Labor Informality, Redistribution, and Development: A Political Economy Perspective

A Dissertation

Submitted to the National Graduate Institute for Policy Studies (GRIPS)

in Partial Fulfillment of the Requirements for the Degree of

Ph.D. in Public Economics

by

Samuel Leyton

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Abstract

This dissertation proposes a political economy explanation, validated with empirical evidence, for high labor informality in developing countries, with a focus on jobs lacking social security coverage. Politicians choose not to enforce formality for personal benefit. This framework can be employed to explain the persistently high levels of informality in developing countries, particularly in the presence of high inequality, and why rapid economic growth may not necessarily lead to reductions in informality. Additionally, the framework can contribute to the design of policies aimed at reducing informality. We develop a two-period OLG model featuring heterogeneous agents and two policies determined through probabilistic voting (Lindbeck & Weibull, 1987): the amount of a basic non-contributory pension for low-income retired workers, funded with lump-sum taxes (consider them as consumption taxes), and the probability/intensity of enforcement for contributions to a mandatory provident pension fund (compulsory savings). In Chapter 2, we present a general version of the model where income inequality within a generation acts as the primary driver of labor formality in the economy. This model helps explain the high informality rates in developing countries, particularly in the presence of substantial income inequality. Calibrating the model to Chile yields a labor formality rate of 67%, close to the observed 62%. Counterfactual analysis reveals that increased inequality results in reduced formality. Empirical analysis supports the model's predictions. We highlight the case of Chile's public-sector employees, a significant portion of whom is exempt from pension contributions. Additionally, using a panel covering 108 countries from 1998 to 2019, we highlight a robust negative correlation, both cross-country and over time, between inequality and the labor formality rate. In Chapter 3, we extend the model introduced in Chapter 2 to its dynamic version by incorporating economic growth. We do this because a mainstream branch of literature explaining the origins of informality posits that economic growth should lead to strong reductions in informality. However, recent empirical evidence shows that the connection is very weak (La Porta & Shleifer, 2014). The dynamic model helps rationalize the persistence of informality despite rapid

economic growth in many developing countries. Calibrating the model to Chile, where the share of employment contributing to the pension scheme only increased from 64% to 68%, despite a tripling of GDP per capita between 1996 and 2017, we conduct counterfactual analysis. This analysis reveals that stagnant labor formality results from the opposing effects of two transformations, applicable to many developing countries in recent decades: a rise in inter-generational inequality (e.g., due to productivity growth) and an increase in the proportion of older citizens (e.g., initially due to improved health conditions and life expectancy, followed by a decrease in natality). The predictions of the calibrated model find empirical support with panel data from 63 developing countries between 1998 and 2019, utilizing different proxies of income inequality and controlling for country fixed-effects. In Chapter 4, we briefly discuss policy insights that can be derived from the theoretical and empirical analyses presented in the previous chapters, as well as potential avenues for future research.

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TABLE OF CONTENTS

CHAPTER 1
INTRODUCTION

The present research deals with labor informality in developing countries from a political economy perspective. In these countries, the informal sector comprises between 30% to 80% of economic activity and is very persistent: for example, Chile tripled its GDP per capita in 30 years, however, informal employment remained to be stagnant at approximately 30%. We can define informality from the perspective of the worker or of firms. In this research, we address informality from the workers perspective: we consider a job to be formal if social security contributions are paid, which is a widely used definition for informality in the literature.

Abundant literature that studies the origins of informality rests upon one of two arguments: either enforcement of formal employment is exogenous, or authorities have imperfect information about workers' income and sector where they work. However, this does not consider that politicians may not be willing to enforce formality in the first place, which is the central argument of this dissertation. I formalize this argument with a political economy model in which enforcement of formality is endogenous and the authority in charge of enforcement has perfect information about workers income and sector. In the model, the degree of enforcement of formality pins down the labor formality rate in the economy.

The main contribution of this dissertation is to propose a novel political-economy framework, that we validate with empirical evidence, in which labor informality persists because politicians opt not to enforce formality for their own benefit. This framework can be used to rationalize why informality is so high in developing countries, especially when inequality is high, and why fast economic growth may not lead to reductions of informality. Finally, as briefly discussed in the fourth chapter of the dissertation, the framework can help in the design of policies to reduce informality.

In the second chapter of this dissertation, we introduce a general version of the model

in which income inequality within a generation is the key driver of labor formality in the economy. Since we assume that there is no growth of labor productivity (which, in the context of the model, can be interpreted as the absence of economic growth), and the population weights of different groups of agents remain constant, the model can be treated as a static framework in practice. In this simple environment, it is possible to find a closed-form solution for the model and understand the essential mechanism built into it. This version of the model can be used to rationalize why informality remains so high in developing countries, especially in the presence of high income inequality.

In the third chapter of this dissertation, we extend the model introduced in the second chapter to its dynamic version by including economic growth. We do this because a mainstream branch of literature explaining the origins of informality posits that economic growth should lead to strong reductions in informality. However, recent empirical evidence shows that the connection is very weak (La Porta & Shleifer, 2014). We use the dynamic version of the model to rationalize why informality is so persistent despite fast economic growth in many developing countries in the past decades.

The static and the dynamic versions of the framework in this dissertation comprise two-period OG models where agents work in the first period of their lives and are forced to retire in the second. In the static version of the model, the essential determinant of labor formality is income inequality within a generation. Therefore, we assume four groups of agents with specific motivations (namely, "ideology") alive each period. There are two groups of active workers: high and low productivity; and two groups of retired workers: they were high or low productivity the previous period, when they worked.

In the dynamic version of the model, the essential determinants of the evolution of formality across time are inter-generational income inequality (i.e., given by wage growth) and the share of retired workers in the economy (i.e., the old-age dependency ratio in the economy). Without loss of generality, for the purpose of providing a close-form solution for the dynamic version of the model as well, we refrain from including inequality between agents within a generation in Chapter 3.

Both the static and dynamic versions of the model are analytically solved in two stages. In the first stage, active workers take government policy as given and decide for themselves how much to work and save; in the second stage, the government internalizes workers'

decisions from the first stage and chooses policy in a probabilistic voting framework à la Lindbeck and Weibull (1987). Additionally, in both models, politicians have two instruments available. First, the level of a basic non-contributory pension given to low-income retired workers: this is funded with taxes on consumption (represented by lump-sum taxes). Second, the degree of enforcement —or, in other words, a "probability of enforcement"— of contributions to a provident pension fund (mandatory savings), in which pension contributions are refunded to workers upon retirement, emulating a fully-funded defined-contribution pension scheme.

In a probabilistic voting scheme politicians face uncertainty regarding workers' ideology, but they have perfect information regarding all aspects affecting worker's consumption (e.g. income and sector where they work). Politicians aim to maximize the expected share of voters in each group and, due to uncertainty about ideology, they choose the level of the instruments that maximizes the weighted welfare of voters.

In both chapters, we calibrate the model to Chile. The objective in the second chapter is to explain formality in a given moment of time: the calibrated model shows a labor formality rate of 67%, close to the 64% observed in the data (for the average 1992-2017). Counterfactual analysis with the static version of the model evidences that higher inequality leads to lower formality. The objective in the third chapter is to explain the stagnation of (in)formality rates in developing countries, despite them experiencing fast economic growth. We calibrate the model to replicate the stagnation of formality rates in Chile between 1996 and 2017 (4 percentage point increase), and show what would have happened with the formality rate in different scenarios. First, if only the old-age dependency ratio would have increased and inter-generational inequality would have remained constant at its 1996 level (instead of sharply increasing), the formality rate would have reached 100% by 2017. Instead, if only inter-generational inequality would have increased and the old-age dependency ratio would have remained fixed at its level of 1996, the formality rate in 2017 would have been 0%.

An intuitive description of the mechanism in the model in the second chapter is as follows: in the face of higher income inequality within a generation, the government maximizes voter support by increasing the basic pension to retired low-income workers. Active low-income workers expect to receive a higher basic pension in the future and have fewer

incentives to save for retirement. Since the government takes workers' preferences into account, it loosens enforcement of contributions to the provident pension fund, resulting in a lower formality rate in the economy.

In the dynamic version of the model, higher inter-generational inequality (i.e., faster wage growth) is linked to lower labor formality and a larger non-contributory basic pension funded with consumption taxes. Additionally, regarding the second determinant of labor formality in the model, a larger share of retired workers in the economy implies two things. First, politicians care more about retired workers' welfare since their population weight increases, favoring a larger basic non-contributory pension for them (for which retired workers did not pay when working), coupled with lower formality for active workers, who are discouraged from saving for retirement because they expect a higher basic pension in the future.

Second, the group that is paying positive net taxes —active workers, given that inter-generational inequality is high enough— shrinks relative to the group that is receiving a positive net transfer—namely, retired workers—tightening the government's budget constraint. The latter effect is linked in the model to a lower basic pension and higher formality in the economy. In the case of Chile, the second effect predominates, and a larger share of retired workers leads to higher formality. Stagnation of the formality rate then arises because the negative effect that inter-generational inequality has on labor formality counteracts with the positive effect coming from a larger old-age dependency ratio in the economy.

We have conducted empirical analysis that supports the predictions of the models in both its static and dynamic versions. In Chapter 2, we begin by documenting the case of public-sector employees in Chile, where the government allows a significant share of them —12% every year— not to contribute to pensions. Like in the model, the government has perfect information about its own employees' income, and arguably, the cost for the government of monitoring pension contributions among them is very low or non-existent. Then, we use a panel of 108 countries between 1998 and 2019 and show that there is a robust negative correlation —both across countries and time— between inequality and the labor formality rate, in line with the prediction of the model.

In Chapter 3, we analyze a panel of 63 countries between 1998 and 2019 and highlight,

through fixed effect regressions, that, in line with the predictions of the dynamic version of the model, the labor formality rate is positively related to the old-age dependency ratio and negatively related to the level of inter-generational income inequality. The panel of countries shrinks considerably compared with the empirical analysis in Chapter 2, because we can only use one of the proxies we have for labor formality (the formal employment rate from ILOSTAT) and also due to the availability of our variable for measuring inter-generational inequality (the GDP per-worker of the year over GDP per-worker twenty years before).

We have structured this dissertation so that each of the two chapters comprising its body represents a separate paper. Therefore, both the second chapter and the third chapter include separate abstracts, introductions, and conclusions. Finally, the fourth and final chapter of this dissertation briefly discusses policy insights that we can derive from the theoretical and empirical analyses in the previous chapters.

CHAPTER 2
LABOR INFORMALITY AND REDISTRIBUTION: A POLITICAL ECONOMY EQUILIBRIUM

2.1 Introduction

The presence of a significant informal sector is a distinctive characteristic of developing economies, comprising one third to two thirds of economic activity, 20% to 80% of employment, and a considerable share of firms (Ulyssea, 2018). In this study, our focus is on labor informality from the perspective of the worker, specifically considering a job as formal if social security contributions are being paid. Using this widely adopted definition in the literature, we also classify workers as "informal" if they do not pay social security contributions due to statutory exemptions that relieve them from the obligation to contribute. The prevalence of these exempt jobs is widespread in Chile and many other developing countries, making them vital for the analysis conducted in this paper.

The abundant literature that studies the origins of informality rests upon one of two arguments: either enforcement of formal employment is exogenous, or authorities possess imperfect information about workers' income and the sector where they work. However, this does not consider that politicians may not be willing to enforce formality in the first place, which constitutes the central argument of this paper. We rationalize this argument with a model, supported by empirical analysis, in which the enforcement of formality is endogenous, and the authority responsible for enforcement has perfect information about workers' income and sector. In the model, the degree of enforcement of labor formality pins down the formality rate. Despite advancements in understanding labor informality, most developing countries have not witnessed substantial decreases in informality rates in recent decades (Rutkowski, 2018). This suggests the existence of additional theoretical explanations for informality in the literature that have not been adequately explored or

considered.[1] This paper aims to address these gaps through a comprehensive theoretical and empirical positive analysis.

The proposed framework can rationalize why informality remains to be so high in developing countries and can help in the design of policies that encourage politicians to reduce informality. Furthermore, I firmly believe that unless we fully understand why politicians in developing countries may be unwilling to reduce labor informality, we will be unable to formalize labor markets. To reduce informality is essential because: 1) there is evidence that it negatively affects economic growth; 2) it negatively affects fiscal sustainability due to lower tax revenue; 3) persistent exposure to informal jobs negatively affects workers life-cycle wage growth.

We propose a two-period overlapping generations model where agents work in the first period of their lives and are forced to retire in the second. Four groups of agents with specific motivations (namely, "ideology") are alive each period. Two groups of active workers: high and low productivity; and two groups of retired workers: they were high or low productivity in the first period of their lives when they where working. We analytically solve the model in two stages: in the first stage, active workers take government policy as given and decide for themselves how much to work and save; in the second stage, the government internalizes workers decisions from the first stage and chooses policy in a probabilistic voting framework *à la* Lindbeck and Weibull (1987).

Politicians have two instruments in this environment. First, the level of a basic non-contributory pension given to low income retired workers that is funded with lump-sum taxes on active workers. Second, the degree of enforcement of contributions to a pension provident fund (compulsory savings), that refunds pension contributions to workers upon retirement. Very importantly, in a probabilistic voting scheme politicians perfectly observe consumption of individuals—in our case this extends to workers' income and sector—, but they face uncertainty about other characteristics orthogonal to consumption that we group under the term "ideology." Due to uncertainty about voters' ideology, politicians choose the level of the instruments that maximizes the weighted welfare of

[1] In the literature, there are three theoretical views to understand informality, as described by La Porta and Shleifer (2014). First, informality is understood as a reservoir of entrepreneurship kept at the margin by burdensome regulation (i.e., the De Soto's, 1989 "romantic view"). Second, informality is viewed as a way for workers/firms to take advantage of evading regulations (i.e., the "parasite view"). Third, informality is seen as a strategy of workers/firms that are too unskilled/unproductive to formalize (i.e., the "survival view"). It is important to mention that these views are complementary and not competing frameworks for understanding informality, as noted by Ulyssea (2018; 2020).

voters (Persson & Tabellini, 2000).

