation to the cross-country relationship between size of a country's informal economy and its tax systems presented in figure 1. The large average ETI rationalizes the strong negative correlation between size of the informal economy and share of revenue that comes from income

[7] This model of tax avoidance is in the spirit of Feldestein (1999) with adjusting cost in similar to Caballero and Engel (1999).
[8] Kleven and Schultz (2014), Chetty (2012) and Chetty et. al. (2014)
[9] See Kleven and Schultz (2014) for a clear discussion of these two issues.

taxes, while the larger response of low-income workers rationalizes the negative correlation between informality and the tax of the lowest income bracket. Interestingly, I found no response of high income people, which is consistent with the lack of correlation between a country informality and its highest marginal income tax. This correlation is presented in figure A.1 in the appendix. In the last part of my empirical analysis, I show two results that support the identification strategy. In Chile, when a worker retires he can continue working but does not have to pay administration fee to his PFA. Therefore, retired workers should not respond to the fee reduction and the fee reduction makes retirement less attractive. I found exactly that, the fee change did not affect the labor decisions of retired workers and workers affected by the fee reduction delayed their retirement.

In the final part of my paper I apply my results to a hypothetical social security policy and show that an increase in forced savings actually reduces, in average, total savings of low income workers. This counter intuitive result arises from the response of low income workers leaving the formal sector, which is large enough to offset the increasing in savings from periods where the worker has income in the formal sector.

This paper follows a long literature that exploits cross-sectional variation to study the elasticity of taxable income. (Saez, Slemrod and Gruber (2012), Chetty et. al. (2014)) I depart from it in two respects. First, the magnitude of treatment is constant across workers of different incomes, which enables heterogeneity analyses. Second, the data are from a country with high level of informality, a phenomena that is pervasive in the world but absent in prior empirical work. These two characteristics enable estimation of the novel empirical evidence on the effect of informality on taxable income responses, which supports the theoretical relationship between them (Gordon and Li (2009), Beasly and Persson (2014)).

There exists an incipient empirical literature that studies the tax systems of developing countries. Kleven and Waseem (2013) study the ETI for Pakistan; Kleven and Waseem (2015) and Bachas (2018) study the corporate taxation of Pakistan and Costa Rica, respectively; and Londono (2019) studies wealth taxes in Colombia.

The most relevant work to this paper is Kleven and Waseem (2013) in which the authors use income tax notches to estimate the ETI in Pakistan. This paper has a different scope of data than my paper and also focus on a different question. The data used in Kleven and Waseem (2013) includes only workers above the 80th percentile of income, whereas my paper contains data from every Chilean worker that has ever received income in the formal economy. Kleven and Waseem analysis uses discontinuities in the level of choice sets (notches) and does not use temporal variation. With their empirical approach they estimate frictions and responses inside the tax system, but not extensive responses through informality. In their own words: *"Third, because our approach does not capture extensive responses (including informality)..., we cannot conclude that the total elasticity of taxable income is necesarily small in Pakistan."* (Kleven and Waseem (2013), pp 713). My data and variation allows me to estimate, for the full distribution of income, the extensive response through formal labor participation.

Finally, this paper is related to the optimization frictions literature. Illanes (2019) and Luco (2014) estimate the switching cost for the Chilean pension system. My results provide evidence supporting the informational friction that workers face, similar to Chetty et al. (2014). The evidence of informational friction is the following. Workers that didn't switch to cheaper pension fund administrators exhibit a behavioral response to a fee reduction. This response means that fees are relevant for them, but they do not switch. My results are also related with the literature of frictions on tax avoidance optimization. High income workers didn't respond to a small fee change, which is in consistent with the results of Kleven and Schultz (2014), and provide evidence to the general argument by Chetty et al. (2011) and Chetty (2012).

Section 1 introduces a model of tax avoidance that guides interpretation of the empirical results. Section 2 describes the Chilean pension system, data and empirical approach. Section 3 presents the empirical estimation, results and robustness tests. In section 4 results are applied to an increase in forced savings. Finally, in section

5 I conclude.

1 Conceptual Approach

I consider a simple model where agents can reduce taxable income to lessen tax payments. They have two channels to do it: reduce their taxable income in the formal economy or leave the formal sector and work in the informality.

The taxable income adjusting in the formal sector hast two components. First, the reduction of taxable income has a variable cost that is in the spirit of Feldestein (1999) model. Second, there is fixed cost to adjust the amount of broad income that don't pay taxes. This adjusting cost departs from the one of Caballero and Engel (1999) in the sense that the cost of the adjustment don't depend on the magnitude of the adjustment.[10]

The modelling of avoidance through informality is related to Lemiux, Fortin and Frechette (1994) and the labor search models. Every period workers have a positive probability of receiving job opportunities in from the informal economy and they take them if the opportunity has higer net income than their job opportunity in the formal economy.

1.1 Tax avoidance in the formal sector

I consider a tax payer with exogenous true income y every period. He can make a share $e \in [0,1]$ of his income to avoid pay taxes with a cost of $g(e)$ every period, where $g(e)$ is a continuous convex function. To adjust the value of e the tax payer must pay a fixed cost f^e. For simplicity, the utility function of the tax payer is lineal on disposable income, t is the marginal and mean tax rate and the worker discounts the future by the factor $\beta < 1$.

Prediction 1 *(i) For a given tax change, high income workers have a weakly larger taxable income elasticity. (ii) For each income level y, there exist a threshold $\bar{t}$ such that if the change in tax in absolute value is smaller than $\bar{t}$, then there is no response of taxable income.*

Proof.

When the agent expect taxes to stay constant in the future and adjust e, the optimal e solves:

$$\max_{e} \quad y(1-e)(1-t) + ey - g(e) + \beta V(e,t)$$

the optimal e, using Benveniste-Scheinkman condition, is given by:

$$yt = g'(e(t)) \tag{1}$$

Let the change in tax be defined by Δt with $t_1 = t_0 + \Delta t$, and $e_1 = e(t_1)$ and $e_0 = e(t_0)$ be the optimal hidden shares given taxes t_1, t_0. The benefit of adjusting e_0 to e_1 is given by:

$$BA(t_1, t_0, y) = (g(e_0) - g(e_1)) - yt_1(e_0 - e_1) + \beta(V(e_1, t_1, y) - V(e_0, t_0, y))$$

and using (1) we get:

$$\frac{\partial BA(t_1, t_0, y)}{\partial t_1} = -(1+\beta)y(e_0 - e_1) < 0$$

[10] Assuming that the cost of adjustment affect the cost of adjustment in a convexly don't affect the results.

The agent adjust if $BA(t_1, t_0) > f$. Assume without loss of generality that $t_1 < t_0$. $BA(t_1, t_0, y)$ has four characteristic: (i) $BA(t_1, t_0, y)$ is continuous on t_1, (ii) $BA(t_1, t_1, y) = 0$, (iii) $BA(t_1, t_1, y)$ is strictly decreasing on t_1 and (iv) $BA(t_1, t_1, y)$ is strictly increasing on y. Therefore, for any given y and $f^e > 0$ there exist a $\bar{t}$ such that if $|t| < \bar{t}$, then $BA(t_1, t_0, y) < f^e$.

■

The intuition of the result is clear. Conditioning on a share to hide, high-income tax payers pay more taxes, therefore they have a larger marginal benefit to hide their taxable income. Also, the value of adjusting the taxable income is increasing on the size of the tax change, therefore if there are frictions to adjust taxable income, then is not optimal to respond to small reforms.

This simple model predicts two of the findings of the literature for developed countries. Kleven and Schultz (2014) show in Denmark that bigger changes in marginal tax generate a larger taxable income elasticity and the ETI is larger for high-income tax payers, and Gruber and Saez (2002) shows for the US that the taxable income elasticity is larger for higher-income tax payers.

1.2 Tax avoidance through informality

Worker j has income y_j in the formal economy and every period receives with probability p_j a job offer from the informal economy with wage y_j^I for that period. The income distribution of the informal jobs are distributed according to $G(y_j^I)$, with probability density function $g_j(y_j^I)$ that is differentiable everywhere and unimodal. I assume that there are a continuous of workers and each of them is characterized by the pair $\{y_j, p_j\}$, with joint distribution $F(y, p)$ and marginal distributions $F^Y(y)$ and $F^p(p)$, respectively. Both marginal pdf functions are unimodal and differentiable everywhere. The payoff for the worker in the formal sector is the net-of-tax income, $NI_j = y_j(1 - t)$ where t represents all income deductions (tax, social security, etc). The following analysis is with respect to a small change in tax from t_0 to t_1. Without loss of generality, I assume that $t_1 < t_0$.

Crucial Assumption: *$G(\cdot)$ first-order stochastically dominates $F^Y(\cdot)$.*

This assumption is the driver of the larger response from low-income workers. There are two arguments to support this assumption. First, survey data show that the unobservable distribution of income in the informal economy is concetrated around low wage opportunities.(Lemieux, Fortin and Frechette (1994) and ILO (2018)) Second, this assumption makes predictions that I test and prove in my data. If the informal economy opportunities have larger wage than formal ones, then high income people would respond more. This is rejected by the data.

Lemma 1 *After the tax change, the change on the probability that worker j will be in the formal economy is given by:*

$$p_j \int_{y_j(1-t_1)}^{y_j(1-t_0)} g(y^I) dy^I \tag{2}$$

and the average response of a group will be given by the average response of the members of the group.

