The Missing Response to Taxes: Informality

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Abstract

This paper estimates the formal earnings responses to the net-of-tax rate using a natural experiment of the Chilean pension system. The variation in the net-of-tax rate is the same for workers with different earnings, which, jointly with rich administrative data, allows me to estimate the heterogeneity of the response across workers. I find that the earnings response to the change in the net-of-tax rate is driven mainly by low-earners, and this response is through the extensive margin of formal labor participation. This extensive margin response generates a tension between coverage and funding of social security programs.

Introduction

Many social security programs– for example, unemployment and healthcare insurances, and pension schemes– rely on formal earnings to provide coverage and get funding: workers are covered if they have formal employment and have to pay deductions over formal earnings. This design can generate tension between coverage and funding of social security programs in the presence of informal employment because if informality is an extensive decision, then larger earnings deductions can reduce formal labor participation. Thus, to define the optimal earnings deduction to fund this program, it is crucial to know if workers leave the formal sector in response to earnings deductions, and if so, which type of worker does it.

In this paper, I answer these two questions. I estimate the extensive and intensive margins of formal earnings to the net-of-tax rate and study the heterogeneity of this response across

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workers. I use Chile as my laboratory because it has a significant informal labor market, rich administrative data, and a quasi-natural experiment over the net-of-tax rate. I find that the earnings response to the net-of-tax rate is driven by low-earners with low attachment to the formal sector. Moreover, this response is driven mainly by the extensive margin of formal labor participation.

The main contribution of my paper is to show that there is a large response of the extensive margin of formal labor participation to the net-of-tax rate. Moreover, this response is driven mainly by vulnerable workers. Thus, funding social security programs through earnings deductions reduces the coverage of social security programs to those who need the program the most. This finding is in clear opposition to results of the literature in the developed world, where the income response is driven mostly by high-earners and with little response of the extensive margin.[1]

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 job offers from the informal economy, which they compare to their net income in the formal sector. They can avoid taxes by participating in the formal economy by switching to the informal sector entirely, where they pay zero taxes but have to pay a fixed cost of doing so.[2] The model predicts that in the presence of a small tax change, high-earners formal earnings does not respond, while those of low-earners do it through the extensive margin.

For my estimation, I rely on administrative data from the Chilean pension system and exploit a variation in earnings deductions generated by the pension system. 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 worker 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 independently set by each PFA but is the same for all the workers affiliated with that administrator. In August 2014, one of the PFA lowered its administration fee by 1.96pp, increasing the adjusted gross income (AGI) of its workers by 2.6pp, while all the other PFA maintained their fees 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 setup allows me to employ a difference-in-difference specification tp estimate the elasticity of earnings to the net-of-tax rate, where the first difference is given by the treatment at the PFA level, and the second one is over time defined by the timing of the fee change– August

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

[2] This model of tax avoidance is in the spirit of Feldestein (1999) with adjusting costs similar to Caballero and Engel (1999).

2014.

The empirical results of my paper are the following. The difference-in-difference estimation of the elasticity of earnings to the net-of-tax rate is around 0.4. This response is driven by the extensive margin of formal earnings: workers are more likely to have formal earnings after the increase in the net-of-tax rate. Interestingly, I find no response from high earners. This finding, an extensive response driven by low earners, contrasts with the literature from the developed world, where the response is larger for high-income people and there is no response of the extensive margin. These findings are consistent with tax avoidance by income shifting, while mines are consistent with the presence of the informal market.

I also find that the elasticity varies widely across workers with different attachment levels to the formal sector. Workers who in the previous five years had more switches between having and not having formal earnings respond more to the change in the net-of-tax rate. Specifically, workers with no switches on their extensive margin of formal earnings in the 5 years prior to the fee change, exhibit no response to the fee change.

I provide several pieces of evidence that cofounders are not driving the results. First, I provide graphical evidence of parallel trends between treated and control groups. Using the pre-treatment period, I also conducted 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 the 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 its fee, and I provide qualitative and quantitative evidence that the change in fee is not related to the characteristics of the affected workers.

Fourth, the results are explained by a specific mechanism, which provides robust subsample analysis and is robust to placebo tests. In contrast, to be confounders the drivers of my findings, the confounders must have unique characteristics: they must be specific to pension fund administrators, 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 the worker's earnings 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.[3]

In the last part of my empirical analysis, I do a placebo analysis to support the identification strategy. In the Chilean pension system, when a worker retires, he can continue working but does not have to pay the administration fee to his PFA. This design implies two things: that already retired workers should not respond to the fee reduction, and the fee reduction

[3]See Kleven and Schultz (2014) for a clear discussion of these two issues.

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, slightly, their retirement.