A political economy equilibrium with imperfect enforcement of labor formality arises in the context of our model because the contribution rate to social security is fixed at a level that, under perfect enforcement of labor formality, would result in a savings level for retirement higher than preferred by voters. In other words, if the government fully enforces contributions to the provident fund, it would lose the election because another politician would come offering not to fully enforce formality. This situation occurs only if the contribution rate to pensions is fixed and cannot be easily modified by politicians (who adjust enforcement of contributions instead). An intuitive justification for assuming a fixed contribution rate is that modifying its level would involve higher political costs than adjusting the degree of enforcement, such as requiring approval from Congress rather than being solely an administrative decision. Regarding the level of the contribution rate, it is well known that workers tend to save less than what is optimal for retirement, providing a theoretical justification for the existence of contributory pension schemes worldwide. This suggests that a well-calibrated pension scheme should feature a contribution rate higher than what workers prefer.

We calibrate the model to Chile by targeting one moment in the data—the labor formality rate of workers without schooling attainment—and adjusting one parameter in the model, namely, the preference for leisure relative to consumption. The values for the remaining parameters in the model are obtained from Chilean data. The calibrated model shows a labor formality rate of 67%, close to the observed 62%. Counterfactual analysis with the model reveals that higher inequality leads to lower formality and a larger basic pension. More specifically, the calibrated model makes three important predictions that we validate in the empirical analysis: 1) even when politicians can perfectly enforce labor formality—because they perfectly observe consumption and sector of workers—they decide to imperfectly enforce it; 2) politicians are considerably less inclined to enforce formality among low-productivity workers; 3) higher income inequality is related to a lower labor formality rate in the model.

An intuitive description of the mechanism built into the model is as follows: Due to uncertainty about voters' ideology, politicians choose the level of the instruments that maximizes the weighted welfare of voters. This means that, in the presence of income

inequality, the government maximizes voter support by increasing the basic pension for low-income retired workers. Naturally, low-income workers currently active in the labor market expect to receive the basic pension in the future as well, implying that they have fewer incentives to save for retirement. Given that the government takes workers' preferences into account to maximize the probability of winning the election, it loosens enforcement of contributions to the provident pension fund for active workers, particularly those of low income, resulting in a lower formality rate in the economy.

To empirically validate the first two predictions of the calibrated model —namely, that even though politicians have perfect information, they might decide not to enforce formality, and that politicians are considerably less inclined to enforce formality among low-productivity workers— in Section IV we document the case of public-sector employees in Chile. Specifically, using the largest cross-sectional survey data in Chile, the Socio-Economic Characterization Survey (CASEN), we conduct an empirical analysis revealing two key findings among the sub-sample of public-sector employees: 1) the probability that they are legally mandated to pay pension contributions is significantly below 100% (due to the presence of statutory exemptions); and 2) the estimated probability increases with higher permanent income levels. Note that the analysis only considers employees in the public sector because, as in the model, the government has perfect information about its own employees' income, and the cost of monitoring contributions to pensions is arguably very low or non-existent.

To empirically validate the model prediction that higher inequality is associated with a lower labor formality rate, in Section V, we compile data from various sources to construct a panel comprising 61 countries between 1998 and 2019.[2] We provide robust evidence of a negative correlation, both across countries and over time, between inequality and the labor formality rate. We show that the results remain robust when using different proxies for the labor formality rate and different proxies for income inequality. Additionally, the results hold for various specifications of the econometric model.

This paper makes a significant contribution to a relatively scarce literature examining the link between inequality and informality. Within this existing literature, some models

[2]The data we gather comes from ASPIRE (The Atlas of Social Protection Indicators of Resilience and Equity), WB (World Bank), ILO (International Labor Organization), and the World Income Inequality Database (WID).

suggest a causal relationship where inequality leads to informality (as seen in Chong & Gradstein, 2007; Dessy & Pallage, 2003; Mishra & Ray, 2010), while others argue for the opposite causality, where informality influences inequality (as shown by Amarante & Arim, 2022). Regardless of the direction of causality, the majority of studies exploring the connection between informality and inequality generally propose a negative relationship between the two. The uniqueness of our paper lies in its introduction of a novel political economy framework to explain this negative correlation between inequality and informality rates. Furthermore, this dataset stands as the most extensive country-panel dataset to date for the comprehensive study of this specific phenomenon, encompassing 108 countries across the years 1998 to 2019.

Additionally, this paper is related to two branches of theoretical literature in economics. First, a small macroeconomics literature has embedded probabilistic voting *à la* Lindbeck and Weibull (1984) in dynamic models to study redistributive policies (Hassler et al., 2003; Hassler et al., 2005; Tabellini, 2002; Basetto, 2008; Gonzalez-Eiras & Niepelt, 2008).[3] However, none of the aforementioned papers study labor informality, which is the focus of the present paper. Second, this paper is related to a growing literature in macroeconomics and labor economics featuring simulated models where informality arises endogenously. To the best of my knowledge, none of the models in this literature features a political economy mechanism to aggregate agents' preferences, and in general, policy is considered to be exogenous. In some of these papers, the informality status is defined as not paying payroll taxes and depends on decisions made exclusively by the firm (Fortin et al., 1997; Charlot et al., 2015; Bosch & Esteban-Pretel, 2012), or on decisions made jointly by workers and firms (Bobba et al., 2020; Narita, 2020; Ulyssea, 2010; 2018; Albrecht et al., 2009; Fugazza & Jacques, 2004). In others, the formality status is defined as being self-employed (Leal-Ordoñez, 2014; Fiess et al., 2010). In our model, the labor formality status is determined by the government, which aggregates workers' preferences through a probabilistic voting scheme. Although this literature generally features search and matching models, there are a few exceptions of papers that use general equilibrium models (Leal-Ordoñez, 2014; Fortin et al., 1997). As already mentioned, our

[3]Within this literature we can also list: Cukierman and Meltzer (1989); Persson and Svensson (1989); Alesina and Tabellini (1990); Song, Storesletten, and Zilibotti (2012); Battaglini (2014).

model features a political-economy equilibrium.

The present paper represents a clear connection between the aforementioned branches of literature by incorporating a political-economy mechanism to aggregate preferences in the context of a model for the study of labor informality. To the best of my knowledge, we are the first to address informality directly from a politico-economic perspective and, simultaneously, consider the enforcement of labor formality as an endogenous variable. Instead of concentrating on the conventional discourse of whether informality is beneficial or detrimental, our progress lies in seeking a positive response to the following question: Under what conditions is it politically feasible to diminish or eliminate informality? Another contribution of our paper to both branches of literature is that our model enables a straightforward analytical solution, enhancing the traceability of its mechanism.

The rest of the paper is organized as follows: Section II presents the model and derives an analytical solution after making some general simplifying assumptions. In Section III we calibrate the model to Chile and show that a political economy equilibrium with imperfect enforcement exists, and that the degree of enforcement is higher for high-productivity workers. We also present the result of counterfactual analysis with the model. Section IV and Section V present the empirical analyses results that support key predictions of the model. Finally, Section VI concludes the paper and outlines future research prospects.

2.2 The model

We develop an overlapping-generations model with four distinct groups of agents: active high-productivity workers, active low-productivity workers, retired high-productivity workers, and retired low-productivity workers. For simplicity, the proportion of high-productivity workers within a generation remains constant at μ. Each period, two policies are determined through probabilistic voting: the size of a non-contributory basic pension given to retired workers that is funded with lump sum taxes on active workers and the degree of enforcement of contributions to a pension provident fund, with contributions being refunded to workers upon retirement.

The purpose of the model is to highlight that despite politicians having perfect infor-

mation regarding the income and sector of the worker, they engage in imperfect enforcement of pension contributions to maximize the probability of winning elections; namely, they allow labor informality to arise because it is convenient for them. In this context, it is natural to allow both policy instruments available to politicians to be specific to the worker's productivity type.

2.2.1 Consumption and life-time utility of workers

Active workers (indexed by y) in generation t, characterized by productivity levels $j \in \{h(high); l(low)\}$, work l_t^j hours and receive an exogenous wage w_t^j. With perfect substitutability between contributory pension benefits and private savings, they lack incentives to work formally (see equation 3.3 and equation 3.15). Consequently, they choose to work informally, without making social security contributions. It is the responsibility of the government to determine the fraction p_t^j of time (i.e., the degree of enforcement) during which these workers engage in jobs where a fraction θ of their earnings goes to a provident fund that is refunded to workers upon retirement in the form of a contributory pension. Henceforth, we refer to θ as the social security contribution rate.

$$c_t^{y,j} = l_t^j w_t^j (p_t^j(1-\theta) + (1-p_t^j)) - a_{t+1}^j - \tau_t^j \tag{2.1}$$

where a_{t+1}^j is the amount of private savings and τ_t^j is a productivity-specific lump sum tax paid by workers that are active in the labor market.

Consumption of retired workers (indexed by o) in the same generation, exhibiting productivity j, is the following:

$$c_{t+1}^{o,j} = a_{t+1}^j(1+r) + A_{t+1}^j + T_{t+1}^j \tag{2.2}$$

where T_{t+1}^j represents the basic non-contributory pension that workers of productivity type j can expect to receive in $t+1$, and A_{t+1}^j is a contributory pension benefit determined by past contributions made by the worker to the provident fund.

The intertemporal link between contributions and benefits can be represented by the following function:

$$A_{t+1}^{j} = f(p_t^j, r) \quad \forall t, j \tag{2.3}$$

where r is the rate of return on the amount of resources contributed to the provident fund; function f is known by agents, and we assume that it is defined such that the contributory pension benefits workers expect to receive upon retirement, are equivalent to what they are able to get on their own by investing the same amount of money in the private asset. While this assumption is realistic, it implies that workers are indifferent between contributing to the provident fund and saving privately.

Given that workers are forced to retire from the labor market at the end of the first period of their lives, we can define consumption of retired workers of generation $t-1$, as follows:

$$c_t^{o,j} = a_t(1+r) + A_t^j + T_t^j \tag{2.4}$$

Finally, for simplicity we assume a logarithmic utility function. Thus, we can represent life-time utility of young workers of productivity type j, belonging to generation t, as follows:

$$V_t^{y,j}(c_t^{y,j}, c_{t+1}^{o,j}, l_t^j) = log(c_t^{y,j}) + \eta log(l_t^j) + \beta log(c_{t+1}^{o,j}) \tag{2.5}$$

where η is a parameter indicating the preference of a worker for leisure relative to consumption; and β is the subjective discount factor.

The utility of retired workers of productivity type j that belong to generation $t-1$, is the following:

$$V_t^{o,j}(c_t^{o,j}) = log(c_t^{o,j}) \tag{2.6}$$

2.2.2 Solving the optimization problem of the individual

Active workers of productivity type j that belong to generation t, maximize their life-time utility by choosing their inter-temporal consumption allocation and labor supply:

$$\max_{c_t^{y,j}, c_{t+1}^{o,j}, l_t^j} V_t^{y,j}(c_t^{y,j}, c_{t+1}^{o,j}, l_t^j) \tag{2.7}$$

subject to a non-negativity constraint on savings, implying that they cannot burrow money:

$$a_{t+1}^j \geq 0 \tag{2.8}$$

After solving, we get the following expressions comprising the solution to the individual decision problem, as functions of $c_t^{y,j}$:

$$c_{t+1}^{o,j} \leq \beta(1+r)c_t^{y,j} \quad \forall t, j \tag{2.9}$$

$$l_t^j = \frac{w_t^j(1-p_t^j\theta) - \eta c_t^{y,j}}{w_t^j(1-p_t^j\theta)} \quad \forall t, j \tag{2.10}$$

Then, $c_t^{y,j}$ as function of the parameters of the model and the governments' policy, is the following:

$$c_t^{y,j} = \frac{(1+r)[w_t^j(1-p_t^j\theta) - \tau_t^j] + A_{t+1}^j + T_{t+1}^j}{(1+r)(1+\eta+\beta)} \quad \forall t, j \tag{2.11}$$

Similarly, the amount of private savings as function of the parameters of the model and the policy variables, is the following:

$$a_{t+1} = \frac{\beta(1+r)[w_t^j(1-p_t^j\theta) - \tau_t^j] - (1+\eta)(A_{t+1}^j + T_{t+1}^j)}{(1+r)(1+\eta+\beta)} \quad \forall t, j \tag{2.12}$$

Retired workers solved an analogous problem the previous period (i.e., when they were active in the labor market). However, they do not face any decisions while they are retired; their consumption is residual, but can be increased by the government through the transfer T_t^j.

2.2.3 The political economy equilibrium

In the political equilibrium, policy is determined through a two-candidate probabilistic voting model *à la* Lindbeck and Weibull (1987), that boils down to the weighted maxi-

mization of life-time utility of all agents alive at period t. The characteristics of this type of model are discussed in detail by Persson and Tabellini (2000). As Hassler et al. (2005) summarize, voters choose between candidates who aim to increase their chances of being elected. They have heterogeneous preferences regarding redistribution, which in the case of the present paper is implemented by the government through the non-contributory transfer and by varying the degree of enforcement. Voters also have heterogeneous preferences regarding a non-economic policy dimension that is independent of redistribution, and candidates cannot make binding commitments about it, so we call it "ideology." Voter preferences on this dimension are influenced by an aggregate shock that candidates are unaware of when deciding on redistribution. In the equilibrium of the model, both candidates end up choosing the same redistribution platform through Nash bargaining and have an equal chance of winning. Therefore, henceforth we refer to the two candidates involved in democratic competition as "government" or "politicians."

Then, the "political" aggregation of preferences of voters in the economy can be summarized by expression W:

$$W = \mu V_t^{y,h} + (1-\mu)V_t^{y,l} + \omega(\mu V_t^{o,h} + (1-\mu)V_t^{o,l}) \tag{2.13}$$

In what follows, we center the analysis on the case when $\omega = 1$, which entails the assumption that agents across two different generations exert the same political influence.

The political parties maximize the expression W with respect to p_t^j (degree of enforcement of labor formality), determining A_{t+1}^j, and with respect to T_t^j (the non-contributory basic pension allocated to current retired workers), funded with τ_t^j (the productivity-specific lump sum tax charged on current active workers).

The government faces a budget constraint for the non-contributory basic pension scheme, that we assume has to be balanced every period t:

$$\mu\tau_t^h + (1-\mu)\tau_t^l = \mu T_t^h + (1-\mu)T_t^l \tag{2.14}$$

and intertemporal budget constraints for the provident funds, also assumed balanced, which is equivalent to assuming that the contributory pillar is fully-funded (FF) and defined-contribution (DC):

$$f(p_t^j, r) = p_t^j l_t^j w_t^j \theta(1+r) = A_{t+1}^j \quad \forall t, j \tag{2.15}$$

where l_t^h and l_t^l are given by equation 3.10 and equation 3.11.