The intuition of this lemma is simple. After the tax change some informal job opportunities became irrelevant for worker j. The change on the probability of being in the formal sector will be given by the probability of those opportunities, conditional on receiving an offer.

Prediction 2 *After a tax change,*

(i) Conditionally on p_j, there exist a $\overline{y}$ such that the average response of workers with incomes above $\overline{y}$ is smaller than the average response of workers with incomes below $\overline{y}$.

(ii) Conditionally on y_j, more switching between formal and informal jobs implies larger response to a tax change.

Proof. (i) follows from the unimodality property, FOSD of $F^Y(\cdot)$ over $G(\cdot)$, and the application of lemma 1. (ii) follows directly from lemma 1. ■

After a tax change there is an interval of informal income that starts to be dominated by the formal job. Given this new dominated interval, the change in behaviour depends on two factors. The first is the likelihood of receiving informal jobs offers with income in that interval, which is given by the density of informal jobs around the formal income. To illustrate this, think about two workers, one is a CEO and the other is a minimal-wage earner. After the tax change, for both workers there are informal incomes that became dominated by their formal job, but for the CEO the probability of receiving one of those offer from the informal economy is zero, while for the minimal wage earner is high. Therefore, the minimal wage earner will respond more to the tax change.

The second factor is the probability of receiving an informal economy offer. A worker that never receives informal offers will not change her behaviour after a tax change. I do not do strong assumptions over the distribution of this probability and how is associated to workers' characteristics. I allow the data to tell me which workers are more prone to receive informal jobs offers by counting the number of switches between formality and informality that a worker exhibits during her labor life. I interpret a worker with more switches as being less attached to the formal economy ,i.e., as having a larger probability of receiving informal offers in my model.

2 Context, Data and Identification Strategy

This paper estimates income and labor response to taxes using Chilean data. The characteristics of the Chilean social security system provide variation on the net-of-tax rate that I use in my estimation. This variation has two characteristics that are useful for estimating the elasticity of taxable income. First, the change in the tax rate only affected a subset of Chilean workers (4.1% of them), providing a natural control group of unaffected workers. Second, within the workers treated by the variation in tax, every worker faces a treatment of similar magnitude. These two characteristics allow estimation of heterogeneous effects of taxes on income and formal labor participation. In addition to this useful tax variation, I have access to administrative data where I can observe people's monthly income.

In this section I describe the Chilean social security system that provides the tax variation, the data and the identification strategy.

2.1 Context

The Chilean social security system provides three services: pensions, health and unemployment which are funded through deductions from workers' income. The retirement part was privatized in 1980 through the creation of a mandatory defined-contribution plan which requires people to contribute 10% of their income to a personal account which is invested until retirement. Workers can choose to retire after they turn 65 years old for males, and 60 for females or sooner if their savings are sufficient to to fund a pension with a replacement rate of 70% of their average income in the last 10 years. Workers can make voluntary contributions in excess of the required 10%.

The personal retirement account is invested by a Pension Fund Administrator (PFAs) selected by the worker. These funds administrators are for-profit and privately owned firms, authorized by the government to be pension fund administrators. Each PFA charges their affiliated workers a management fee as a share of the worker's income and is deducted from their income every month. Every worker in the same PFA pay the same percentage of their income as administration fee. The size of the fee is set independently by each PFA. Figure 2 shows the time series of these fees. I use the sharp change in the administration fee of Planvital PFA in August of 2014 as variation to the net-of-tax rate.

There are six Pension Fund Administrators (PFAs) among the workers can choose. The pension fund administrator selection process has changed over time. Before August 2010, people chose between PFAs when they received income for the first time. By law, at the moment of choice workers were given information about each PFA fee and past returns. After a worker choose a PFA, he is affiliated to it, having to pay that PFA management fee every time he receives income. To switch administrator after the initial choice, a worker has to actively do it by a cumbersome process, where the worker is required to make in-person visits to both the old and new PFA offices. After August 2010, the system was reformed to its current state, in which PFAs bid fees and the lowest wins the affiliation of every new worker for the next two years. The winning PFA is required to maintain the low fee for 2 years during which the recently affiliated workers cannot switch from the winning administrator.

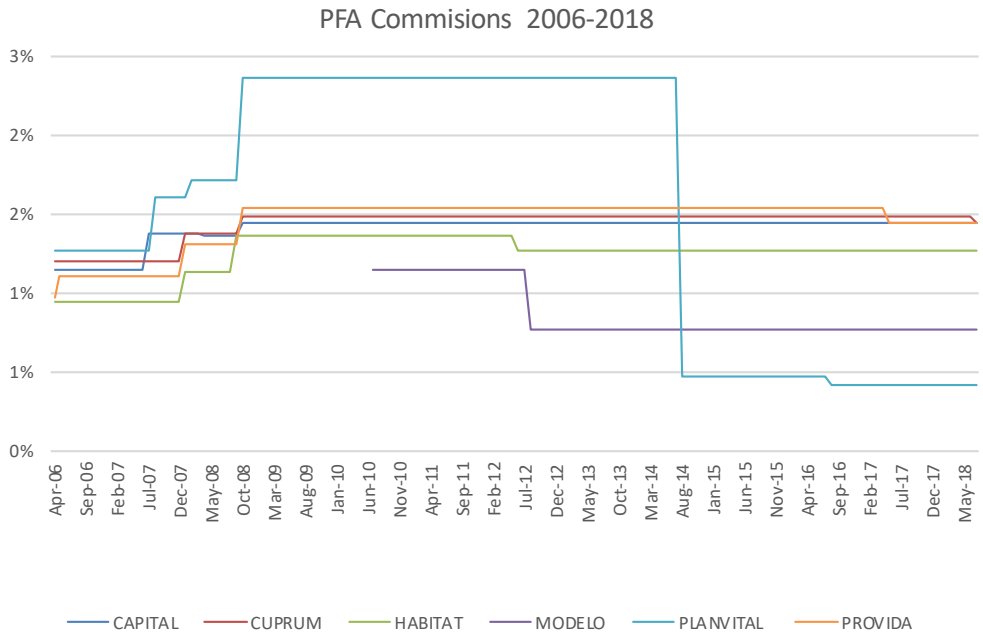


Figure 2: Fee charged by PFAs

The Chilean social security also takes 10% of people income to fund health and unemployment insurance. In total, income deductions associated with social security add up to 20% plus the PFA management fee. Taxes are calculated on the post-deduction income (AGI). For example, a worker affiliated to Planvital will get a 22.92

2.2 Data

I use monthly data from the Chilean pension system. This administrative data consist of all the income generated by Chileans in the formal economy and I have access to a representative sample of it.[11] My data is a panel that follows worker's monthly income. This data is employer reported in the case of wage-earners and self-reported in the case of self-employed. In my sample I cannot separate betwee these gorpus.

My sample consists of a 0.5% random sample of the administrative data of workers forced savings. Specifically, I use 28,135 workers random selected, for whom I follow monthly from January 1991 to January 2018. I observe worker level information on sex, birth date, death date, date of affiliation to the pension system (i.e. first time receiving income in the formal economy), Pension Fund Administrator, income, employer, pension account value, voluntary contributions, voluntary account value and number of children. In the case of a retired worker, I can also see retirement date, type of pension and monthly pension amount.

The definition of the main variables that I use in my analysis are the following:

- Active: is a variable at worker level that takes value 1 if a worker has received income in the formal sector before and is not retired.
- Gross Formal Income: is the individual's total monthly income before taxes or other deductions. I can observe it directly in my data. I adjusted it by CPI to make it comparable across time.
- Taxable Income: is gross formal income minus deductions. These deductions are 20% plus administration fee, which varies across individuals and time.
- Formal: is a variable at worker and time level. It takes the value of 1 if the worker received income in the formal sector in a given month, and 0 otherwise.
- Treated: is defined at worker level. Is defined equal to one if a worker belong to Planvital PFA before and after the fee change, and 0 otherwise. Alternatives definition of this variable is used to test robustness of the result. These definitions are: (i) equal 1 if a worker was always affiliated to Planvital PFA, (ii) for an instrumental variable analysis I define it as a projection of being affiliated Planvital before and after based on the original affiliation, (iii) for an instrumental variable analysis I define it as a projection of being affiliated to Planvital before and after based on affiliation before the fee reduction, (iv) was affiliated to Planvital during the fee change.
- Magnitude of the treatment: is the effective variation on the net of tax rate induced by the fee reduction. This magnitude varies across income because there exist brackets of income with different marginal tax rate. The minimal marginal tax rate is 0 and the maximal tax rate is 35%. 98% of my sample paid a marginal tax rate below 8%, keeping in their after tax income more than 92% of the fee reduction. I use this variable to compute elasticities.
- After: is defined at time level, taking values of 1 for periods after Planvital's fee reduction of August 2014.
- Before: is defined as the months that are part of the analysis time frame and are before the change in fee. (Is the complement of After)
- Average income before: is defined as the average monthly income of the T months before the fee change, where the worker was active. The T used in the analysis are 60, 24 and 12 months.

[11] Representativeness is based on "Encuesta de Previsión Social 2015".