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 my treatment is constant across workers of different incomes, which enables heterogeneity analyses. Second, the data are from a country with significant levels of informal employment. These two characteristics enable the 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 necessarily small in Pakistan."* (Kleven and Waseem (2013), pp 713). My data and variation allow 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 who 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 the 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. Finally, in section 4, 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 informal sector.

The taxable income adjusting in the formal sector has two components. First, the reduction of taxable income has a variable cost in the spirit of Feldestein (1999) model. Second, there is a fixed cost to adjust the amount of broad income that doesn't pay taxes. This adjusting cost departs from the one of Caballero and Engel (1999) in the sense that the cost of the adjustment doesn't depend on the magnitude of the adjustment.[4]

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 from the informal economy, and they take them if the opportunity has a higher net income than their job opportunity in the formal economy.

1.1 Tax avoidance in the formal sector

I consider a taxpayer with exogenous true income y every period. He can make a share $e \in [0, 1]$ of his income to avoid paying 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.

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

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:

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

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 distribu-

tion 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 concentrated 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 higher 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 in 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 workers j. The difference in 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 1 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.

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.[5] My data is a panel that follows worker's monthly income. This data is

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

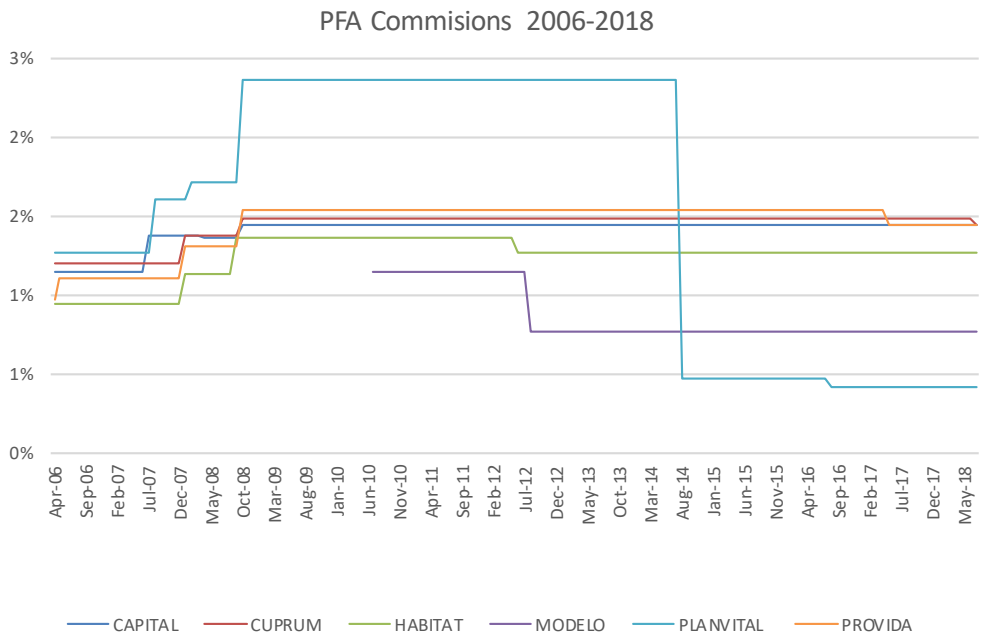


Figure 1: Fee charged by PFAs

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.

- 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

	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 2: 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 $T = 64$.

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 2 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 3. 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.[6] 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.[7]

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 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.[8] 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,

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

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

[6] Encuesta Suplementaria de Ingresos 2017, INE

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

[8] Memoria Anual 2014 Planvital S.A.

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.

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).

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%.

	(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 elasticity of taxable income is 0.38, which is larger than estimates of other studies that use a similar empirical strategy .[9]

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 extensive margin 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

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

regressions of the form of equation (3). The last three specifications present regressions of the form of equation (4).

	(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.

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 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 .[10] 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.

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

The statistical 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 Dynamic Response: Informality as the driver of the income response

In this subsection, I analyze the dynamics of both responses, formal earnings, 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.