Additionally, we have that p_t^j cannot be such that contributory benefits to be received by current active workers upon retirement, are negative:

$$A_{t+1}^j \geq 0 \quad \forall t, j \tag{2.16}$$

Generally speaking, the cost of monitoring contributions to the provident fund (i.e., we may refer to it as the real cost of enforcement) is assumed to be equal to zero, regardless of the productivity type of workers. While this assumption may not be very realistic, making it is even more demanding for our purposes; in fact, we want to show that, due to political-economy considerations, the degree of enforcement of labor formality that the government exerts may still be different from one, even in a frictionless environment.

Recall that we have that active workers are indifferent between saving for retirement through the provident fund or the private asset. Then, there are two closely related implications arising from this. First, the political equilibrium has an upper bound for the level of enforcement the government can choose, and still win the election. This upper bound is given by the amount of private savings a worker would have chosen in the absence of a contributory pension scheme; that is to say, the government cannot force workers to save more than what they want, and still be popular. Second, we will have a problem of indeterminacy of the solution of the political problem: following the preferences of voters, the government is indifferent between enforcing labor formality such that the pension asset perfectly substitutes private assets (the so called upper-bound), not enforcing labor formality at all, and any enforcement level between these two options. We solve this indeterminacy issue by making Assumption 1, specified below.

Assumption 1: The government values a larger pension fund in the economy. This leads the government to choose a positive degree of enforcement for labor formality instead of zero enforcement, thereby solving the indeterminacy issue introduced above. Three intuitive arguments support this assumption: 1) a larger fund improves borrowing conditions for the economy internationally; 2) a larger pension fund can provide liquidity during

emergencies; 3) a larger pension fund can stimulate the development of the domestic financial market by creating demand for more complex financial assets.

Finally, to obtain an analytical solution, we make the assumption of no wage growth, i.e., $w_t^j = w_{t+1}^j = w^j$ for all periods t and productivity types j. This assumption renders the political problem static. Another consequence of this assumption is that only active high-productivity workers are subjected to income tax, while only retired low-productivity workers receive a positive transfer (i.e., τ^h, $T^l > 0$ and τ^l, $T^h = 0$). Henceforth we drop the time subindex and refer to T^l as T.

By solving the political problem in equation 3.13 to equation 3.16, we reach the following solution for the size of the non-contributory pension scheme:

$$T = \mu[w^h - (1+r)w^l] \tag{2.17}$$

Then, under Assumption 1 to Assumption 3, the government chooses the level of enforcement, p^j, that perfectly substitutes private savings for each agent of productivity type j.

Assumption 2: The contribution rate to social security, θ, is constant. This implies that the government adjusts the size of the contributory scheme by modifying the degree of enforcement of labor formality. This assumption is supported by the fact that changing the contribution rate typically requires costly political approval (e.g., involving the Congress), while enforcement is an administrative decision. In Chile, the contribution rate to pensions had remained unvaried since the introduction of the fully-funded pension scheme in 1981.

Assumption 3: The contribution rate has been set (outside the model) such that, under perfect enforcement (i.e., $p^j = 100\%$), workers would save more than their voluntary choice. This assumption allows for the presence of imperfect enforcement of labor formality. While this assumption may appear strong, the literature widely acknowledges that individuals tend to save less than what is optimal for their retirement consumption. This provides a theoretical basis for the existence of mandatory contributory pension schemes in most countries. Consequently, under perfect enforcement, the effective contribution to the pension scheme is likely to be higher than what the average worker prefers.

Finally, we determine the degree of enforcement of labor formality that the government exerts for high and low productivity workers, respectively.

$$p^l = \frac{(\beta + \mu(1+\eta))(1+r)w^l - \mu(1+\eta)w^h}{[(1+\beta+\mu\eta)(1+r)w^l - \mu\eta w^h]\theta} \tag{2.18}$$

$$p^h = \frac{\beta[\mu w^h + (1-\mu)(1+r)w^l]}{[(1+\beta+(1-\mu)\eta)w^h - (1-\mu)\eta(1+r)w^l]\theta} \tag{2.19}$$

2.3 Calibration and quantitative analysis

We begin this section by briefly describing the Chilean pension scheme. Then, we take the solution of the model in equation 3.18 and equation 3.19 and derive the conditions necessary for the described political equilibrium to exhibit: 1) imperfect enforcement of labor formality for both types of young agents, and 2) a lesser degree of enforcement for low-productivity workers than for high-productivity workers. We then show that the aforementioned conditions are satisfied in the case of Chile and that the model is able to generate labor formality rates quantitatively consistent with the data. In the final part of the section we provide counterfactual analysis with the model, and measure the effect of different changes in the environment on labor formality rates in the economy.

2.3.1 Chilean context

In 1981, the Chilean government, led by the dictator Augusto Pinochet (General), implemented a fully-funded defined-contribution pension scheme to replace the old pay-as-you-go defined-benefit scheme (PAYG-DB), which had become greatly insolvent. Under the "new" FF-DC pension scheme, all wage employees must save 10% of their earnings in an individually owned investment account. Contributions are invested in the international and national stock and bond markets by privately owned Pension Fund Administrators (AFP, from the Spanish acronym), who charge a commission based on a percentage of monthly earnings of the participant worker for their investment and administrative services. Then, every worker who has contributed to the pension scheme at least once in their life is entitled to access the resources accumulated in their individual account in the

form of an annuity when they reach the legal retirement age (60 years for females and 65 years for males).

By the early 2000s, it had become apparent that pensions under the FF-DC pillar would be considerably lower than originally estimated in 1981. In 2008, a means-tested non-contributory component was added to complement the "insufficient" pensions paid under the contributory FF-DC component of the national pension scheme. This non-contributory pillar started offering two types of benefits, which were only allocated to individuals over 65 years of age belonging to the first 6 deciles of the income distribution at the time of retirement —thus making it means-tested. The first benefit was a Basic Solidarity Pension (PBS, from the Spanish acronym), given to those who had never contributed during their active life. The second benefit was a Solidarity Pension Complement (APS, from the Spanish acronym), in which the amount of benefits decreased in proportion to the amount of money contributed (i.e., saved in the individually-owned investment account). The design of the non-contributory pension scheme remained largely unchanged from its implementation in 2008 until the end of 2021 when it was modified to become a flat non-contributory transfer —now only the richest 10% is not eligible to receive this transfer.

For wage workers, contributions to the pension scheme are made in conjunction with contributions to other branches of social security. Therefore, the total contribution rate encompasses: i) the rate of contribution to pensions; ii) the commission paid to private administrators of pension savings; iii) the mandatory contribution rate for health care (where formal workers must choose between contributing to the private health insurance system or the public one); and iv) various additional insurances (such as disability insurance and unemployment insurance).

2.3.2 Calibration of the model to Chile

If the following conditions are satisfied, we will observe imperfect enforcement of labor formality (i.e., a formality rate less than 100%) for high and low productivity workers, respectively:

$$\theta > \frac{\beta[\mu w^h + (1-\mu)(1+r)w^l]}{(1+\beta+(1-\mu)\eta)w^h - (1-\mu)\eta(1+r)w^l} \tag{2.20}$$

$$\theta > \frac{(\beta+\mu(1+\eta))(1+r)w^l - \mu(1+\eta)w^h}{(1+\beta+\mu\eta)(1+r)w^l - \mu\eta w^h} \tag{2.21}$$

If the following condition is met, the degree of enforcement will be greater for high-productivity workers than for low-productivity workers:

$$\frac{w^h}{w^l} \leq \frac{(1-\mu)(1+r)(\beta+\mu\eta)}{\mu(1+(1-\mu)\eta)} \tag{2.22}$$

We show that these three conditions are satisfied in the case of Chile. This is significant because in the following section of the paper, we provide empirical evidence that the Chilean government does not fully enforce the mandate to contribute to social security, even when monitoring costs are nearly zero. Moreover, we find that the probability of enforcement is higher for workers with the highest educational level, where educational level corresponds to the productivity type of a worker in the model.

In the model, w denotes the level of productivity of the worker. We approximate the ratio w^h/w^l empirically using the ratio of hourly earnings of workers with some college attainment (representing high-productivity workers) and those without any college attainment (representing low-productivity workers). The hourly wage of low-productivity workers (w^l) corresponds to the average wage of workers without college attainment that were between 25 and 35 years of age in 1992, the first year of our sample (these will be 50 to 60 years of age the last year of our sample, 2017). We consider two different scenarios for calibrating the value of the hourly wage of high-productivity workers (i.e., w^h): the average wage of workers with college attainment that were between 25 and 55 years of age in 2017 (superior panel in Table 3.1), and the average wage of workers with college attainment that were between 25 and 35 years of age on the same year (inferior panel in Table 3.1).

In the model, θ represents the rate of contribution to social security. In Chile, the contribution rate to pensions has remained fixed at 10% of the taxable earnings of workers since 1981, and the commission paid to private administrators of pension savings has

remained close to 2% of taxable earnings for the majority of the period. The mandatory rate of contribution for health-care has also remained fixed during the period, at 7% of taxable earnings. Finally, a series of additional insurances have to be paid by every formal worker, representing less than 3% of taxable earnings. Summing up, a good approximation for what was the average level of the rate of contribution to social security during the period of analysis is in the neighborhood of 20% of taxable earnings.

The superior panel in Table 3.1 shows that the conditions in equation 3.20 to equation 3.22 are easily satisfied when w^h/w^l equals 4.3. The inferior panel of Table 3.1 shows that the conditions in equation 3.20 and equation 3.21 are not satisfied when parameter η takes values between 0 and 0.5 and w^h/w^l equals 3.3. For other values of η the conditions in equation 3.20 and equation 3.21 are always satisfied. Finally, in the scenario when the ratio of productivities equals 3.3, we have that the condition in equation 3.22 is always satisfied.

θ	0.2
r	106%
β	0.49
μ	0.26

Avr. Wage of low-productivity workers 25-55 years of age, 2017

	LHS Eq. 21	RHS Eq. 21	LHS > RHS in Eq. 21	LHS Eq. 22	RHS Eq. 22	LHS > RHS in Eq. 22	LHS Eq. 23	RHS Eq. 23	LHS > RHS in Eq. 23
η = 0	0.2	0.12	✓	0.2	0.14	✓	4.3	2.8	✓
η = 0.5		0.11	✓		0.05	✓		2.6	✓
η = 1		0.1	✓		-0.07	✓		2.5	✓
η = 1.5		0.09	✓		-0.21	✓		2.4	✓
η = 2		0.08	✓		-0.39	✓		2.4	✓
η > 2		< 0.13	✓		< –0.39	✓		< 2.2	✓

Avr. Wage of low-productivity workers 25-35 years of age, 2017

	LHS Eq. 21	RHS Eq. 21	LHS > RHS in Eq. 21	LHS Eq. 22	RHS Eq. 22	LHS > RHS in Eq. 22	LHS Eq. 23	RHS Eq. 23	LHS > RHS in Eq. 23
η = 0	0.2	0.24	×	0.2	0.22	×	3.3	2.8	✓
η = 0.5		0.21	×		0.16	×		2.6	✓
η = 1		0.19	✓		0.09	✓		2.4	✓
η = 1.5		0.18	✓		0.01	✓		2.3	✓
η = 2		0.17	✓		-0.08	✓		2.2	✓
η > 2		< 0.17	✓		< –0.08	✓		< 2.2	✓

Table 2.1: Calibration of equation 20, equation 21, and equation 22 to Chile.

We consider different values for the parameter representing the worker's preference for leisure relative to consumption (i.e. η from 0 to 2) in two different scenarios for the calibration of the ratio w^h/w^l. The proportion of high-productivity workers (i.e., μ) correspond to the average proportion of workers with some college attainment between 1992 and 2017. The hourly wage of low-productivity workers (i.e., w^l) corresponds to the average wage of workers without college attainment that were between 25 and 35 years of age in 1992, the first year of our sample (these will be 50 to 60 years of age the last year of our sample, 2017). We consider two different scenarios for calibrating the value of the hourly wage of high-productivity workers (i.e., w^h): the average wage of workers with college attainment that were between 25 and 55 years of age in 2017 (superior panel), and the average wage of workers with college attainment that were between 25 and 35 years of age on the same year (inferior panel). The superior panel shows the value considered for parameters that remain constant across scenarios (i.e., θ β and r). Data comes from the CASEN survey, rounds 1992, 1994, 1996, 1998, 2000, 2001, 2003, 2006, 2009, 2010, 2011, 2013, 2015, and 2017.

Finally, we derive the conditions for p^h and p^l to be strictly positive. We can easily see from equation 3.19 that p^h is always positive. Now, in order for p^l to be strictly positive, the following condition must be satisfied:

$$\frac{w^h}{w^l} < \frac{(1+r)(\beta+\mu(1+\eta))}{\mu(1+\eta)} \tag{2.23}$$

Given the values of the parameters we are considering for calibration in Table 3.1, to ensure that p^l is strictly positive, equation 3.23 imposes a maximum value for the parameter η, which is around 0.5 when the ratio w^h/w^l equals 4.3 and of around 1.5

when the ratio equals 3.3.

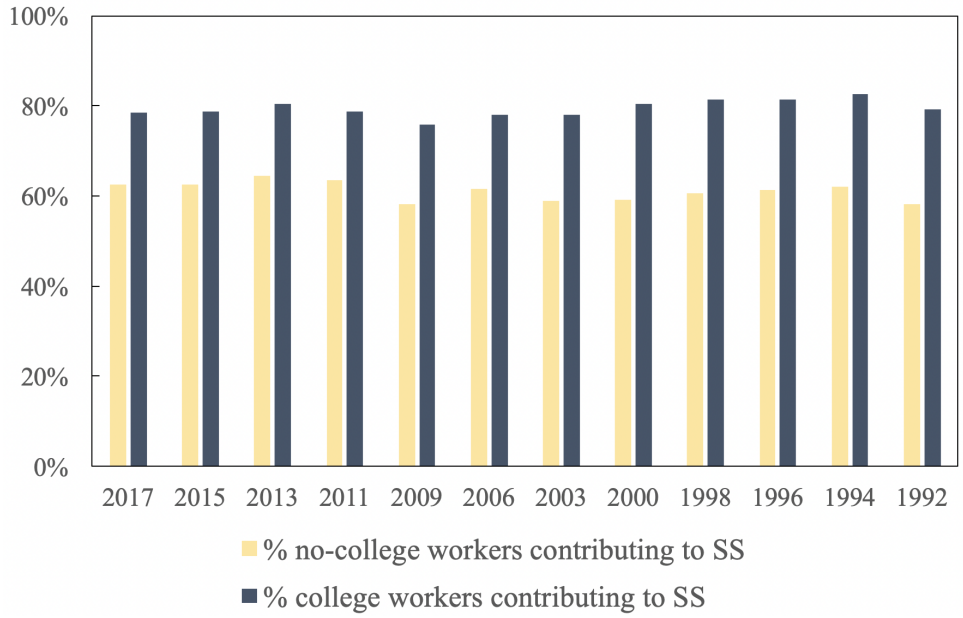

Figure 2.1: Labor formality rates of workers with some college attainment and workers without any college attainment, between the years 1992 and 2017.