	Treated (Planvital PFA)				Control (Other PFAs)			
	Min	Max	Mean	S. D.	Min	Max	Mean	S. D.
Age (Years)	21	99	51.4	16.82	20	104	45.8	15.72
Sex (male=1)	0	1	0.56	0.5	0	1	0.55	0.5
Retired (=1)	0	1	0.26	0.44	0	1	0.16	0.37
Affiliation Date (Months)	256	594	371	100.5	256	594	407	112.2
Income Before	0	16,077.7	1,376	2,098.3	0	18,241	1,799	3,141.99
Attachment Before	0	0.7	0.41	0.41	0	0.71	0.40	0.40
Annual Taxable Income	0	43,649	2,854	4,532	0	44,472	3,225	6,612
Formal	0	1	0.66	0.47	0	1	0.63	0.48
Switcher	0	1	0.17	0.38	0	1	0.11	0.44
Observations	1,613				19,676			

Figure 3: Summary Statistics

Notes: Affiliation date is in number of months after January 1969. Money unit is 2018 U.S. dollars. Income Before and Attachment before are Average income before and Average formal switches before, respectively, with $T = 64$.

- Average presence before: is defined as the total number of formal months divided by the total months that the worker is active in the T months before the fee change. This number is bounded between 0 and 1, where 0 is no participation in the formal sector and 1 is complete participation in the formal sector. The T used in the analysis are 60, 24 and 12 months.
- Average gaps before: is 1 minus average presence before, defined before.
- Average formal switches before: is defined as the number of switches between formality and informality in the T months before the fee change, normalized by the number of months that the worker was active during that period. The T used in the analysis are 60, 24 and 12 months. I interpret this variable as attachment to the formal sector.
- Switcher: is defined at worker level. Takes value 1 for workers that have switched between pension fund administrators in any moment of my sample.

In figure 3 I show the summary statistics of my sample at the month of the fee reduction.

Every manipulation of the data that I do is described in the appendix. These manipulations consist of merging different data sets and using existing variables to define new variables.

2.3 Identification Strategy

I aim to identify the causal effect of the marginal tax rate on taxable income and formal labor participation. To do so I leverage a change in the management fee of the Planvital PFA. In August of 2014, Planvital reduced its fee by 1.89pp for its 384,778 affiliated workers. The reduction increased the monthly adjusted gross income (AGI) of Planvital's affiliated workers by 2.54%, while the workers on other PFAs kept their income deductions associated to social security at the same level. I use this fee variation at the administrator level in a difference-in-difference specification.

In the analysis I restrict the time frame to the 40 months before and after the fee change. This time frame has two characteristics that make it suitable for the analysis. First, is a period where every administration fees

were stable, except for the studied change. Second, the length of the pre-treatment period is equal to the length of the post-treatment period. In the appendix, I show that my results are robust to different time frames.

I restrict my analysis to workers who affiliated with the pension system before August of 2010 because workers affiliated after July 2010 are assigned according to the auction of new affiliated workers, contaminating my control group by cohort effects. This removes 22% of the observation in the original sample. My estimates are robust to set the limit on affiliation date to an earlier date.

Variation in management fee is at the level of pension fund administrator, so a key identifying assumption is that the change in fee is independent of other pension fund administrator shocks. I provide several pieces of evidence to support this assumption. First, I show graphical evidence that the treatment and control groups exhibit parallel trends. Second, I provide statistical evidence that the treatment effect presents only after the fee reduction. Third, I give quantitative and qualitative arguments that (i) there is no important auto-selection of Planvital's affiliated workers, and (ii) the fee change is not related to the characteristics of workers affiliated to Planvital.

In figure **??** I show the time series for the average income and average formal labor participation of the workers in treated and control groups. In this figure: (i) average income and average formal labor participation of both groups exhibit parallel trends before the fee reduction, (ii) there is a treatment effect after the fee reduction, and (iii) the trends revert to parallel two years after the fee reduction. As additional evidence of the parallel trends assumption, I use the months before the fee change as a placebo for treatment and I find no effect. This test is display in figure 4. The existence of parallel trends and the correct timing of the treatment effect support the assumption behind the identification strategy used in this paper.

The parallel trends of income and participation between Planvital and non-Planvital affiliated workers suggests that the groups are suitable for comparison. Two characteristics of the pension system that pose an additional threat to comparability between control and treatment groups: workers choose to which PFA affiliate and after their affiliation, they can switch among them. Luckily, workers' disinformation and design features of the selection and switching process limit this issue.

Workers choose pension fund administrators with limited information. Only two characteristics - management fee and past returns - were required disclosures. Before 2009, fees and returns of the PFAs were similar, making the different PFAs homogeneous. From 2002-2011 Planvital's average return was 6.06% compared with 6.02% for the rest of the system. Planvital's average fee was 2.51%, compared to an average fee of 2.45% for the rest. Therefore, at the moment of choice PFAs where closely homogeneous goods.

The ability to switch from pension fund administrators is not an important issue because they rarely do so. The panel nature of my data allows observation of worker's who switch PFA. I define a switcher as someone that has switched at least once in his life. In my sample, 86% of the workers did not switch at any point in the full span of the sample (1990-2019). Using similar data to mine, Illanes (2018) estimates the cost of switching between PFAs is \$1,200, which is a large relative to the median monthly salary of \$820.[12] Misinformation about the fees and returns of the different pension fund administrators is common. Less than 11% of workers know the administration fee that they pay to their PFA and only 8% of the workers know how much of their gross income goes to the pension system.[13]

The fee reduction induces switching toward Planvital. To separate treatment effects from selection effects I switchers are removed the my primary specification. To interpret the results without considering switchers, I two behavioral types of types of workers, switchers and non-switchers, which implies that results are only valid for non-switchers. In my sample, more than 86% of the workers are of the non-switcher type. The results are

[12] Encuesta Suplementaria de Ingresos 2017, INE

[13] Encuesta de Opinión y Percepción del sistema de Pensiones en Chile.

robust to the inclusion of switchers and in several specifications. Among others, I use an instrumental variable approach and instrument for switchers using their PFA affiliation.

Finally, Planvital's fee reduction is not related to the characteristics of its affiliated workers and was done to win the auction for new affiliated workers. This objective is explicitly stated in the Planvital's annual memory of 2014.[14] Furthermore, fees were constant across other years because Planvital lost the auction for new customers and thus did not adjust their fee. The 2014 reduction occurred only after Planvital won the 2014 auction. At the time the number of workers affiliated to Planvital was small compared to the number of workers at stake in the auction. Before 2014 Planvital had 394,968 affiliated workers which increased to 1,626,124 by 2018. Planvital's fee reduction was not driven by it's affiliated workers' characteristics, but rather by an interest in increasing the base of affiliated workers.

3 Estimation and Results

I use a regression framework to estimate the effect of the fee reduction by implementing a difference-in-difference specification,

$$y_{it} = \beta_1 AFTER_t + \beta_2 TREATED_i + \gamma AFTER_t \cdot TREATED_i + X_{it}\phi + \epsilon_{it} \tag{3}$$

where the variables are the ones defined in the data section and X_{it} are controls at the worker level.

I also use the following more general specification,

$$y_{iat} = \gamma_{0a} + \gamma_{1a} t + \lambda_t + \delta D_{at} + X'_{it}\beta + \epsilon_{iat} \tag{4}$$

Where the subscript a represents the PFA to which the worker i is affiliated. The variable t is a time trend and the coefficient γ_{1a} is PFA specific, therefore $\gamma_{1a}t$ captures PFA a specific time trend. γ_{0a} and λ_t are PFA and time fixed effects, respectively. D_{it} is defined by $AFTER_t \cdot TREATED_i$. This specification allows for differential variation among pension funds of intercept and trends.

As the dependent variable, I use two variables: the log of Taxable Income and the variable Formal Participation. The objective is to estimate the effect of a fee reduction on income and formal labor participation. Formal is a dummy variable that takes a value of 1 if the worker reports an income above zero.

I interpret the results as responses with respect to change in marginal tax, i.e., the change in management fee is equivalent to a change in tax. The assumption behind the interpretation is that tax-payers are atomistic; therefore, their tax payment does not affect the total tax revenue of the government. In this scenario, tax-payers are indifferent about paying to the government or to a pension fund administrator. In the model, this is captured with the assumption that tax-payers only value their disposable income and not their contribution to government revenue.

I organize the presentation of results in subsections. In the first subsection, I show the positive effect of fee reduction on taxable income. Then, I show the formal labor participation positive response for treated workers. In subsection 3.3 I estimate the dynamics of the response and use it for: (i) to test the parallel trends assumption and (ii) in a variance decomposition analysis to show that the increase in formal labor participation is the driver of the increase in taxable income. Then I move to analyze how the response varies by workers' heterogeneity. Finally, I use the fact that retired workers do not pay a management fee to do a placebo test and to estimate the effect of the fee reduction had on retirement age.

[14] Memoria Anual 2014 Planvital S.A.

3.1 Taxable Income Response

The estimation of the treatment effect on taxable income is presented in table 1. The first three specifications of the table present regressions of the form of equation (3). The last three specifications present regressions of the form in equation (4).