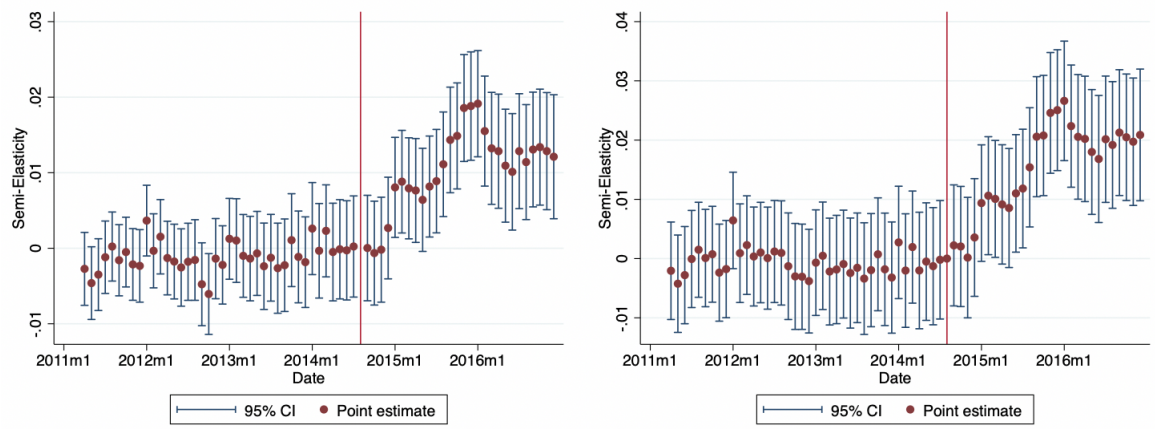
I use this dynamic estimation with two objectives. First, in periods before the treatment, there should be no difference between being in Planvital (the treated) and others PFAs (the control). Second, I use the dynamic of the responses to provide evidence that the taxable income response is driven by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

In figure 3 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:

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

where I_{it} is income of worker i in period t, P_{it} is his labor participation, W_{it} is his wage,



(a) Taxable Income Response

(b) Formal Labor Participation

Figure 3: 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.

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 4 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:

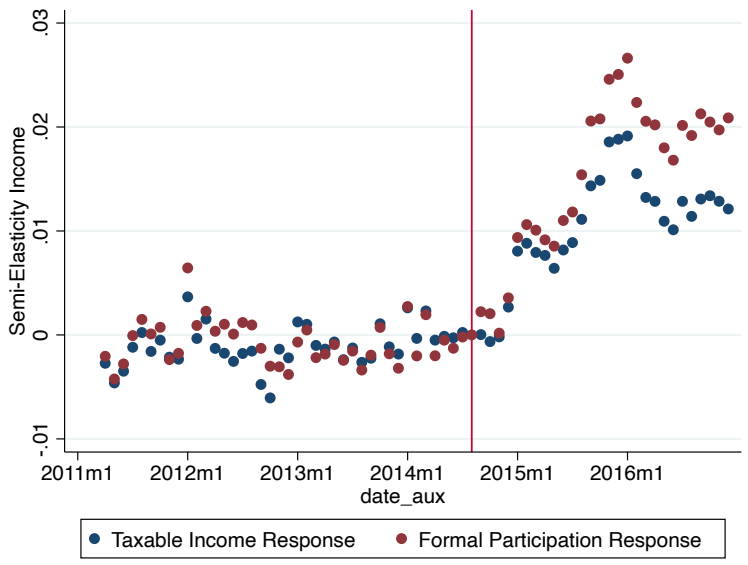


Figure 4: Comparison between Income and Formal Labor Participation response

Notes: Is the same estimation plotted in figure 3.

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

This expression means that the average income response is a weighted average of the wage, where the weights 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 4 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.

3.4 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,

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

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.

I start by analyzing the heterogeneity of responses with respect to income. Table 3 shows the response when the treatment effect is interacted with worker's earnings in the previous 5 years. The taxable income response of workers to fee reduction is decreasing on their eanings. 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. We observe the same pattern in formal labor participation. 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, it is 0.3 and for workers in the 57th percentile, it is 0.01. Table

	(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.

4 shows the sub-sample 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 in column (3), we can see 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 formal earnings response to the payroll tax 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-wage 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-earners exhibit a larger response provides evidence that the distribution of informal jobs has a larger density around low-wage jobs. This result is consistent with the findings of Lemieux, Fortin, and Fréchette (1994), who used a survey to collect data about the informal economy and found that low wages are

	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.

pervasive in informal jobs.

Now, I analyze the heterogeneity of response concerning the attachment to the 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.

Table 5 shows the response when the treatment effect interacts with the 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), we can see that workers above the median show no significant response to the

	(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.

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

	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.

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.

3.5 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.

There are two issues with the estimation of fee reduction effect on retirement that I have

	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.

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.[11] 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 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.

[11] 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.

	(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 Conclusion

This paper estimates the response of formal earnings to the net-of-tax rate using a quasi-experimental variation in the Chilean pension system. I find that the response of formal earnings to the net-of-ta rate is driven by low earners and through their extensive margin of formal labor participation.

Importantly, the extensive margin response generates a tension between funding and coverage of social security programs, pointing towards funding these programs through other channels than earnings deductions.

5 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". [12]

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

[12] Available at https://www.spensiones.cl/

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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