Within a group, the labor formality rate is defined as the proportion of workers in that group that contribute to social security in a given year. For calculating formality rates, only workers between 25 and 65 years of age are considered each year. Data comes from the CASEN survey, rounds 1992, 1994, 1996, 1998, 2000, 2001, 2003, 2006, 2009, 2010, 2011, 2013, 2015, and 2017.

As can be seen in Figure 3.1, between 1992 and 2017 workers with some college attainment, i.e., high-productivity, had an average formality rate of 79%, while workers without college attainment, i.e., low-productivity, had a rate of 56%. In the model, labor formality rates are determined by enforcement (p^j). For calibration, we target the moment in equation 3.18 and adjust the parameter η accordingly. Parameters θ, μ, and the ratio w^h/w^l are obtained from the data. Assuming a 2.4% annual interest rate, equivalent to a 106% return over 30 years ($r = 106\%$), we determine the subjective discount factor (β) as $\beta = 1/(1+r)$. Setting $\eta = 1.16$ accurately predicts the formality rate for workers without college attainment (our target), but overestimates it for workers with some college attainment (just below 97%). Table 3.2 summarizes the values of the parameters of the model and the predicted labor formality rates in the baseline scenario.

Parameters calibrated outside the model (Chile)		Parameters calibrated inside the model	
μ	0.26	η	1.16
r	106%		
β	0.49		
w^h/w^l	3.3		
Prediction of the model		Data (average 1992-2017)	
p^h	97%	79%	
p^l	56%	56%	
Total	67%	62%	

Table 2.2: The superior panel shows the calibration of the model in the baseline scenario.

The first column in the inferior panel shows labor formality rates predicted by the model in the baseline scenario, and the second column of the inferior panel shows average labor formality rates in Chile for the period 1992-2017.

2.3.3 Quantitative analysis

Counterfactual analysis is based on comparing steady states. We define the total labor formality rate as follows:

$$P = \mu p^h + (1 - \mu)p^l \tag{2.24}$$

In this section, we briefly analyze the effect of i) a change in the contribution rate to social security (θ), ii) a change in income inequality within a generation (w^h/w^l), and iii) a change in the proportion of high-productivity workers in the economy (μ), on total labor formality as defined in equation 2.24.

When we increase θ in equation 3.19, we can see that the formality rate of high-productivity workers monotonically decreases. The same happens with the labor formality rate of low-productivity workers in equation 3.18. Therefore, when the rate of contribution for social security increases, total labor formality in equation 2.24 monotonically decreases. When the productivity ratio w^h/w^l increases (i.e., inequality increases), we observe that labor formality of both worker types sharply decreases. The explanation is that with greater income inequality within generations, the non-contributory transfer

that the government gives to low-productivity retired workers increases, and the intensity of enforcement of labor formality towards both types of agents decreases. While high-productivity active workers are discouraged from contributing to social security due to higher taxes, low-productivity active workers are discouraged because they anticipate receiving a positive transfer during retirement. Finally, when μ increases, we can see from equation 3.19 that the formality rate of high-productivity workers increases. Similarly, from equation 3.18 we can see that when μ increases, the formality rate of low-productivity workers decreases. In the case of the present simulation exercise, the negative effect over the labor formality rate of low-productivity workers dominates, and the higher proportion of high-productivity workers results in a lower total labor formality rate in the economy (i.e. higher informality rate). Table 3.3 summarizes the results of the counterfactual analyses.

	Labor formality rates		
	Low-productivity worker	High-productivity worker	Total
μ increases (from 26% to 30%)	37%	100%	56%
θ increases (from 20% to 30%)	37%	65%	44%
w^h/w^l increases (from 3.3 to 3.5)	36%	92%	51%
Baseline of the model	56%	97%	67%

Table 2.3: Summary of the results of the counterfactual analysis using the model solution.

2.3.4 The mechanism

Due to uncertainty about voters' ideology, politicians choose the level of the instruments that maximizes the weighted welfare of voters. This means that, in the presence of income inequality, the government maximizes voters support by giving a basic pension to low-income retired workers. Naturally, low-income workers currently active in the labor market expect to receive the basic pension in the future as well, implying that

they have less incentives to save for retirement. Given the structure of funding that we impose for the basic-non-contributory pension (lump-sum taxes on active workers, high-productivity workers specifically), high-income workers are also discouraged to save for retirement.[4] Given that the government takes into account workers preferences to maximize the probability of winning the election, it loosens enforcement of contributions to the mandatory pension saving account for active workers, particularly those with low-income, resulting in a lower formality rate in the economy.

To further understand the intuitive functioning of the model, let us consider two extreme cases. First, assume that there is no inequality. In this case there is no need of a basic pension, low-income workers have strong incentives to save for retirement, and the government follows workers preferences and enforces pension contributions for everyone. Second, consider that inequality is very high: the government gives a large basic pension to low-income workers, who do not need to save for retirement anymore. The government is not willing to enforce contributions to the mandatory pension saving account for low-income workers if they do not want to save for retirement, which results in a low total formality rate in the economy.

2.4 Empirical analysis with Chilean micro-data

When calibrating the solution of the model to Chile, the prediction is that, given earnings inequality in the country, 1) enforcement is imperfect for both young agent types, and 2) it is lower for low-productivity workers than for high-productivity workers. In this section, we show that these predictions of the model are supported by Chilean data. We use data from the largest cross-sectional survey in Chile, the Socio-Economic Characterization Survey (CASEN). We select survey rounds that enable us to differentiate between employees in the public and private sectors and contain information on whether contributing to social security is legally required or not for a specific job. The survey rounds we use are 1996, 2000, 2003, 2006, 2009, 2011, 2013, 2015, and 2017. We also

[4]Note that this is not necessarily true when the non-contributory basic pension is funded with a flat tax on consumption, which probably has a closer resemblance with the tax structure of Latin American countries, where VAT represent around 50% of total tax-revenue and income taxes less than 10%. In this case, that we are currently solving to be soon included in an Appendix, the essential qualitative predictions of the model are exactly the same: i) enforcement of formality is higher for high-income workers, and ii) higher income inequality leads to lower enforcement of formality for low-income workers, and a lower labor formality rate in the economy.

limit our sample to individuals between the ages of 25 and 65 who are more likely to be active in the labor market.

Figure 2.2 shows the proportion of public-sector employees who are legally mandated to contribute to social security. The Chilean government allows a portion of public-sector employees, known as *honorario* workers, to not contribute to social security, accounting for roughly 11% of total employees in the public sector. By focusing our econometric analysis on public-sector employees, we can isolate the political economy mechanism proposed in our model. This approach offers two advantages: 1) there is no cost associated with monitoring and enforcing social security contributions, and 2) enforcing such contributions does not result in increased unemployment. This scenario is similar to the one described in the model, where the monitoring cost is assumed to be zero.

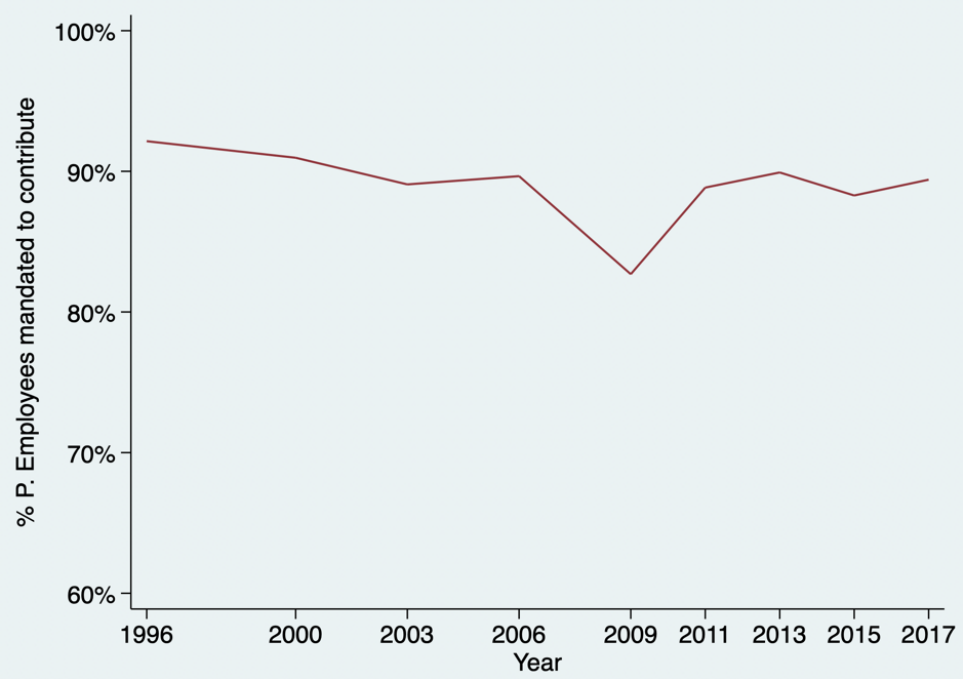

Figure 2.2: Evolution of the proportion of public-sector employees in Chile for whom contributing to social security is legally mandatory.

Data comes from the Chilean CASEN survey: rounds 1996; 2000; 2003; 2006; 2009; 2011; 2013; 2015; and 2017.

In what follows, we estimate the probability of holding a job where contributing to social security is legally mandatory, conditional on the worker being a public-sector employee. Table 3.4 shows that the estimated probability, accounting for the degree of enforcement in the model, is lower for workers with lower levels of schooling attainment, which represents their productivity level. We consider three models: a linear probability

model, a probit model, and a logit model. Specifically, we estimate the following equation for the subgroup of employees in the public sector:

$$P_{it} = \alpha + \sum_{e \in E} \phi_e D_i^e + \gamma_t + \delta_c + C_{it} + \epsilon_{it} \tag{2.25}$$

where P_{it} is a dichotomous variable taking the value of one when the public-sector employee is legally mandated to contribute to social security; D_i^e is a dummy that takes value of one if worker i belongs to schooling group e ranging from 1 to 3 (1 being some elementary education; 2 some secondary education; and 3 some college attainment); γ_t is a vector containing year fixed effects; δ_c is a vector containing cohort effects; C_{it} is a vector containing suitable controls that may be related with P_{it}.[5] Table 2.4 indicates that the estimated probabilities are higher for public-sector employees with higher levels of schooling when using a linear probability model (column 1), a probit model (column 2), and a logit model (column 3).

[5] We include: (i) a dummy indicating if the worker the head of the household, (ii) a dummy for males, (iii) indicator of affiliation with a political party, (iv) indicator of membership to a union or equivalent organization, (v) categorical variables for contemporary decile of earnings.

	(1) Linear prob. b/se	(2) Probit b/se	(3) Logit b/se
Secondary Ed.	0.0584***	0.2819***	0.5213***
	(0.00)	(0.02)	(0.04)
Some college	0.0665***	0.3358***	0.6150***
	(0.00)	(0.03)	(0.05)
Constant	0.6149***	-0.0078	-0.1845
	(0.01)	(0.06)	(0.10)
Cohort FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Age FE	Yes	Yes	Yes
Region FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Obs	63250	63250	63250

t statistics in parentheses

* 0.05, ** 0.01, *** 0.001

Table 2.4: Linear/Probit/Logit regressions for the probability of having a job where contributing to social security is legally mandatory, conditional on being an employee in the public sector.

Data comes from CASEN survey rounds 2003, 2006, 2009, 2011, 2013, 2015, and 2017.

2.5 Empirical analysis with cross-country data

We present robust evidence of a negative correlation, both across countries and over time, between various measures of income inequality and two distinct indicators of the labor formality rate. To conduct our analysis, we collect macro-data from 61 countries spanning the years 1998 to 2019, forming an unbalanced panel dataset.[6] Our methodology involves combining data from multiple sources to derive measures for our dependent variable (labor

[6]Refer to the Appendix for a comprehensive list of countries and the corresponding periods for which we have data.

formality) and our independent variable of interest (income inequality).

To obtain various measures of labor formality, we utilize the Atlas of Social Protection Indicators of Resilience and Equity (ASPIRE) database, an initiative by the World Bank (WB), and the International Labor Organization database (ILOSTAT). From the former database, we use an indicator known as Coverage of Contributory Pension Schemes (hereafter CCP indicator), serving as the first measure of labor formality. Simultaneously, from the latter database, we retrieve an indicator identified as the Rate of Formal Employment (hereafter FR), which we adopt as our preferred measure of labor formality.

For various measures of income inequality, we draw on the WB database, accessing the Gini index, as well as the share of income held by the highest and lowest 20% of the income distribution. It is noteworthy that the income inequality measures reported by the WB pertain to income after taxes; however, the quantitative analysis performed with our calibrated model focuses on before-tax income inequality. Keeping this in mind, we obtain measures of before-tax income inequality from the World Inequality Database (WID).

In the first part of the analysis, we define the variables used for the cross-country analysis and highlight that, when employing raw data, a significant negative correlation exists between different measures of labor formality and income inequality. In the second part of the section, we add more structure to the analysis, include several controls, and also account for country fixed-effects.

2.5.1 Correlations with raw data

A precise definition of the variables we are utilizing can be found on the websites of the World Bank, the International Labor Organization, and the World Inequality Database.[7] Let us begin by defining the different measures employed for our dependent variable, namely, labor formality.

Firstly, the CCP indicator is defined as the percentage of the population participating in the contributory pension scheme of a country, encompassing both direct and indirect beneficiaries. According to the detailed definition provided by ASPIRE, the indicator is

[7] ILOSTAT Database Description: https://ilostat.ilo.org/resources/concepts-and-definitions/description-labour-force-statistics/

computed as the number of individuals living in a household where at least one member receives contributory pension benefits divided by the population.