	(1) log(Income)	(2) log(Income)	(3) log(Income)	(4) log(Income)	(5) log(Income)	(6) log(Income)
Treated	-0.046***	-0.090***	-0.005***			
	[0.002]	[0.002]	[0.001]			
Post	0.023***	0.012***	0.010***			
	[0.001]	[0.001]	[0.001]			
Treated and Post	0.015***	0.011***	0.010***	0.012***	0.012***	0.012**
	[0.003]	[0.003]	[0.002]	[0.002]	[0.002]	[0.006]
Observations	1,758,680	1,371,661	1,371,661	1,371,661	1,371,661	1,371,661
R-squared	0.001	0.002	0.581	0.582	0.582	0.582
Switchers	Yes	No	No	No	No	No
Controls	No	No	Yes	Yes	Yes	Yes
Time FE	No	No	No	Yes	Yes	Yes
PFA Trend	No	No	No	Yes	Yes	Yes
Cluster	None	None	None	None	Time-PFA	Worker

Table 1: Taxable Income Response

Notes: *, **, *** indicates significance at 90%, 95% and 99% of confidence, respectively. Standard errors are inside []. Estimations on columns (1)-(3) follow equation (3), and estimation on columns (4)-(6) follow equation (4). The dependant variable is the log of income adjusted by CPI. The differences between the columns, apart from the specification, is described in the last 4 rows of the table. Controls: Age, Age^2, Income Before, Attachment Before and Sex.

The point estimate implies a semi-elasticity of taxable income of 0.58, which means that an increase of 1% in the marginal tax rate decreases the average taxable income in 0.58%. The elasticity of taxable income is 0.38, which is larger than estimates of other studies that use a similar empirical strategy .[15]

The estimation is robust to every specification. These specifications are: (i) not use switchers in the estimation, (ii) add sex, a polynomial of the age, pre-treatment income, and pre-treatment attachment to the formal economy as controls, (iii) allow for pension fund administrators' specific trends and intercepts, and (iv) allow for time and PFAs fixed effects.

The statistic significance of the estimation is robust to the following assumptions over the standard errors: shocks are at PFA and serially uncorrelated (cluster at PFA and time), and shocks are at worker level and serially correlated (cluster at worker level).

3.2 Participation in the Formal Economy Response

The treatment effect on the presence of workers in the formal economy is presented in table 2. In this estimation, I use a linear probability model, where the elasticity can be interpreted as an extensive response of participation in the formal economy. The first three specifications of the table present regressions of the form of equation (3). The last three specifications present regressions of the form of equation (4).

The point estimate implies that the semi-elasticity of participation in the formal sector is 0.78, which means that an increase in 1% of the marginal tax rate decreases the probability of receiving income in the formal

[15] Kleven and Schultz (2014), Saez, Slemrod and Giertz (2012)

	(1) Formal (=1)	(2) Formal(=1)	(3) Formal(=1)	(4) Formal(=1)	(5) Formal(=1)	(6) Formal(=1)
Treated	-0.049***	0.004***	-0.003**			
	[0.002]	[0.001]	[0.002]			
Post	0.010***	0.006***	-0.002***			
	[0.001]	[0.001]	[0.001]			
Treated and Post	0.017***	0.013***	0.017***	0.019***	0.019***	0.019*
	[0.004]	[0.003]	[0.003]	[0.003]	[0.003]	[0.011]
Observations	1,662,660	1,662,660	1,300,841	1,300,841	1,300,841	1,300,841
R-squared	0.000	0.550	0.566	0.567	0.567	0.567
Switchers	Yes	Yes	No	No	No	No
Controls	No	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	No	Yes	Yes	Yes
PFA Trend	No	No	No	Yes	Yes	Yes
Cluster	None	None	None	None	Time*PFA	Worker

Table 2: Formal Labor Participation

Notes: *, **, *** indicates significance at 90%, 95% and 99% of confidence, respectively. Standard errors are inside []. Estimations on columns (1)-(3) follow equation (3), and estimation on columns (4)-(6) follow equation (4). The dependant variable is the dummy variable Formal, which takes the value 1 if the worker received income in that month, and 0 otherwise. The differences between the columns, apart from the specification, is described in the last 4 rows of the table. Controls: Age, Age^2, Income Before, Attachment Before and Sex.

sector in 0.78%. The estimated elasticity is 0.58, which is larger than estimates of other studies that use similar micro estimates but is in line with macro estimations .[16] This larger extensive response is in line with the argument of the paper that the presence of informal economy gives workers an extra channel to avoid taxes through adjustments of formal labor participation.

The estimation is robust to every specification. These specifications are: (i) not use switchers in the estimation, (ii) add sex, a polynomial of the age, pre-treatment income, and pre-treatment attachment to the formal economy as controls, (iii) allow for pension fund administrators' specific trends and intercepts, and (iv) allow for time and PFAs fixed effects.

The statistic significance of the estimation is robust to the following assumptions over the standard errors: shocks are at PFA and serially uncorrelated (cluster at PFA and time), and shocks are at worker level and serially correlated (cluster at worker level).

3.3 Income response when no extensive response

The model predicts that now lower incomne jobs in the formal sector will be acepted. Therefore, the average income of the jobs should go down for affected workers. To check this in the data, I see the effect of the fee reduction on income, only considering positive income observation (shutting down the extenseive margin).

Figure xx show that the average income in the formal sector of affected workers goes down as predicted by the model.

Write this well.

[16] In Chetty et al. (2014) is discussed, and reviewed, the difference between macro and micro estimates of the extensive margin in labor supply.

VARIABLES	(1) log(Income)
Treated and Post	-0.002**
	[0.001]
Age	0.001***
	[0.000]
Age^2	-0.000***
	[0.000]
Male (=1)	0.007***
	[0.000]
Average Income Before	0.000***
	[0.000]
Average Gap Before	0.008***
	[0.000]
Observations	693,054
R-squared	0.508
Switchers	No
Time FE	Yes
PFA Trend	Yes
Cluster	Worker
Positive Income	Yes

3.4 Dynamic Response: Informality as the driver of the income response

In this subsection, I analyze the dynamics of both responses, income, and formal participation. To do so, I use the following specification,

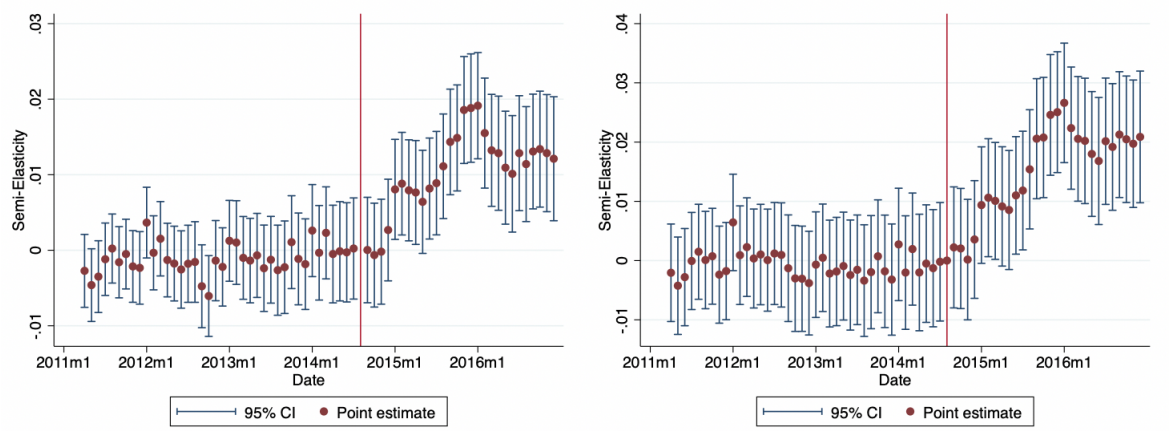
$$y_{iat} = \gamma_{0a} + \gamma_{1a}t + \lambda_t + \sum_{\tau=0}^{m} \delta_{-\tau} D_{a,t-\tau} + \sum_{\tau=1}^{q} \delta_{+\tau} D_{a,t-\tau} + X'_{it}\beta + \epsilon_{iat} \tag{5}$$

The estimated coefficients are normalized by omitting in the estimation the last month before the management fee reduction.

I use this dynamic estimation with two objectives. First, in periods before the treatment, there should be no difference between being in Planvital (the treated) and others PFAs (the control). Second, I use the dynamic of the responses to provide evidence that the taxable income response is driven by the formal participation response.

In figure 4 I show, graphically, the estimation of $(\{\delta_{-\tau}\}_{\tau=0}^{\tau=m}, \{\delta_{\tau}\}_{\tau=1}^{\tau=q})$ for taxable income and formal labor participation. The dot is the point estimation, and the lines represent the 95% confidence interval of the estimation. It is clear from the figure that before the change in fee, no coefficient is significantly different from zero. The coefficients become significant, with the right sign and magnitude, six months after the fee reduction, and stabilize after eighteen months. The timing of the response is in line with frictions that are prevalent in the Chilean labor market. In Chile, there are frictions to adjust formal labor, so the full effect will not be seen immediately. Most contracts are annual and are signed in January; therefore, most of the adjustment should be seen in that month. Overall, the patterns shown in the figure are consistent with the empirical strategy and support the assumption of parallel trends of both variables, formal labor participation, and taxable income.

The second objective of the dynamics of response estimation is to study the mechanism behind the taxable income response. In the data, I can only observe participation and total income, but not the intensive margin. To overcome this, I show the relationship between income, formal labor participation, and wage:



(a) Taxable Income Response (b) Formal Labor Participation

Figure 4: Dynamics of Response

Notes: Plotted is the estimation of $(\{\delta_{-\tau}\}_{\tau=0}^{\tau=m}, \{\delta_{\tau}\}_{\tau=1}^{\tau=q})$ from equation (5). In this estimation I use time and PFA fixed effects and PFA specific time trends. Controls: Age, Age^2, Income Before, Attachment Before and Sex. Switchers and workers affilliated to the pension system after august 2010 are not part of the estimation.

$$I_{it} = P_{it}(\tau_t) \cdot W_{it}(\tau_t)$$

where I_{it} is income of worker i in period t, P_{it} is his labor participation, W_{it} is his wage, and τ_t is the tax in period t. Differentiating this expression with respect to taxes we get:

$$\frac{\partial I_{it}}{\partial \tau_t} = \frac{\partial P_{it}}{\partial \tau_t} W_{it} + \frac{\partial W_{it}}{\partial \tau_t} P_{it}$$

For simplicity in the exposition, I assume that the wage do not respond to taxes and we get:

$$\frac{\partial I_{it}}{\partial \tau_t} = \frac{\partial P_{it}}{\partial \tau_t} W_{it} \tag{6}$$

Using (6) we get two predictions, one about the correlation between income and formal labor participation, and one about their levels. The first prediction is:

$$Corr\left(\frac{\partial I_{it}}{\partial \tau_t}, \frac{\partial P_{it}}{\partial \tau_t}\right) = 1 \tag{7}$$

This result is not surprising given the assumption that the income response is driven solely by the participation in the formal market, but makes a testable empirical prediction. Using my estimates, I test this prediction in the data. In figure 5 I show the estimated coefficients of both income and formal labor participation in the same plot. In this figure is evident the strong correlation between the formal labor participation and taxable income responses. After the fee reduction, the correlation between the point estimates is 0.987, being consistent with a model where only the extensive margin reacts to the tax reduction.

The second prediction of the relationship (6) is:

$$E\left[\frac{\partial I_{it}}{\partial \tau_t}\right] = E\left[\frac{\partial P_{it}}{\partial \tau_t} W_{it}\right] \tag{8}$$

This expression means that the average income response is a weighted average of the wage, where the weights

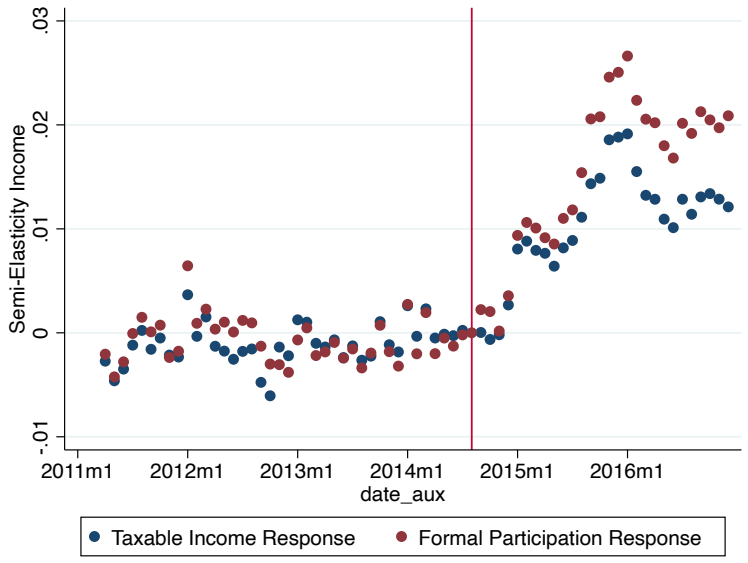


Figure 5: Comparison between Income and Formal Labor Participation response

Notes: Is the same estimation plotted in figure 4.

are the formal labor participation response. The empirical prediction of (8) is that if $E\left[\frac{\partial I_{it}}{\partial \tau_t}\right] < E\left[\frac{\partial P_{it}}{\partial \tau_t}\right]$, then low-income workers are responding more. In figure 5 is visually clear that the formal labor participation response is larger than the income response. The ratio between the estimated coefficients is 1.64, indicating that low-income workers respond more. This larger response of low-income workers is consistent with the existence of a large informal economy and is tested formally in the next section.

My findings are relevant for policy design and provide rationalization to the cross-country relation between informality and taxes. So far, the paper has two findings. First, the ETI for Chile is larger than for other developed countries. Second, this larger response is driven by the workers' participation in the formal economy. Being the informal economy one of the alternatives of being formal, the size of the informal economy shapes this response. Under the assumption that the ETI is a sufficient statistics to estimate the dead-weight loss of taxation, the presence of a big informal economy makes it more expensive to tax income. This argument is consistent with the strong negative cross-country correlation between the share of revenue that comes from income taxes and the size of the informal economy.

3.5 Heterogeneity of Response

Using the rich nature of the data data I test whether the response to taxes varies among workers. I estimate the response among two dimensions of workers' heterogeneity: income and attachment to the formal economy. The conceptual framework makes four predictions:

1. High-income workers not responding is consistent with adjustment cost.
2. The response through informality is associated with the extensive margin of formal labor participation.
3. Low-income workers respond more.
4. Workers less attached to the formal economy respond more.

To test these predictions, I do two types of estimations:

(i) I estimate a regression with interactions terms following,

$$y_{iat} = \gamma_{0a} + \gamma_{1a}t + \lambda_t + \lambda_1 POST \cdot Z_i + \lambda_2 Z_i + \delta_1 D_{at} + \delta_2 D_{at} \cdot Z_i + X'_{it}\beta + \epsilon_{iat} \tag{9}$$

where Z_i is either average income before or average presence before defined in the data section. Note that they are defined before the treatment. The estimation is a linear approximation to the effect of the worker's characteristic on the of the treatment response. From an statistic point of view, this estimation is equivalent to a triple difference-in-difference, where the third difference is with respect to worker's income or attachment to the formal economy.

(ii) I do a sub-sample analysis, where I split the sample by the median of the studied characteristic, either income or attachment and do two separate regressions. The estimations give me the average treatment effect of each sub-sample.

In all of the following estimations, switchers are not used, there are controls for workers' characteristics, pension fund administrator and time fixed effects, PFAs' specific time trends, and the standard errors are clustered at the worker level.

	(1) log(Income)	(2) log(Income)	(3) Formal(=1)	(4) Formal(=1)
Treated*(Average income before)	1.958***	1.380***	0.110***	0.135***
	[0.373]	[0.302]	[0.041]	[0.039]
Post*(Average income before)	-0.851***	-0.452***	-1.122***	-0.490***
	[0.033]	[0.029]	[0.014]	[0.012]
Treated*Post*(Average income before)	-1.011***	-0.496*	-0.359***	-0.119
	[0.357]	[0.288]	[0.099]	[0.089]
Treated and Post	0.034***	0.023*	0.024***	0.022***
	[0.012]	[0.012]	[0.006]	[0.006]
Observations	1,377,838	1,377,838	1,377,838	1,377,838
R-squared	0.348	0.348	0.409	0.408
Switchers	No	No	No	No
Controls	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
PFA Trend	Yes	Yes	Yes	Yes
Cluster	Worker	Worker	Worker	Worker
Months Before	60	24	60	24

Table 3: Income Interaction

Notes: *, **, *** indicates significance at 90%, 95% and 99% of confidence, respectively. Standar errors are inside []. The specification used is the one of equation (4). Controls: Age, Age^2, Income Before, Attachment Before and Sex. In columns (1) and (3) the average income before is from the 60 months before the fee reduction, while in columns (2) and (4) is from the 24 months before the fee reduction. Standard errors are clustered at worker level.

I start by analyzing the heterogeneity of responses with respect to income. In table 3 I show the response when the treatment effect is interacted with worker's income. The taxable income response of workers to fee reduction is decreasing in their income. For workers in the 25th percentile of income, their taxable income semi-elasticity is 1.24, for workers in the 50th percentile of income is 0.25 and for workers in the 57th percentile is 0.001. The same happens with formal labor participation; the response is decreasing in their income. For workers in the 25th percentile of income, the formal labor participation semi-elasticity is 1.41, for workers in the 50th percentile of income is 0.3 and for workers in the 57th percentile is 0.01. In table 4 I show the sub-sample

	Low Income		High Income	
	(1) log(Income)	(2) Formal(=1)	(3) log(Income)	(4) Formal(=1)
Treated and Post	0.032**	0.046**	-0.014	-0.009
	[0.015]	[0.018]	[0.012]	[0.023]
Observations	629,147	525,947	629,147	525,947
R-squared	0.211	0.167	0.300	0.261
Switchers	No	No	No	No
Controls	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
PFA Trend	Yes	Yes	Yes	Yes
Cluster	Worker	Worker	Worker	Worker
Months Before	60	60	60	60

Table 4: Sub-samples by Income

Notes: *, **, *** indicates significance at 90%, 95% and 99% of confidence, respectively. Standar errors are inside []. The specification used is the one of equation (4).Controls: Age, Age^2, Income Before, Attachment Before and Sex. Columns (1) and (2) shows the estimation for workers below the median income, while (3) and (4) do the same for workers above the median income. The dependant variable is at the top of each column. Standard errors are clustered at worker level.

analysis, where the sample is divided by the median income. In column (1) we can see that the average response of taxable income for workers below the median income is large and significant, while column (3) shows that workers above the median show no significant response to the fee reduction. In the same way, columns (2) and (4) show that workers below the median of attachment show a large formal participation response, while those above the median show no significant response.