Secondly, the FR indicator from the ILO database is defined as the proportion of workers who are employed and not in informal employment. Informal employment includes persons who are: i) employees (or persons not classified by employment status) not protected by national labor legislation in that job;[8] ii) entrepreneurs in a unit of production considered informal, where entrepreneurs refer to employers, members of producers' cooperatives, and own account workers (only if what is produced is for sale); iii) and contributing family workers.

Concerning labor (in)formality, our preferred measure is provided by ILOSTAT because it closely aligns with the model's definition of formality. In the model, labor formality corresponds to the status of contributing to pensions (social security). In contrast, the measure obtained from the ASPIRE database, the CCP index, is defined based on whether a person is directly or indirectly receiving contributory pension benefits. This means that the indicator is primarily associated with individuals who are no longer working, making it more relevant to past labor formality rather than formality in the present. Additionally, it remains unclear how the inclusion of indirect beneficiaries within the household may impact the results.

Recall that one of the key predictions of the model is that higher income inequality leads to lower labor formality rates. The raw data in Figure 2.3 indicates that this prediction of our model appears to hold true when considering the two aforementioned measures of labor formality that we are accessing. The model's prediction also seems to be consistent with the raw data when considering two different measures of income inequality before taxes and transfers, available from the WB database: the Gini index and the share of income held by the highest 20% over the share of income held by the lowest 20% (that we label Income Share Ratio, henceforth IR).

The latter measure of income inequality is preferred to the Gini index because it better aligns with the model's prediction; specifically, that income inequality is negatively related to labor formality, where inequality is represented by the ratio of productivities between

[8]This includes employees not affiliated with a social security scheme related to the job (or as a proxy pension funds), and employees not entitled to certain employment benefits, such as paid annual vacation and paid sick leave;

the two tails of the income distribution, keeping the weights of the tails unchanged (i.e., maintaining the share of high and low productivity workers unvaried). Importantly, we observe that the distribution of IR shows some extreme values to the right side of the distribution, so we exclude the top 1% to avoid the serious distortion that outliers may introduce in the context of a linear regression model (note that this excludes only 2 observations from our sample of 378).

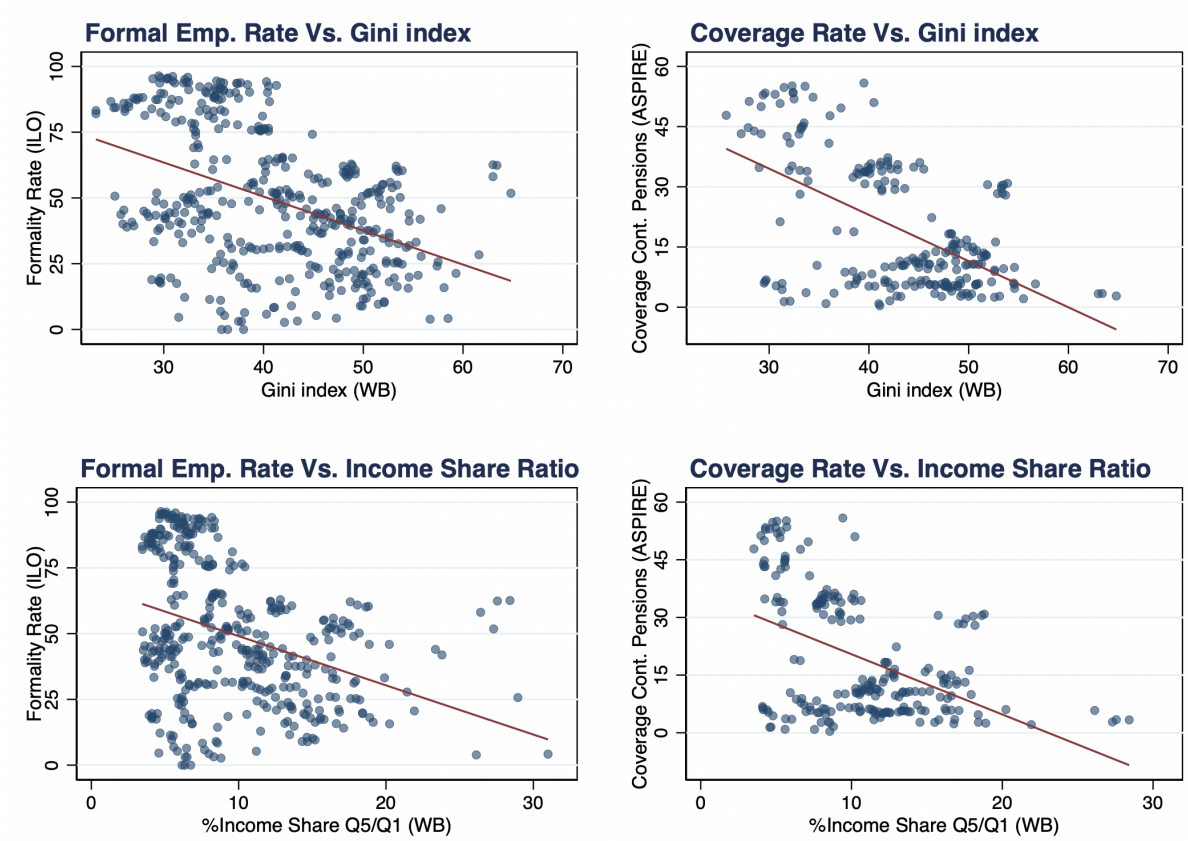

Figure 2.3: Correlation between income inequality (after taxes) and two different measures of labor formality.

The superior panels of the figure show the correlation between labor formality and the Gini index, with the latter obtained from the WB database. In the subpanel to the left, labor formality is measured with the formal employment rate (FR) obtained from ILOSTAT, and in the subpanel to the right, labor formality is measured with the CCP index obtained from the ASPIRE database. The inferior panels of the figure show the correlation between labor formality and the Income Share Ratio (IR), with the latter obtained from the WB database. Again, in the subpanel to the left, labor formality is measured with FR, and in the subpanel to the right, labor formality is measured with the CCP index. Data is for 108 countries between 1998 and 2019.

Furthermore, the raw data in Figure 2.4 indicates that the prediction of our model, suggesting that higher income inequality leads to lower labor formality rates, appears to hold true when considering our preferred measure of labor formality (FR from ILOSTAT) and an additional measure of inequality, the Palma Ratio. The Palma Ratio is measured

both before taxes (left panel of the figure) and after taxes (right panel of the figure) and is defined as the share of income held by the top 10% of the income distribution divided by the share of income held by the bottom 40% of the distribution. This measure is available from WID. Henceforth, we refer to the Palma Ratio before taxes as PRb and to the Palma Ratio after taxes as PRa.

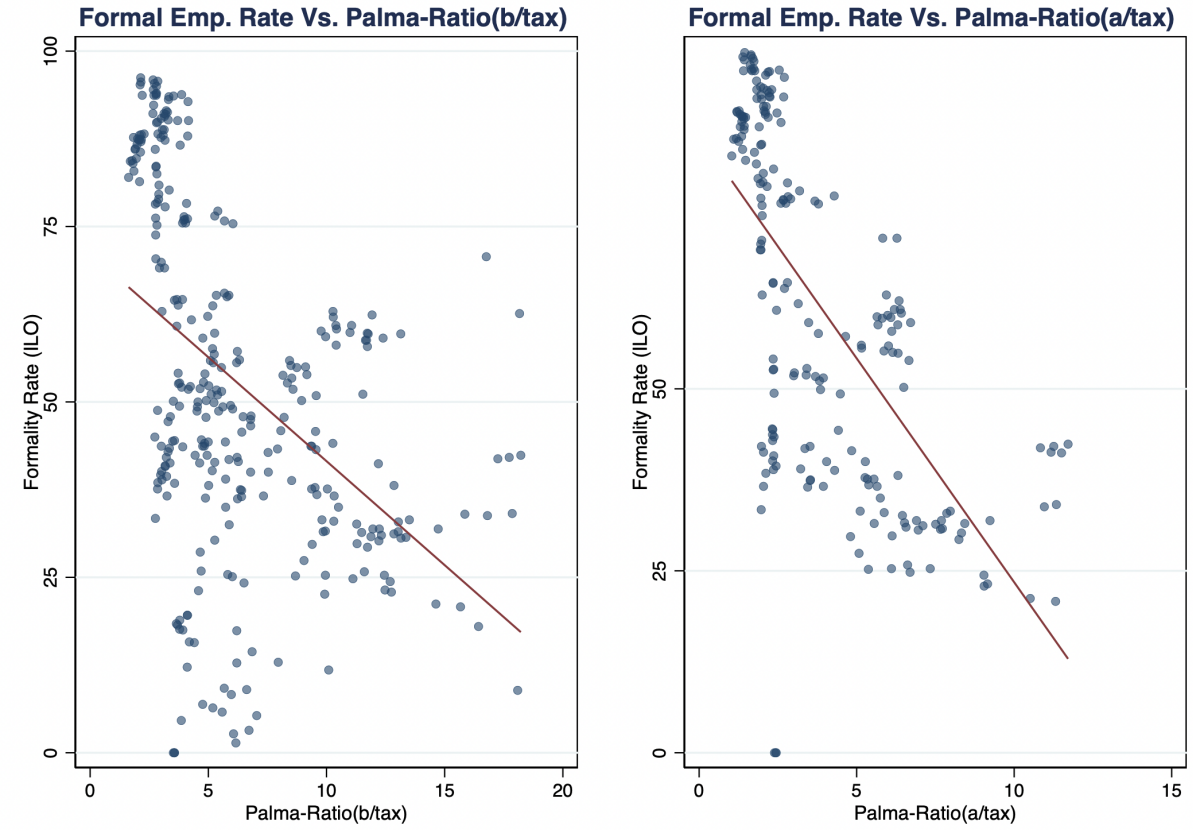

Figure 2.4: Correlation between income inequality before taxes and after taxes and the the rate of formal employment.

The panel to the right of the figure shows the correlation between the formal employment rate (FR) obtained from ILOSTAT and the Palma-Ratio measured before tax (PRb), obtained from WID. The panel to the left of the figure shows the correlation between FR and the Palma-Ratio measured after tax (PRa), also obtained from WID.

2.5.2 Cross-country regressions

In what follows, we highlight that the negative correlation between the labor formality rate and different measures of income inequality, as revealed in Figure 2.3 and Figure 2.4, persists even with the inclusion of different controls. Furthermore, our aim is to establish that this result not only holds across countries but also over time (i.e., when accounting for country fixed-effects).

The econometric model presented below is structured to assess whether the prediction of our theoretical model, that inequality negatively influences labor formality (as observed in the counterfactual analysis in Section III), is supported by cross-country evidence. More specifically, we propose the following model to estimate the impact of income inequality ($Ineq_{ct}$) on the labor formality rate (LF_{ct}), where Subindex c denotes the country, and subindex t denotes the year:

$$LF_{ct} = \alpha + \beta Ineq_{ct} + \kappa_c + \phi_t + I_{ct} + \pi_{ct} \tag{2.26}$$

where κ_c is a vector of country fixed-effects; ϕ_{ct} is economic growth in country c at year t; and I_{ct} is a categorical variable indicating the level of income of the country as defined by WB criterion (low; medium-low; medium-high; high); and π_{ct} is the error term.

In Table 2.5 and Table 2.6, labor formality is measured with FR (accessed from ILO-STAT), which, as mentioned above, is the preferred measure for our dependent variable.[9] In column (1) and column (2) of Table 2.5 and 3.6, regressions are estimated considering all the countries in our sample, while in column (3) and column (4), only Latin American countries (LA) are considered. In both tables, column (1) and column (3) show the estimated coefficients for the corresponding measure of income inequality when running an OLS regression, and column (2) and column (4) show the estimated coefficient when controlling country fixed effects. In every specification of the model, we control for the level of income of the country and economic growth of the country in a given year to capture the effect that the economic cycle may have on the labor formality rate.

Considering only Latin American countries has two advantages vis-à-vis the model's prediction. First, as seen from the derivation of a different model in the Appendix, the result that higher income inequality generates lower labor formality depend on some aspects of policy design that are not easy to identify in the data. Specifically, we show that when we do not allow for the existence of a basic pension given to low-income workers and instead allow for redistribution to be made by politicians within the contributory pension scheme, as is the case in many developed countries with traditional pay-as-you-go pension schemes featuring defined benefits, higher inequality may lead to higher formality. In this

[9] In the Appendix, we repeat the empirical exercises in the present section using the CCP index as the measure of labor formality and find somewhat weaker results: the estimated coefficient is still negative after controlling for country fixed-effects, but it loses significance.

context, by limiting the analysis to countries in LA, we make sure that this is not the case because contributory pension schemes in the overwhelming majority are defined-contribution pension schemes.

Second, recall that the political economy mechanism is based on a probabilistic voting scheme, which means that it should be representative of a democratic regime. Even though the probabilistic voting scheme boils down to the weighted welfare maximization of agents alive, and this may still be the same objective function governing policy decisions of an autocratic regime, this discussion is beyond the focus of the paper. During the period of analysis (1998 to 2019), every country in the Latin American sample had a democratic regime in place.

	(1)	(2)	(3)	(4)
	OLS(all)	FE(all)	OLS(LA)	FE(LA)
	b/se	b/se	b/se	b/se
Gini (a/tax)	-0.5946***	-0.7100***	-0.3246	-1.0300***
	(0.10)	(0.14)	(0.21)	(0.15)
Constant	45.7412***	80.5633***	38.1697***	88.5789***
	(9.31)	(5.55)	(10.29)	(7.15)
Country FE	No	Yes	No	Yes
Income FE	Yes	Yes	Yes	Yes
Ec. Growth	Yes	Yes	Yes	Yes
R-sqr	0.67	0.10	0.52	0.11
Obs	373	373	178	178

t statistics in parentheses

* 0.1, ** 0.05, *** 0.01

Table 2.5: Cross-country regressions with Gini index (a/tax) as the independent variable of interest.

The dependent variable is the total formality rate, as reported in the ILO database. The independent variable of interest is the Gini index, which is obtained from the WB database. In all specifications we control for the GDP growth obtained from the WB database. In column (1) and column (3) regressions are estimated considering all the countries in our sample, while in column (2) and column (4), only Latin American countries are considered.