These results are in line with the model predictions. First, the lack of response of taxable income of high-income workers is consistent with the existence of adjusting costs on tax avoidance. Second, the larger response of low-income workers is consistent with a distribution of informal opportunities concentrated around low wages jobs. By definition, jobs that are out of the formal economy can not be seen in administrative data, but we can obtain information about them through agents' behavior. The empirical fact that low-income workers exhibit a larger response provides evidence that the distribution of informal jobs have a larger density around low-wages jobs. This result is consistent with the findings of Lemieux, Fortin, and Fréchette (1994), where they use a survey to collect data about the informal economy and find that low wages are pervasive in informal jobs.

Now I analyze the heterogeneity of response with respect to the attachment to formal economy. Attachment to the formal sector is defined as the inverse of the number of switches between formality and informality before the fee change, normalized by the number of active months of the worker. In table 5 I show the response when the treatment effect is interacted with worker's attachment to the formal sector. The taxable income response of workers to fee reduction is decreasing in their attachment. For workers in the 25th percentile of attachment, their taxable income semi-elasticity is 1.42, for workers in the 50th percentile of income is 0.85 and for workers in the 60th percentile is 0.4 and for the 75th percentile is 0.04. The same happens with formal labor participation; the response is decreasing in their attachment. For workers in the 25th percentile of attachment, the formal labor participation semi-elasticity is 1.62, for workers in the 50th percentile of income is 0.65 and for workers in the 75th percentile is 0.05. In table 6, I show the sub-sample analysis, where the sample is divided by the median attachment to the formal economy. In column (1) we can see that the average response of taxable income for workers below the median of attachment is large and significant, while in column (3) workers above

	(1) log(Income)	(2) log(Income)	(3) Formal(=1)	(4) Formal(=1)
Treated*(Average Attachment before)	0.038**	0.035**	0.004	0.011
	[0.015]	[0.015]	[0.005]	[0.021]
Post*(Average Attachment before)	0.138***	0.050***	0.273***	0.071***
	[0.004]	[0.004]	[0.002]	[0.008]
Treated*Post*(Average Attachment before)	-0.006***	-0.005***	-0.053***	-0.071*
	[0.002]	[0.002]	[0.011]	[0.040]
Treated and Post	0.034**	0.036**	0.038***	0.045**
	[0.015]	[0.015]	[0.005]	[0.018]
Observations	1,381,373	1,381,373	1,381,373	1,381,373
R-squared	0.525	0.498	0.416	0.376
Switchers	No	No	No	No
Controls	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
PFA Trend	Yes	Yes	Yes	Yes
Cluster	Worker	Worker	Worker	Worker
Months Before	60	24	60	24

Table 5: Interaction with Formal Economy Attachment

Notes: *, **, *** indicates significance at 90%, 95% and 99% of confidence, respectively. Standard errors are inside []. The specification used is the one of equation (4).Controls: Age, Age^2, Income Before, Attachment Before and Sex. In columns (1) and (3) the average income before is from the 60 months before the fee reduction, while in columns (2) and (4) is from the 24 months before the fee reduction. Standard errors are clustered at worker level.

	Low Attachment		**High Attachment**	
	(1) log(Income)	(2) Formal(=1)	(3) log(Income)	(4) Formal(=1)
Treated and Post	0.023*	0.025***	-0.009	-0.007
	(0.013)	[0.005]	[0.012]	[0.015]
Observations	679,670	649,133	657,881	677,289
R-squared	0.130	0.150	0.184	0.228
Switchers	No	No	No	No
Controls	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
PFA Trend	Yes	Yes	Yes	Yes
Cluster	Worker	Worker	Worker	Worker
Months Before	60	60	60	60

Table 6: Sub-sample by Formal Economy Attachment

Notes: *, **, *** indicates significance at 90%, 95% and 99% of confidence, respectively. Standard errors are in []. The specification used is the one of equation (4). Controls: Age, Age^2, Income Before, Attachment Before and Sex. Columns (1) and (2) shows the estimation for workers below the median attachment to the formal economy, while (3) and (4) do the same for workers above the median income. The dependant variable is at the top of each column. Standard errors are clustered at worker level.

the median show no significant response to the fee reduction. In the same way, workers below the median of attachment show a significant formal participation response, while those above the median show no significant response.

These findings are consistent with the model and previous studies. The International Labor Organization

shows in their article "Women and Men in the Informal Economy: A Statistical Picture" that not every worker is prone to informal jobs, but only a sub-group of them. In this analysis, I am using the rich nature of the data to identify these workers and found that only they respond to the fee reduction. Under the model the interpretation is that a worker that constantly switches from formality to informality is better informed about jobs offers and therefore is more elastic to respond when one type of job gets relatively better than the other.

The response heterogeneity provides more evidence supporting that the taxable income response is driven by the existence of alternatives to the formal economy. Using my model to interpret the results, I can argue that the heterogeneity in the size of the elasticity is given by exposition to the informal economy. In addition to this, knowing which workers are more elastic to taxes is relevant for tax policy design. The results of this section points towards progressive income taxation in the presence of informality, which is consistent with the strong negative cross-country correlation between informality and income tax of the lowest bracket of income, and the lack of correlation between informality and the highest marginal tax rate.

3.6 Retirement and Response of Retired Workers

In Chile, a worker can continue working in the formal economy after she retires and if she does so, she is not mandated to save the 10% of her income in her retirement account, and therefore, she does not have to pay the management fee to the pension fund administrator. This feature of the Chilean pension system has two unambiguous predictions that can are tested in the data. (i) The fee reduction should make the retirement less attractive to the worker. Therefore Planvital's workers should have postponed their retirement after the fee reduction. (ii) After retirement, the fee change should not affect labor decisions. This prediction is a placebo test; workers affiliated to Planvital that do not pay the management fee should not have changed their labor behavior.

	Meet Retirement conditions Before Treatment	Meet Retirement conditions After Treatment	Difference	Difference-in-differences
Treated	755.2	751.27	-3.9	
	[1.4]	[2.5]	[2.8]	
Control	755.9	745.3	-10.7	6.8**
	[1.5]	[1.4]	[3.1]	[3.0]

Table 7: Effect of fee reduction on retirement age (Age is in Months)

Notes: *, **, *** indicates significance at 90%, 95% and 99% of confidence, respectively. Standard errors are inside []. The number of this table are the average of age in months of retirement of workers that meet the conditions to retire before, in the first column, and after, in the second column, the fee reduction. In the first line the average is calculated for the treatment group and in the second line is calculated for the control group.

There are two issues with the estimation of fee reduction effect on retirement that I have to deal with. First, retirement is an absorbent state because a worker retires only once in her life. Therefore the difference-in-difference approach does not work directly to analyze the change in retirement age. Second, not everyone can choose to retire, so not every worker is suitable for this estimation. For these two reasons, I analyze only workers that fulfilled the retirement condition before and after the fee reduction.[17] I compare the average retirement age of Planvital's workers that fulfilled the condition to retire before and after the change and then compare this change with those of the workers that were in other PFAs. Under the assumption that workers that meet the condition to retire before and after the fee reduction are comparable, this comparison of averages is the

[17] As discussed in the context section, there are two conditions that allow a worker to retire. A worker can choose to retire after turning 65 years old for males (60 for females) or before if their savings is enough to fund a pension with a replacement rate of 70% of their average income in the last 10 years.

causal effect of fee reduction on retirement age. In table 7 I show this estimation. The fee reduction significantly increased the retirement age of workers.

	(1) log(Income)	(2) Formal(=1)
Treated and Post	0.003	0.002
	[0.007]	[0.009]
Observations	329,613	329,613
R-squared	0.042	0.039
Switchers	No	No
Controls	Yes	Yes
Time FE	Yes	Yes
PFA Trend	Yes	Yes
Cluster	Worker	Worker

Table 8: Response of Retired Workers

Notes: *, **, ** indicates significance at 90%, 95% and 99% of confidence, respectively. Standard errors are inside []. The specification used is the one of equation (4). Controls: Age, Age^2, Income Before, Attachment Before and Sex. Column (1) shows the estimation for the log of income adjusted by CPI. In Column (2) the dependant variable is the dummy variable Formal. Standard errors are clustered at worker level.

In table 8 I show the treatment effect for retired workers. Column (1) is shown the effect of fee reduction on income, and on column (2) is shown the effect on formal labor participation. We can see that both estimates are not significantly different from zero. Even though there is a reduction in the number of observations, the no significance is due to the point estimation being close to zero and not due to a precision reduction.

Both results provide support to the identification strategy. Workers affiliated to Planvital's that do not pay the administration fee do not respond to the fee reduction. Also, workers that could retire and were affected by the fee reduction postponed their retirement.

4 Application to Forced Savings

In Chile, there is a discussion about how to increase the pensions of low-income workers. Given that a worker's savings determine the pension, to increase pensions is necessary to increase total savings. With this objective, the current government proposed to increase the forced saving amount from 10% to 14%.

I use my estimation to evaluate this policy. To do so, I make two strong assumptions:

(i) I assume that low-income people do not consider their savings account in their labor decision, i.e., the share they are forced to save is equivalent to a tax on working. Three arguments support this assumption. First, people are uninformed about the pension system. The disinformation is especially strong for low-income workers: only 7% for workers below the median of income know their contribution, and less than 10% are broadly informed about the value of their retirement account. Second, Chilean households present a high level of commercial debts, with high interest rates. 55% of households have commercial debt, with an average annual interest rate of 22%. This interest rate is much larger than the return on pensions savings, which is around 3%. Therefore, households face a liquidity problem, and the present value of the future pension is small compared to the present value of debts payments. Third, the justification for the existence of forced savings is the myopia of people. Under this same argument, people place a low present value on future pensions. Overall, these arguments support the assumption that workers compare their formal economy net income with that of their alternative in the informal economy.

(ii) I use my estimates as they were general equilibrium. Clearly, my results are a partial equilibrium, and the proposed policy will have general equilibrium effects. In my analysis, I just do not take this issue into account.

The low amount saved by low-income workers has two reasons. First, they have low salaries, and they save only 10% of it to fund their pension. Second, low-income workers are out of the formal economy most of the time. These types of workers make, on average, contributions in only 42% of the months of their active life. The latter is the main reason for low pensions. A worker with income equal to the minimum wage for 40 years will retire with a pension that is above the median pension of the system.

The government proposal aims to increase total savings by increasing the saved amount when a worker receives income in the formal economy. This policy will increase total savings if workers do not reduce their formal labor participation as a consequence of the policy. The formal labor participation is endogenous to the amount of income deductions. Therefore the response of formal labor participation with respect to income deduction is crucial for the consequences of the government's proposed policy. My findings differ with studies in the developed world about the taxable income response to income deductions. Modern estimates place the ETI of low-income workers below 0.15.[18]. This estimate predicts that low-income workers barely respond to changes in net-of-tax income, and therefore, under the two discussed assumptions, the government proposed

[18]Kleven and Schultz (2014), Gruber and Saez (2002); Kleven and Schultz (2014); Saez, Slemrod, and Giertz (2012); Kopczuk (2005)

policy will increase the total savings of low-income workers more than 32%. In opposition to this prediction, this paper finds a large response of low-income workers to a reduction in their effective income. Under the discussed assumptions, my estimates predict that this policy will reduce the total savings of workers below the 25th percentile of income in 22%. The mechanism behind this prediction is that workers will leave the formal market, reducing their taxable income in more than 4%, offsetting the increase in forced savings.

5 Conclusion

This paper estimates the response in formal labor participation resulting from a change in the net-of-tax rate using variation and data generated by the Chilean pensions system. This variation in net-of-tax rate affected workers from the whole income distribution who are observed across monthly panel data. This feature of the quasi-natural allow me to determine the mechanism behind the taxable income response: transition between formal and informal work. Only workers that are less attached to the formal economy and have low income respond to the tax variation.

The empirical ETI literature has found that the response to changes in taxes is driven by high income people's response, primarily through tax deductions and shifting income between different tax bases. Most of this literature relies on data from countries with no informal economy and thus no channel for low-income tax avoidance. This paper provides evidence of the importance of the informal economy as a tax avoidance channel. This channel is consistent with the pattern seen across countries, where the size of the informal economy is strongly correlated with tax systems around the world.

The evidence for response through formal labor participation provided in this paper shows that informality is important for tax response and that taxes affect the participation decision in the formal economy. The findings demonstrate that the existence of the informal economy is crucial in the analysis of taxes, but this paper provides evidence only regarding the costs of formality (in the form of taxes). Full understanding requires future research on the benefits of participating in the formal economy and how these benefits shape the relation between informality and taxes.