The results in Table 2.5 show that the coefficient for the Gini index after taxes is negative and significant when running OLS and controlling for the country income fixed-

effect and the country's economic growth for that year. When controlling for country fixed-effects (Columns 2 and 4), the estimated coefficients for the Gini index are even more negative than in OLS and still statistically significant.

	(1) OLS(all) b/se	(2) FE(all) b/se	(3) OLS(LA) b/se	(4) FE(LA) b/se
Gini (b/tax)	-0.6903***	-0.4710**	-0.4024**	-1.2691***
	(0.11)	(0.21)	(0.19)	(0.18)
Constant	69.2847***	82.6223***	58.3236***	127.6373***
	(16.82)	(12.12)	(12.93)	(11.68)
Country FE	No	Yes	No	Yes
Income FE	Yes	Yes	Yes	Yes
Ec. Growth	Yes	Yes	Yes	Yes
R-sqr	0.65	0.04	0.49	0.44
Obs	286	286	111	111

t statistics in parentheses

* 0.1, ** 0.05, *** 0.01

Table 2.6: Cross-country regressions with Gini index (b/tax) as the independent variable of interest.

The dependent variable is the total formality rate, as reported in the ILO database. The independent variable of interest is the Gini index before tax, which is obtained from the World Inequality Database. In all specifications we control for the GDP growth obtained from the WB database. In column (1) and column (3) regressions are estimated considering all the countries in our sample, while in column (2) and column (4), only Latin American countries are considered.

Similarly to the results shown in Table 2.5, the coefficient for the Gini index before taxes reported in Table 2.6 is negative and significant when running OLS and controlling for the country income fixed-effect and the country's economic growth for that year. The result still holds when controlling for country fixed-effects (Columns 2 and 4), and independently of considering the whole sample of countries or only countries in Latin America (Column 4).

	(1) OLS(all) b/se	(2) FE(all) b/se	(3) OLS(LA) b/se	(4) FE(LA) b/se
%Inc. Q5/Q1 (a/tax)	-0.8184***	-1.3701***	-0.3388	-1.4739***
	(0.17)	(0.19)	(0.27)	(0.18)
Constant	34.7473***	64.8699***	26.9603***	58.4544***
	(2.79)	(1.82)	(4.43)	(2.28)
Country FE	No	Yes	No	Yes
Income FE	Yes	Yes	Yes	Yes
Ec. Growth	Yes	Yes	Yes	Yes
R-sqr	0.66	0.02	0.51	0.14
Obs	365	365	175	175

t statistics in parentheses

* 0.1, ** 0.05, *** 0.01

Table 2.7: Cross-country regressions with %Inc. Q5/Q1 (a/tax) as the independent variable of interest.

The dependent variable is the total formality rate, as reported in the ILO database. The independent variable of interest is the share of income held by the richest 20% over the share of income held by the poorest 20% (i.e. %Inc. Q5/Q1), which is obtained from the WB database. In all specifications we control for the GDP growth obtained from the WB database. In column (1) and column (3) regressions are estimated considering all the countries in our sample, while in column (2) and column (4), only Latin American countries are considered.

Table 2.7 shows that when inequality is measured by the Income Share Ratio (IR), the result is remarkably similar to the case where inequality is measured with both versions of the Gini index. Specifically, the coefficient for the ratio is negative and significant when running OLS and controlling for the country income fixed-effect and the country's economic growth for that year. When controlling for country fixed-effects (Columns 2 and 4), the estimated coefficients for IR index are even more negative than in OLS and still statistically significant. Moreover, when considering only LA countries the coefficient for IR is even more negative than in OLS, and still statistically significant.

	(1) OLS(all) b/se	(2) FE(all) b/se	(3) OLS(LA) b/se	(4) FE(LA) b/se
Palma-Ratio(a/tax)	-2.7405***	-3.1494***	-1.3578***	-3.0901***
	(0.38)	(0.63)	(0.39)	(0.38)
Constant	91.8179***	73.6584***	41.8266***	64.9295***
	(1.91)	(2.71)	(5.74)	(2.39)
Country FE	No	Yes	No	Yes
Income FE	Yes	Yes	Yes	Yes
Ec.Growth	Yes	Yes	Yes	Yes
R-sqr	0.67	0.14	0.53	0.51
Obs	204	204	105	105

t statistics in parentheses

* 0.1, ** 0.05, *** 0.01

Table 2.8: Cross-country regressions with Palma-Ratio (a/tax) as the independent variable of interest.

The dependent variable is the total formality rate, as reported in the ILO database. The independent variable of interest is the Palma-Ratio after tax, which is obtained from the World Inequality database. In all specifications we control for the GDP growth obtained from the WB database. In column (1) and column (3) regressions are estimated considering all the countries in our sample, while in column (2) and column (4), only Latin American countries are considered.

Finally, in Table 2.8 and Table 2.9, we show that when inequality is measured by the Palma Ratio after taxes and before taxes, respectively, the estimated coefficients closely resemble those in all the previous cases. Importantly, the coefficient for PRb in Table 2.9, our preferred measure for income inequality, is negative and significant when running OLS and controlling for the country income fixed-effect and the country's economic growth for that year. When controlling for country fixed-effects (Columns 2 and 4), our preferred specification of the model, the estimated coefficients remain negative and statistically significant. Moreover, when considering only LA countries, the coefficient for PRb is even more negative than when considering the whole sample of countries.

	(1)	(2)	(3)	(4)
	OLS(all)	FE(all)	OLS(LA)	FE(LA)
	b/se	b/se	b/se	b/se
Palma-Ratio(b/tax)	-1.2750***	-0.7423**	-0.6531***	-1.3591***
	(0.20)	(0.33)	(0.23)	(0.26)
Constant	37.9521**	60.5590***	40.9535***	59.9378***
	(15.59)	(2.21)	(5.85)	(2.70)
Country FE	No	Yes	No	Yes
Income FE	Yes	Yes	Yes	Yes
Ec.Growth	Yes	Yes	Yes	Yes
R-sqr	0.66	0.04	0.50	0.35
Obs	286	286	111	111

t statistics in parentheses

* 0.1, ** 0.05, *** 0.01

Table 2.9: Cross-country regressions with Palma-Ratio (b/tax) as the independent variable of interest.

The dependent variable is the total formality rate, as reported in the ILO database. The independent variable of interest is the Palma-Ratio before tax, which is obtained from the World Inequality database. In all specifications we control for the GDP growth obtained from the WB database. In column (1) and column (3) regressions are estimated considering all the countries in our sample, while in column (2) and column (4), only Latin American countries are considered.

We believe that the results reported in this section represent evidence of a strong negative link between inequality and labor formality in the economy, as shown when running counterfactual analysis with the model in Section III. This negative correlation remains when considering two different measures for the labor formality rate, the CCP indicator and the FR, and five different measures for income inequality, the Gini index (both before and after taxes), the IR, PRa, and PRb. Furthermore, the negative correlation is robust to the inclusion of several controls, including country fixed effects. At this point, it is important to mention that we do not consider the above results indicative of a causal relation between inequality and formality, as our model suggests; making this assertion would require further analysis beyond the scope of the present paper.

2.6 Final remarks

In this paper, we examine the connection between redistribution and labor informality from a politico-economic perspective by analyzing a model that features probabilistic voting and endogenous enforcement of labor formality. The presence of a non-contributory basic pension given to low-income retired workers implies that young agents are discouraged from contributing to a provident fund (representing the contributory pension scheme, or social security). Politicians align with the preferences of voters to maximize their chances of winning the election, leading to a steady state with a lower degree of enforcement of labor formality and a reduced labor formality rate.

To offer empirical support for the mechanism outlined in the model, we employ microdata from Chile to estimate the probability of holding a job where contributing to social security is legally mandatory. This estimation is conditional on the worker being a public-sector employee, and it takes into account their level of education as a measure of productivity. Our results highlight that the probability of a public-sector employee contributing to pensions increases with higher levels of education, in line with the model.

The counterfactual analysis we conduct with the model sheds light on the policies that can be implemented to limit the existence of political incentives negatively linked to labor formality. For instance, when the rate of contribution to social security is lowered, informality decreases. Additionally, allowing for a lower pension contribution rate for low income workers would sharply increase labor formality in this environment. Other environment changes not necessarily linked with public policy, like a higher proportion of high-productivity workers in the economy and higher levels of income inequality, greatly affect the degree of enforcement of labor formality predicted by the model.

We focus on further empirically validating the model by emphasizing the result obtained in the counterfactual analysis, where greater income inequality is shown to be associated with lower labor formality. We gather a panel comprised of 61 countries between years 1998 and 2019 and document that there is a negative correlation between several measures of income inequality and the Rate of Formal Employment available from ILOSTAT. The uncovered relation is robust to several specifications, including controlling country fixed-effects. Our model provides a new theoretical framework to explain this

relation, but further research beyond the scope of this paper should address the issue of causality between income inequality and labor formality.

We argue that the proposed political economy mechanism provides a feasible explanation for why informality remains high in most developing countries. To the best of our knowledge, we are the first to address labor informality from a politico-economic perspective. There are many future prospects for research using the proposed model. One of the most straightforward is to endogenize investment in education, which is linked to labor productivity and income inequality. In this case, we should find that differences in the degree of enforcement of labor informality between high-productivity and low-productivity workers would also distort the decision to invest in human capital, affecting output in the economy.

A final remark regarding the findings of this paper is that no matter how well-designed a contributory pension scheme is, and regardless of whether it is publicly or privately managed, or if it features defined-benefits or defined-contributions, it cannot fulfill its goal of providing sufficient retirement income for beneficiaries and their dependents if they do not fulfill their contribution obligations (McGillivray, 2001). In this context, a low degree of enforcement of the mandate to contribute to social security, which translates into a high labor informality rate in the economy, has obvious implications for individuals. It also has important implications for the State, which may be driven by strong political incentives to implement large non-contributory pension programs to supplement inadequate contributory pension benefits, distorting workers' decisions and affecting welfare in the economy.

CHAPTER 3
WHY DOES INFORMALITY PERSIST DESPITE ECONOMIC GROWTH? A POLITICAL ECONOMY PERSPECTIVE

3.1 Introduction

Informality is prevalent in developing countries, representing a significant portion of economic activity, employment, and firms in the economy (Ulyssea, 2018). The impact of economic development on informality remains a contentious issue. The traditional dual market perspective on informality, which views the formal and informal sectors as largely separated entities in terms of products, technology, inputs, and customer base, is supported by various formal theories (Lewis, 1954; Harris & Todaro, 1970; Rauch, 1991; Chong & Gradstein, 2007). According to this view, informality should decrease as development progresses.

However, evidence from developing countries shows persistent stagnation in informality rates in recent decades despite many of them showing rapid economic growth (Rutkowski, 2018). Recent research by La Porta and Shleifer (2014) supports some predictions of the dual view, however it finds that economic growth leads to modest reductions in informality rates—with a country doubling its GDP per capita experiencing only a 5-percentage points reduction in labor informality. This paper presents a political economy explanation that we support with evidence, to explain stagnant informality, even in the face of rapid economic development. We examine informality from the viewpoint of workers, and consider a job to be formal if contributions to social security are paid, and informal otherwise.

In the model proposed in this paper, stagnation in labor formality rates arises from the opposing effects of two observed transformations in many countries in recent decades. First, there is fast and persistent economic growth that leads to a rise in inter-generational

inequality.[1] [2] Second, there is an increase in the proportion of older citizens (e.g., initially due to improved health conditions and life expectancy, followed by a decrease in natality).

We propose a simple political economy model that incorporates heterogeneous agents and a probabilistic voting scheme (Lindbeck & Weibull, 1987). Politicians decide on two policies: 1) the degree of enforcement of contributions to a provident fund (i.e., compulsory savings), with contributions being refunded to workers upon retirement, and 2) a basic non-contributory pension funded with a flat tax on consumption (modeled as a lump-sum tax on active workers). The population in the model consists of two types (groups) of agents: active (young) workers and retired (old) workers.

The consumption of active workers depends on their work hours and labor productivity. As briefly mentioned above, they are subject to a lump-sum tax that funds the basic pension for retired workers and have to contribute to the provident pension fund at a frequency determined by politicians. The degree of enforcement of contributions to the provident fund is what determines the labor formality rate in the modeled economy. The consumption of retired workers depends on the amount of private savings they accumulated during their active working years and the resources saved in the provident fund, determined by their past contributions to the fund (influenced by past enforcement, labor supply in the past, past productivity, and the interest rate). Retired workers also receive the non-contributory pension funded with consumption taxes.

In Section III, we calibrate the model to replicate the stagnation of labor formality rates in Chile between 1996 and 2017. During this period, fast economic growth led the country to triple its GDP per capita from approximately US$5,000 to over US$15,000. However, contrary to what the dual perspective on informality would predict, the labor formality rate slightly rose from 64% to 68% of employment. With the calibrated model, we show what would have happened to the formality rate in different scenarios. First, if only the old-age dependency ratio had increased and no economic growth had been observed, the formality rate would have reached 100% by 2017. Instead, if only economic growth had occurred and the old-age dependency ratio had remained fixed at its 1996

[1] In his classic paper, Kuznets (1955) proposes the existence of an inverse U-shape relationship between economic development and inequality. Arnand and Kanbur (1993) formalize this view with a model.

[2] Additionally, note that low past labor formality rates—coupled with lower productivity in the past— can result in lower contributory pensions for the current retired generation, especially under defined-contribution pension schemes.

level, the formality rate in 2017 would have been 0%.

In Section IV, we measure labor formality using the rate of formal employment available from ILOSTAT and conduct cross-country regressions using a panel of 63 developing countries from 1999 to 2019. We show that the predictions of the calibrated model, as obtained from the counterfactual analysis, find empirical support. Firstly, we highlight a positive correlation between labor formality and the old-age dependency ratio, which persists across various specifications of the econometric model, even when accounting for country-fixed effects. Secondly, we observe a negative correlation between labor formality and the ratio of GDP per worker in a given year over GDP per worker twenty years earlier (to account for persistent economic growth) after controlling for economic growth in the short run and for country fixed-effects. Additionally, we emphasize that these results remain robust and are even more pronounced when running the same regressions in a subsample of only Latin American countries. The advantage of this exercise is that countries in Latin America feature a design of their national pension schemes that closely resembles the environment in the model: a defined-contribution pension scheme in combination with a basic non-contributory pension funded mainly with taxes on consumption.

The mechanism in the model can be intuitively explained as follows. Under a probabilistic voting scheme, politicians have perfect information regarding every aspect related to the consumption of workers, including income and the sector where they work (i.e., formal or informal). However, they face uncertainty regarding other characteristics orthogonal to consumption, which we group under the label "ideology." It can be shown that under some general conditions, the probabilistic voting framework implies that politicians end up maximizing the weighted welfare of voters when dealing with uncertainty regarding their ideology.[3] In this context, the presence of persistent economic growth implies that politicians find it desirable to have a more generous basic non-contributory pension for redistributing resources from active to retired workers. Active workers now expect to receive a bigger basic pension in the future and have fewer incentives to save for retirement. Since the government takes into account workers' preferences, it loosens

[3]The essential condition is that all groups of individuals are assigned the same party preference distribution (i.e., "ideology" distribution). In this case, each group of individuals is weighted by politicians according to their relative proportion in the population. In cases where groups of individuals have different 'ideology' distributions, it can be shown that groups with a lesser ideological bias—who are more sensitive to changes in consumption—have a greater weight than they do in the population for politicians.

enforcement of contributions to the provident pension fund, resulting in a lower formality rate in the economy when long-term economic growth is higher.

Additionally, concerning the second determinant of labor formality in the model, we find that a larger share of retired workers in the economy implies two things. First, politicians care about the welfare of retired workers more, given their increased population weight, favoring the implementation of a larger basic non-contributory pension. This, in turn, is associated with lower formality for active workers who are now discouraged from saving for retirement due to the expectation of a higher basic pension upon retirement. Second, the group that is paying positive net taxes—active workers—shrinks relative to the group that is receiving a positive net transfer—namely, retired workers—thus tightening the government's budget constraint. The latter effect is linked in the model to a lower non-contributory basic pension and higher labor formality in the economy. In the calibration to Chile, the second effect predominates, and a larger share of retired workers leads to higher formality. Finally, stagnation of the formality rate arises according to the model because the negative effect that economic growth has on labor formality counteracts with the positive effect coming from a larger old-age dependency ratio in the economy.

This paper contributes to the literature in economics in at least two dimensions. First, it contributes to the literature on the theoretical relationship between informality and economic development. The existing literature, largely influenced by Lewis (1954) dual view on informality, suggests that economic development should result in significant reductions in informality. Recently, La Porta and Shleifer (2014) conducted a comprehensive analysis using a panel of over 60 countries, which provides supporting evidence for some of the predictions made by the dual markets literature. Notably, their analysis reveals a negative impact of faster labor force growth on formality rates, as well as improvements in formality associated with economic growth, albeit not as substantial as initially anticipated. While we draw inspiration from their main finding regarding the modest effects of economic growth on reducing informality, our contribution lies in providing a theoretical explanation for this phenomenon. Furthermore, we complement this theoretical framework by offering empirical support through cross-country panel data analysis, validating the political economy mechanism outlined in our model.

Third, the present paper establishes a clear connection between two branches of theoretical economics literature. Firstly, a small body of macroeconomics literature has incorporated probabilistic voting into dynamic models to analyze redistributive policies (Hassler et al., 2003; Hassler et al., 2005; Tabellini, 2002; Basetto, 2008). However, none of these studies specifically explore labor informality, which is the primary focus of our research. Secondly, our paper contributes to the expanding literature in macroeconomics and labor economics that employs simulated models to examine endogenous informality (Fugazza & Jacques, 2004; Bosch & Esteban-Pretel, 2012; Narita, 2020; Ulyssea, 2018). To the best of our knowledge, none of the models in this literature incorporate a political economy mechanism for aggregating agents' preferences, and policy is generally treated as exogenous.

The remainder of the paper is structured as follows: Section II introduces the model and obtains an analytical solution by applying certain general simplifying assumptions. Section III proceed to calibrate the model using data from Chile and highlights its ability to reproduce the stagnant labor formality rates observed in the country from 1996 to 2017. We also conduct counterfactual analyses based on the model's framework. Section IV presents the empirical analysis conducted across multiple countries, providing evidence that supports the predictions of the model. Finally, Section V concludes the paper, summarizing the main findings and highlighting potential avenues for future research.

3.2 The model

We develop a two-period overlapping-generations model featuring two distinct groups of agents: active workers (high-productivity) and retired workers (low-productivity). Long-term economic growth is modeled as the difference in productivity between two consecutive generations. In each period, politicians determine two policies through probabilistic voting: the size of a non-contributory basic pension given to retired workers, funded with a flat tax on consumption, and the degree of enforcement of contributions to a pension provident fund, with contributions being refunded to workers upon retirement.[4]

We analytically solve the model in two stages. In the first stage, active workers take

[4]Note that the non-contributory pension, funded with a flat VAT, is modeled as a lump-sum transfer given to retired workers, which is funded with a lump-sum tax on active workers.

government policy as given and decide for themselves how much to work and save. In the second stage, the government internalizes the decisions made by workers in the first stage and chooses policies within a probabilistic voting framework. We begin this section by examining the consumption patterns of the two worker types within the modeled economy, as well as their lifetime utility and the optimization problem they solve. Then, we define the political economy equilibrium and discuss the optimization problem faced by the government, offering a comprehensive analysis of the solution.

3.2.1 Consumption and life-time utility of workers

In the first period of their life, active workers (indexed by y) of generation t choose the amount of time they work, l_t, given that they are paid an exogenous wage w_t. Since private assets and contributory pension benefits are perfect substitutes in the model, workers do not have any incentive to contribute to social security and thus decide to work informally, i.e., without contributing to social security. Then, is the government who decides when a worker has to pay the contribution rate θ, by choosing the degree of enforcement of social security contributions p_t.

$$c_t^y = l_t w_t(p_t(1-\theta) + (1-p_t)) - a_{t+1} - \tau_t \tag{3.1}$$

where a_{t+1} is the amount of private savings that active workers decide to accumulate, τ_t is a lump-sum tax accounting for a net tax on active workers' consumption. The resources raised by the tax finance a lump-sum transfer, T_t, provided to retired workers, constituting a basic non-contributory pension.

Consumption of retired workers (indexed by o) of generation t, is as follows:

$$c_{t+1}^y = a_{t+1}(1+r) + A_{t+1} + T_{t+1} \tag{3.2}$$

where T_{t+1} corresponds to the basic non-contributory pension that workers can expect to receive in period $t+1$ upon retirement from the labor market, and A_{t+1} is a contributory pension benefit determined by the worker's past contributions to the provident fund.

The intertemporal link between contributions and benefits can be represented by the following function:

$$A_{t+1} = f(p_t, r) \quad \forall t \tag{3.3}$$

where r is the rate of return on the amount of resources contributed to the provident fund (which is the same return than for private savings); function f is known by agents, and we assume that it is defined such that the contributory pension benefits workers expect to receive upon retirement, are equivalent to what they are able to get on their own by investing the same amount of money in the private asset. While this assumption is realistic, it implies that workers are indifferent between contributing to the provident fund and saving privately.

In this scenario, the degree of enforcement of social security contributions that the government decides to exert, p_t, directly represents the fraction of total working time an individual spends in jobs covered by social security. That is to say, we can think of it as the labor formality rate of workers of generation t.

We define consumption of retired workers of generation $t-1$, as follows:

$$c_t^o = a_t(1+r) + A_t + T_t \tag{3.4}$$

Finally, for simplicity we assume a logarithmic utility function. Thus, we can represent life-time utility of active workers of generation t, as follows:

$$V_t^y(c_t^y, l_t, c_{t+1}^o) = log(c_t^y - \hat{c}) - \eta log(1 - l_t) + \beta log(c_{t+1}^o - \hat{c}) \tag{3.5}$$

where η is a parameter indicating the preference of workers for leisure relative to consumption; β is the subjective discount factor; and $\hat{c}$ is a survival consumption level (i.e., the minimum consumption level) that we assume to be constant across generations.

The utility of retired workers of generation $t-1$, is the following:

$$V_t^o(c_t^o) = log(c_t^o - \hat{c}) \tag{3.6}$$

3.2.2 Optimization problem of workers

Active workers of generation t maximize their lifetime utility by choosing the inter-temporal allocation of consumption and their labor supply for the first period of their lives.

$$\max_{c_t^y, l_t, c_{t+1}^o} V_t^y(c_t^y, l_t, c_{t+1}^o) \tag{3.7}$$

subject to a non-negativity constraint on savings:

$$a_{t+1} \geq 0 \tag{3.8}$$

After solving, we obtain the following expressions, which constitute the solution to the optimization problem of workers. These expressions are functions of c_t^y, the parameters of the model, and the government policy variables.

$$c_{t+1}^o = \beta(1+r)c_t^y \tag{3.9}$$

$$l_t = \frac{w_t(1-p_t\theta) - \eta c_t^y}{w_t(1-p_t\theta)} \tag{3.10}$$

Then, c_t^y is a function of the model parameters and government policies:

$$c_t^y = \frac{(1+r)[w_t(1-p_t\theta) - \tau_t] + A_{t+1} + T_{t+1}}{(1+r)(1+\eta+\beta)} \tag{3.11}$$

Similarly, the amount of private savings as a function of the model parameters and government policy variables is as follows:

$$a_{t+1} = \frac{\beta(1+r)[w_t(1-p_t\theta) - \tau_t] - (1+\eta)(A_{t+1} + T_{t+1})}{(1+r)(1+\eta+\beta)} \tag{3.12}$$

Retired workers solved an analogous problem in the previous period when they were active in the labor market. They do not have any further decisions to make while they are retired; thus, their consumption is residual. However, the government can still increase their consumption level by adjusting the basic non-contributory pension T_t.

3.2.3 The political economy equilibrium

In the political equilibrium, policy is chosen through repeated voting. We have a two-political candidates model of probabilistic voting in the spirit of Lindbeck and Weibull (1987). In this environment, candidates have perfect information about anything related to workers' (i.e., voters) consumption, which in our case extends to income and the sector of workers. However, they face uncertainty about other characteristics of workers orthogonal to consumption, labeled as "ideology." It can be shown mathematically that, due to uncertainty about voters' ideology, the probabilistic voting scheme boils down to the weighted maximization of the lifetime utility of agents alive at t. Other features of these types of models are discussed in depth by Persson and Tabellini (2000), so they will not be detailed here.

In the equilibrium of this model, both candidates choose the same platform over redistribution, and each of them has a fifty percent probability of winning. Therefore, from now onward, we speak of the "government" or "politicians" when referring to the two candidates embedded in democratic competition.

The "political" aggregation of preferences of workers (i.e., voters) can be summarized by the function W:

$$W = V_t^y + \gamma \epsilon_{t-1} V_t^o \tag{3.13}$$

where ϵ_{t-1} represents the relative size of generation $t-1$ compared to generation t, commonly referred to as the old-age dependency ratio. The parameter γ indicates the subjective political weight that politicians give to retired workers relative to active workers. It is important to note that ϵ_{t-1} is influenced by factors such as population growth and technological advancements that lead to improvements in healthcare, likely increasing the average life expectancy of workers and the likelihood of individuals surviving beyond retirement age.

Politicians maximize the expression W with respect to p_t (degree of enforcement of labor formality), determining A_{t+1}, and with respect to T_t (the non-contributory basic pension allocated to current retired workers), funded with τ_t (the lump-sum tax charged on current active workers).

The government faces a budget constraint for the non-contributory basic pension scheme, that we assume has to be balanced every period t:

$$\tau_t = \epsilon_{t-1} T_t \tag{3.14}$$

and intertemporal budget constraints for the provident fund, also assumed balanced, which is equivalent to assuming that the contributory pillar is fully-funded (FF) and defined-contribution (DC):

$$f(p_t, r) = p_t l_t w_t \theta (1 + r) = A_{t+1} \quad \forall t \tag{3.15}$$

where l_t is given by equation 3.10 and equation 3.11.

Additionally, we have that p_t cannot be such that contributory benefits to be received by current active workers in the next period, are negative:

$$A_{t+1} \geq 0 \quad \forall t \tag{3.16}$$

Generally speaking, the cost of monitoring contributions to the provident fund (i.e., we may refer to it as the real cost of enforcement) is assumed to be equal to zero. While this assumption may not be very realistic, making it is even more demanding for our purposes; in fact, we want to show that, due to political-economy considerations, the degree of enforcement of labor formality that the government exerts may still be different from one, even in a frictionless environment.

3.2.4 Analytical solution for a simple case: workers expect a constant transfer in the future

To derive an analytical solution for the political problem, we assume that: i) $\epsilon_{t-1} = \epsilon_{t-2} = \epsilon$, and that ii) $w_t = w^y$ and $w_{t-1} = w^o$, with $w^y > w^o$, which accounts for economic growth in the model. In slightly different words, we assume that the future evolution of the old-age dependency ratio is constant, and so it is the future evolution of economic growth.

Under these circumstances, we further assume that active workers expect that the

transfer received by retired workers will remain constant in the future: that is to say, we impose $T_{t+1} = T_t$. We further normalize $w^o = 1$ and assume $W = w^y/w^o$. Lastly, we assume that the survival consumption level equals zero (i.e., $\hat{c}$).

The assumption that workers are indifferent between saving for retirement through private assets or through the provident fund has two implications for solving the political problem. First, the political equilibrium exhibits an upper bound on the level of enforcement of labor formality that politicians can choose while still winning the election. This upper bound is determined by the amount of private savings a worker would have chosen in the absence of the provident fund. In other words, the government cannot force workers to save more than they desire and still maintain popularity and win the election. Second, we encounter a problem of indeterminacy in the political solution. Following workers' preferences, the government is indifferent between enforcing labor formality such that the pension asset perfectly substitutes private assets (the so-called upper bound), not enforcing labor formality at all, and any enforcement level between these two options. To resolve the indeterminacy issue, we make the following assumption.

Assumption 1. The government weakly values a larger pension fund in the economy. We can consider at least three intuitive arguments to support this assumption. First, a larger fund ends up lowering the risk premium associated with newly issued public and private debt in the international financial market, improving the borrowing conditions that the economy faces abroad. Second, pension funds may be used in serious emergencies.[5] Third, a larger pension fund may positively affect the development of the internal financial market by generating demand for more complex financial assets.