Appendix

A Figures

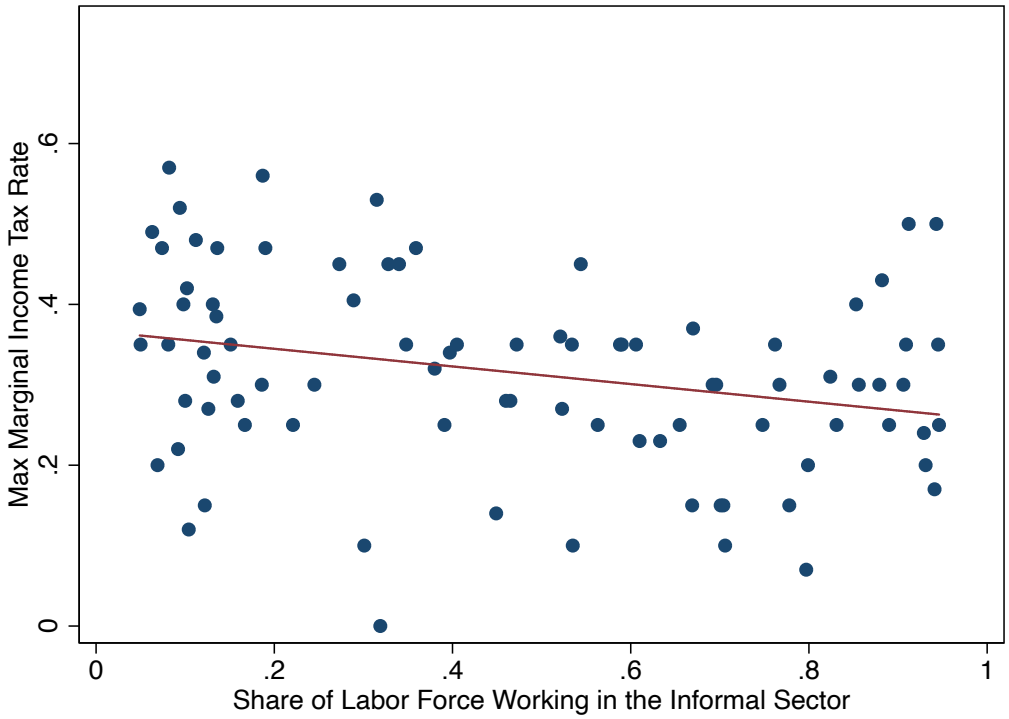


Figure A.1: Informal Economy Share and Highest Marginal Income Tax

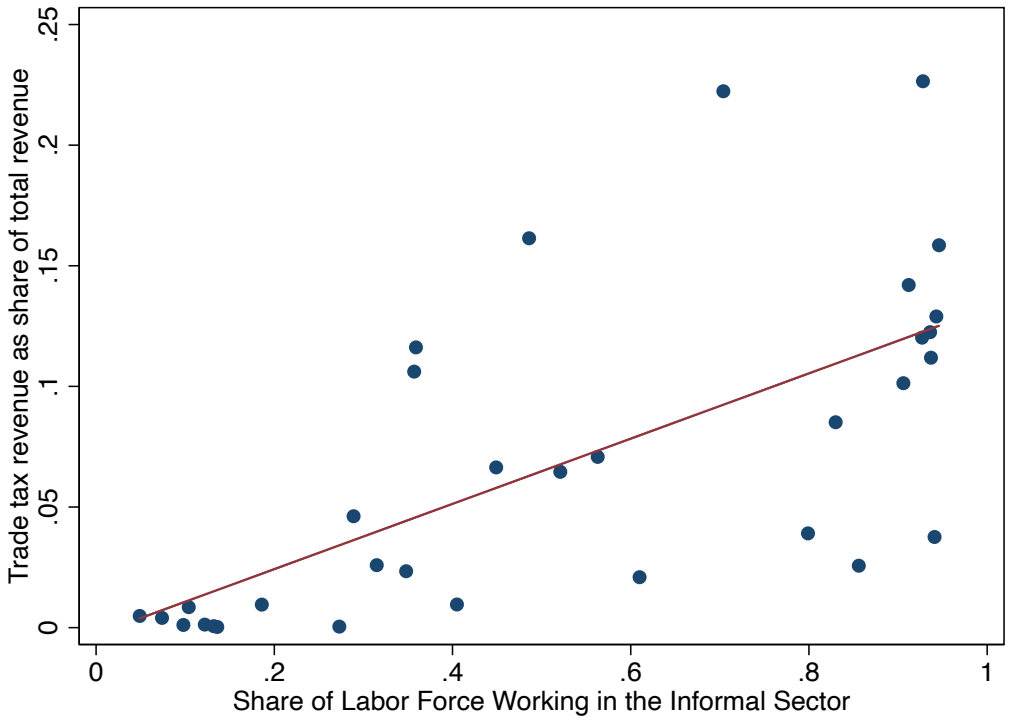


Figure A.2: Informal Economy Share and share of revenue from trade taxes

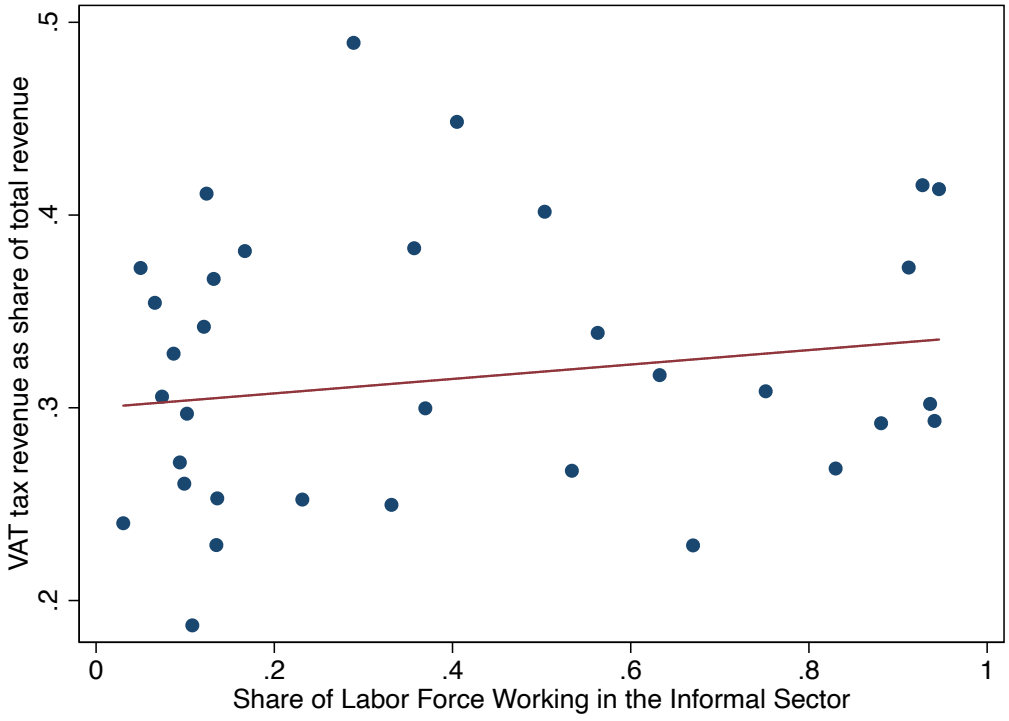


Figure A.3: Informal Economy Share and share of revenue from VAT taxes

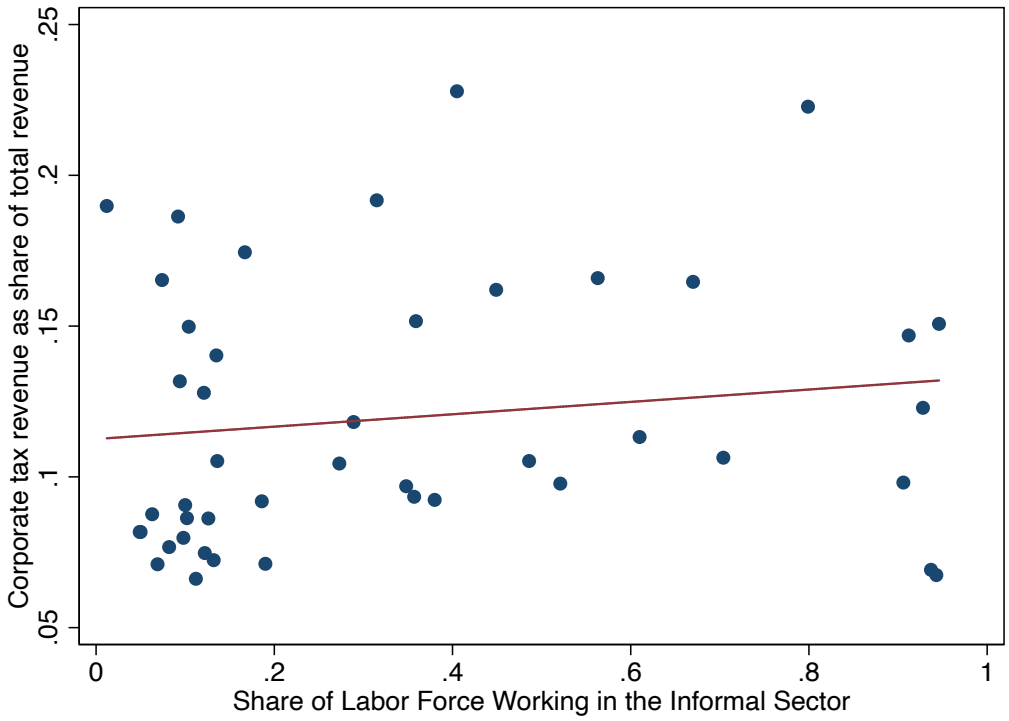


Figure A.4: Informal Economy Share and share of revenue from corporate taxes

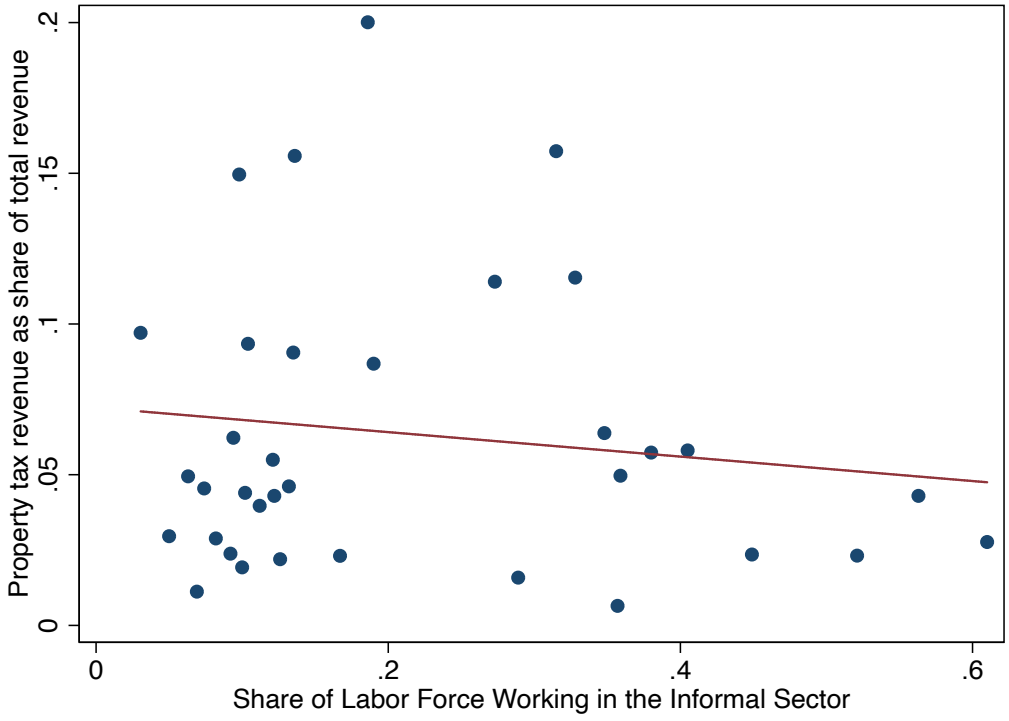


Figure A.5: Informal Economy Share and share of revenue from propoerty taxes

B Tables

C Data Manipulation

I work with a database that tracks the monthly contributions of workers to the pension system. This database follows 28.315 workers from their affiliation to the system to December 2017. This sample of workers is representative of the population according to the "Encuesta de Previsión Social 2015". The main variables that I use in my analysis are: sex, date of birth, affiliation date, contributions, income, voluntary contributions and retirement date. More information about the variables can be found in "Historia Previsional de Afiliados Activos, Pensionados y Fallecidos" from October of 2018 created by the "Superintendencia de Pensiones de Chile". [19]

The database is separated in seven modules and in for my analysis I use three of them: containing worker demographic characteristics, workers monthly mandatory contribution and workers voluntary contributions.

I split the rest of the section in two. First, I describe the manipulation that I did with each of the modules that I use, which variables I created, how I filled gaps or missing information and how I merged them. In the second subsection I describe step by step the econometric analysis over the merged data that I show in the paper.

In "1 workers demographics.do" I open the file "caracteristicas_afiliados.csv", rename the variables and save it as "workers_Demographics.dta"

In "2 workers contributions to dta.do" I open "informacion_mensual_ccico.csv". Then I rename the variables I will use. My information is monthly, so I define the date in month format. Also, when a worker has gaps in his contribution, I fill those gaps with income and contributions of $0. By construction, the months with contribution gaps have no Pension Fund Administrator (PFA). If the information of a worker Pension Fund Administrator (PFA) is missing I fill it with the last non-missing PFA of that worker. This criteria to fill gaps is in line with the fact that a workers is affiliated to a PFA, independently if he is working or not. Finally, I save the resulting database as "workers_contributions.dta".

In "3 voluntary to dta.do" I open "informacion_mensual_cav.csv". Then I rename the the variables and if a worker has two observation in a month, because he contribuite twice, I sum those contribution, leaving only one observation per worker with his total contribution. I save the resulting database as "workers_voluntary.dta".

In "4 merge workers info.dta" I do three things. First, I merged the three .dta files that I generated before and fill gaps. Second, I created variables that are useful in my posterior analysis. These variables are described in the data section. Third, there are workers that are affiliated but don't have an PFA. This are the workers that were affiliated to a PFA that got merged with other one and had not work in the formal sector since the merge, therefore the database have not updated the new name of their PFA. The observations with missing PFA since 2009 are less than 0.3% of the total observations. I fill these missing observations with the next not missing PFA of the worker. I save the resulting database as "Main.dta". This is the database that I use in my econometric analysis.

Every do-file is accessible upon request.

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