Finally, the solution of the model rests in two additional assumptions:

Assumption 2. The rate of contribution to social security, θ, is fixed. This implies that the government adjusts the size of the contributory pension scheme (i.e., the size of the provident fund) solely through changing the intensity of enforcement. We argue that this assumption is realistic since, in a democracy, changes in the social security contribution rate must generally be approved by Congress—a costly political process. Instead, the degree of enforcement of labor formality appears as an administrative decision, easier for

[5]Such was the case in the recent Covid-19 pandemic, where in Chile, Australia, and Peru, people were allowed to spend part of the resources accumulated in their mandatory pension accounts.

the government to modify.

Assumption 3. The contribution rate has been set (outside the model) such that, under perfect enforcement (i.e., $p_t = 100\%$), workers would save more than their voluntary choice. This assumption allows for the presence of imperfect enforcement of labor formality. While Assumption 3 may appear strong, the pension literature widely acknowledges that individuals tend to save less than what is optimal for their retirement consumption. This provides a theoretical basis for the existence of mandatory contributory pension schemes in most countries. Consequently, under perfect enforcement, the effective contribution to the pension scheme is likely to be higher than the preference of the average worker.

Under Assumption 1 to Assumption 3, the government chooses the level of enforcement, p_t, that perfectly substitutes private savings for each worker, and we can focus on solving the political problem for T_t. We can then solve the optimization problem and obtain the following value for the non-contributory basic pension at period t as a function of the model parameters and the value of the transfer at period $t-1$:

$$T_t = \frac{\gamma\epsilon(1+r)W + ((1+r)\gamma\epsilon - 1)(1+\eta+\eta)(1+r)(\gamma\epsilon T_{t-1})}{((1+r)\gamma\epsilon - 1)(1+\eta+\beta+\gamma\epsilon)} \tag{3.17}$$

Next, we can determine the value of p_t as a function of T_t and the model parameters, based on the assumption that the pension asset is a perfect substitute for private savings.

$$p_t = \frac{\beta(1+r)W - (\beta(1+r)+1+\eta)T_t}{((1+\beta)(1+r)W + \eta r T_t)\theta} \tag{3.18}$$

3.3 Calibration and quantitative analysis

In this section, we calibrate the model to Chile by targeting the observed stagnant behavior of labor formality rates between 1996 and 2017. Subsequently, we employ the calibrated model to explore the impacts of variations in the economic growth rate and the old-age dependency ratio on the size of the non-contributory pension and the degree of enforcement of contributions to the provident pension fund. Recall that in this environment, the degree of enforcement of labor formality determines the formality rate in

the economy.

The final objective of the calibration is to extrapolate the findings from the counterfactual analysis to other countries when conducting cross-country empirical analyses in Section IV. Additionally, we analyze the impact of changing the rate of contribution to social security on labor formality, providing insights into potential public policy recommendations.

3.3.1 Calibration to Chile

For the calibration, we target two data moments by adjusting two parameters of the model. We aim to match the labor formality rate in 1996, denoted as p_{1996}, and the evolution of the labor formality rate between 1996 and 2017, represented as $p_{2017} - p_{1996}$. We adjust the values of η, which accounts for the preference of workers for leisure relative to consumption, and γ, which represents the subjective political weight of retired workers relative to active workers.

In what follows, we define the variables for the case of Chile to be used in the calibration:

The average non-contributory basic pension relative to GDP per capita. This variable accounts for T_t in the model and is sourced from the LIS Cross-National Data Center in Luxembourg (hereafter LIS). The numerator represents the average non-contributory pension transfer received by individuals aged 70 to 79, including those receiving zero benefits in the calculation of the average. According to the LIS database definition available on their webpage, this variable encompasses 'pensions and similar monetary transfers for old-age, disability, and survivors, stemming from non-contributory public programs.[6] The average non-contributory pension benefit for each year is deflated by the CPI series for Chile provided by LIS. The denominator is GDP per capita at constant local currency, obtained from the World Bank national accounts data. In the Chilean data, the value of this variable rose by 435%, from 1.5% of GDP per capita in 1996 to 6.5% in 2017.

Long-term/persistent economic growth. This variable accounts for W in the model. The

[6]Includes: (1) universal programs covering the whole or part of the population based on criteria other than previous employment, income, or assets; (2) social assistance programs for individuals or households in need; (3) veteran pensions if non-insurance based.

numerator is the CPI-deflated average earnings of individuals aged 30 to 49, where we include those not participating in paid work (e.g., unemployed). The denominator is the CPI-deflated average contributory pension benefits received by individuals age 70 to 79 years old, where we include individuals receiving zero benefits. According to the definition available in the webpage of the LIS database, contributory pension benefits account for "...pensions and other monetary transfers for old-age, disability, and survivors, stemming from the main pension insurance system[7] (can be either pay-as-you-go, fully-funded, or a mix)". This measure of inter-generational inequality rose 152% during the period in Chile, from 2.5 times in 1996 to 3.8 times in 2017.

The old-age dependency-ratio from the LIS database. This variable accounts for ϵ in the model. The numerator is the population of age 30 to 49. The denominator is the population of age 70 to 79. This variable saw a sharp increase during the period in Chile, from 12% in 1996 to 25% in 2017.

Labor formality rate. This variable accounts for p_t in the model. It is defined as the share of employees contributing to social security at the moment the survey was taken (i.e., 1996 and 2017). The data is from the Chilean CASEN survey. As mentioned throughout the paper, the labor formality rate in Chile increased by only 4 percentage points during the period of analysis, rising from 64% in 1996 to 68% in 2017.

The result of the calibration is shown in Table 3.1.

[7] It also includes minimum pension benefits if they exist in the contributory-based pension system; "...such pensions are considered as contributory pensions in the LIS incomes classification as persons become eligible to such a minimum pension when they have accumulated sufficient years of a previous employment relationship." Additionally, it includes transfer for permanent full or partial disability or death cause by a work-injury or occupational disease.

Parameters calibrated outside the model			Parameters cailibrated inside the model		
	1996	2017		1996	2017
θ	0.2	0.2	η	0.81	0.81
β	0.33	0.33	γ	4.31	4.31
r	200%	200%			
ϵ	0.116	0.248			
w^o	1	1			
w^y	2.5	3.8			
T_{t-1}	0.0	0.4			
Prediction of the model			Values in the data		
	1996	2017		1996	2017
T_t	0.40	0.57		0.40	1.74
p_t	64%	68%		64%	68%

Table 3.1: Summary of the calibration to Chile.

To calibrate the model to Chile, we target p_{1996} and $p_{2017} - p_{1996}$ and allow for the subjective political weight, γ, and the preference for leisure relative to consumption, η, to freely adjust.

As seen in Table 3.1, the calibrated model accurately replicates the labor formality rates in 1996 and 2017. The model predicts an increase in the average non-contributory pension (by 70%), yet the observed increase in the data is much larger (435%).

In the following, we obtain the partial derivatives of: 1) the non-contributory pension, T_t, with respect to long-term economic growth (W); 2) T_t with respect to the old-age dependency ratio (ϵ); (3) the degree of enforcement of contributions, p_t, with respect to W; and (4) p_t with respect to ϵ. Then, we show the signs taken by these derivatives under the baseline calibration in 1996.

Firstly, we calculate the derivative of the basic non-contributory pension with respect to W:

$$\frac{\partial T_t}{\partial W} = T_t^w = \frac{\gamma\epsilon(1+r)}{((1+r)\gamma\epsilon - 1)(1+\eta+\beta+\gamma\epsilon)} \tag{3.19}$$

Secondly, we calculate the derivative of the basic non-contributory pension with respect to ϵ:

$$\frac{\partial T_t}{\partial \epsilon} = T_t^{\epsilon}$$
$$= \frac{(1+r)\{[(1+r)\gamma\epsilon - 1][1+\eta+\beta+\gamma\epsilon(3+(1+r)(1+\eta))] - [1+\eta+\beta-(1+r)\gamma^2\epsilon^2]W}{[((1+r)\gamma\epsilon-1)(1+\eta+\beta+\gamma\epsilon)]^2} \tag{3.20}$$

Thirdly, we obtain the derivative of the degree of enforcement of contributions to the provident fund with respect to W:

$$\frac{\partial p_t}{\partial W} = -\frac{2(2+r+\eta(1+r))(T_t - T_t^w)}{\theta[(2+r)W + \eta r T_t]^2} \tag{3.21}$$

Finally, we obtain the derivative of the degree of enforcement with respect to ϵ:

$$\frac{\partial p_t}{\partial \epsilon} = -2T_t^{\epsilon}\frac{(2+r+\eta)W + \eta r(2+\eta)T_t}{\theta[(2+r)W + \eta r T_t]^2} \tag{3.22}$$

When substituting the calibrated parameters into equation 3.19, we confirm that the partial derivative of the non-contributory basic pension with respect to long-term economic growth, represented by W, is positive, as expected. Substituting into equation 3.20, we confirm that the partial derivative of the non-contributory pension with respect to the old-age dependency ratio is negative. Moreover, equation 3.21 shows that the partial derivative of enforcement with respect to economic growth is negative. Finally, equation 3.22 shows that the partial derivative of enforcement with respect to the old-age dependency ratio is positive for the case of Chile.

3.3.2 Counterfactual analysis

In this part of the section, we begin with the 1996 baseline parametrization of the model and illustrate potential outcomes for the labor formality rate and the size of the basic non-contributory pension in different scenarios. First, we consider a scenario where only the old-age dependency ratio (ϵ) increases between 1996 and 2017, with no observed economic growth. Second, we examine a scenario where only economic growth ($W = w^y/w^o$) occurs, while the old-age dependency ratio remains fixed at its 1996 level. Additionally, we analyze the case of a change in the contribution rate to social security (θ). The results

of the counterfactual analysis are summarized in Table 3.2.

	Predicted transfer (T)	Predicted formality rate (p)
Baseline of the model (1996)	0.4	64%
θ increases (from 0.2 to 0.3)	0.4	43%
ϵ increases (from 0.116 to 0.121)	0.18	97%
W increases (from 2.5 to 3)	0.99	8 %

Table 3.2: Summary of the results of the counterfactual analysis using the model solution.

The baseline version of the model corresponds to the calibration to Chile in the year 1996.

First, as observed in the results presented in Table 3.2, when only the old-age dependency ratio, ϵ, increases, we find that the labor formality rate of active workers increases, and the non-contributory basic pension becomes less generous. Second, only long-term economic growth occurs, W, we note a sharp decrease in labor formality, accompanied by an increase in the generosity of the non-contributory basic pension. Finally, in the scenario where the rate of contribution to social security increases (or decreases), the non-contributory basic pension remains constant, while the labor formality rate experiences a sharp decrease (or increase). This occurs because the degree of enforcement of contributions to social security perfectly adjusts to variations in the contribution rate, leaving the amount of contributory pension benefits unchanged.

3.3.3 The mechanism

In the model, higher long-term economic growth prompts politicians to increase the non-contributory basic pension for retired workers, as redistribution tends to bolster electoral success under a probabilistic voting scheme (recall that the probabilistic voting scheme boils down to the weighted welfare maximization of voters). Consequently, active workers are discouraged from saving for retirement because they anticipate receiving a higher basic pension upon retirement as well. To optimize electoral success, the government aligns itself with voters' preferences by relaxing enforcement of contributions to the pension provident fund.

A larger share of retired workers in the economy implies two things in the context of the model. First, politicians care more about the welfare of retired workers since

their population weight increases, favoring a larger basic non-contributory pension for retired workers, coupled with lower formality for active workers who are discouraged from saving for retirement because they expect a higher basic pension in the future. Second, the group that is paying positive net taxes, active workers, shrinks relative to retire workers, accounting for the group that receives a positive net transfer. This tightens the government's budget constraint, which, in the model, is linked to a lower basic pension and a higher labor formality rate. In the case of Chile, the second effect predominates, and a larger share of retired workers in the economy leads to higher labor formality.

Summing up, in the context of this political economy model calibrated to Chile, the stagnation of the labor formality rate arises because the negative effect that sustained economic growth has on labor formality counteracts with the positive effect coming from a larger old-age dependency ratio in the economy.

Put differently, we assert that sustained economic growth prompts an increase in transfers from active workers to retirees, which, in turn, adversely impacts the government's political incentives to enforce contributions to a provident fund (accounting for the social security scheme) among the former group. This, when compared to scenarios with lower long-term economic growth, leads to higher rates of labor informality. However, the presence of a larger share of retired workers mitigates this effect by fostering a less generous non-contributory pension scheme and creating favorable political incentives for enforcing pension contributions. Consequently, these conflicting political motivations result in the stagnation of labor formality rates.

3.4 Empirical evidence

In Section III, we illustrate that the political equilibrium for the case of Chile exhibits two key characteristics: 1) decreased enforcement of labor formality in the presence of higher sustained economic growth, and 2) heightened enforcement of formality when the proportion of retired workers in the economy rises. In this section, we collect macro-data from 63 countries between the years 1999 and 2019 to build an unbalanced panel and test whether these predictions are supported by cross-country evidence.

In what follows, we measure labor formality with the rate of formal employment as

reported in the ILO database (hereafter, FR). The labor formality rate from ILOSTAT is defined as the proportion of workers who are employed and not engaged in informal employment. Informal employment includes persons who are: i) employees (or persons not classified by status in employment) not protected by national labor legislation in that job;[8] ii) entrepreneurs in a unit of production considered informal, where entrepreneurs refer to employers, members of producers' cooperatives, and own account workers (only if what is produced is for sale); iii) and contributing family workers.

A first step to test the aforementioned predictions of the model in the cross-country data is to check for the presence of correlations using raw data. To examine the existence of a negative correlation between long-term economic growth and labor formality, we present a scatter plot between the formal employment rate and the ratio of GDP per worker in a specific year over GDP per worker twenty years before (both at constant 2017 PPP values), hereafter referred to as the Ratio GDP per-worker. In this case, the correlation between labor formality and the Ratio GDP per-worker is virtually zero, as observed in the right panel of Figure 3.1.

To examine the existence of a positive correlation between labor formality and the share of retired workers in the economy, we present, in the left panel of Figure 3.1, a scatter plot between FR and the old-age dependency ratio (obtained from the World Bank database).[9] Consistent with the prediction of the calibrated model, there is a clear negative correlation between these two variables.

[8] This includes employees not affiliated with a social security scheme related to the job (or as a proxy pension funds), and employees not entitled to certain employment benefits, such as paid annual vacation and paid sick leave;

[9] The old-age dependency ratio is the ratio of people older than 64 to the working-age population — those between 15 and 64 years old.

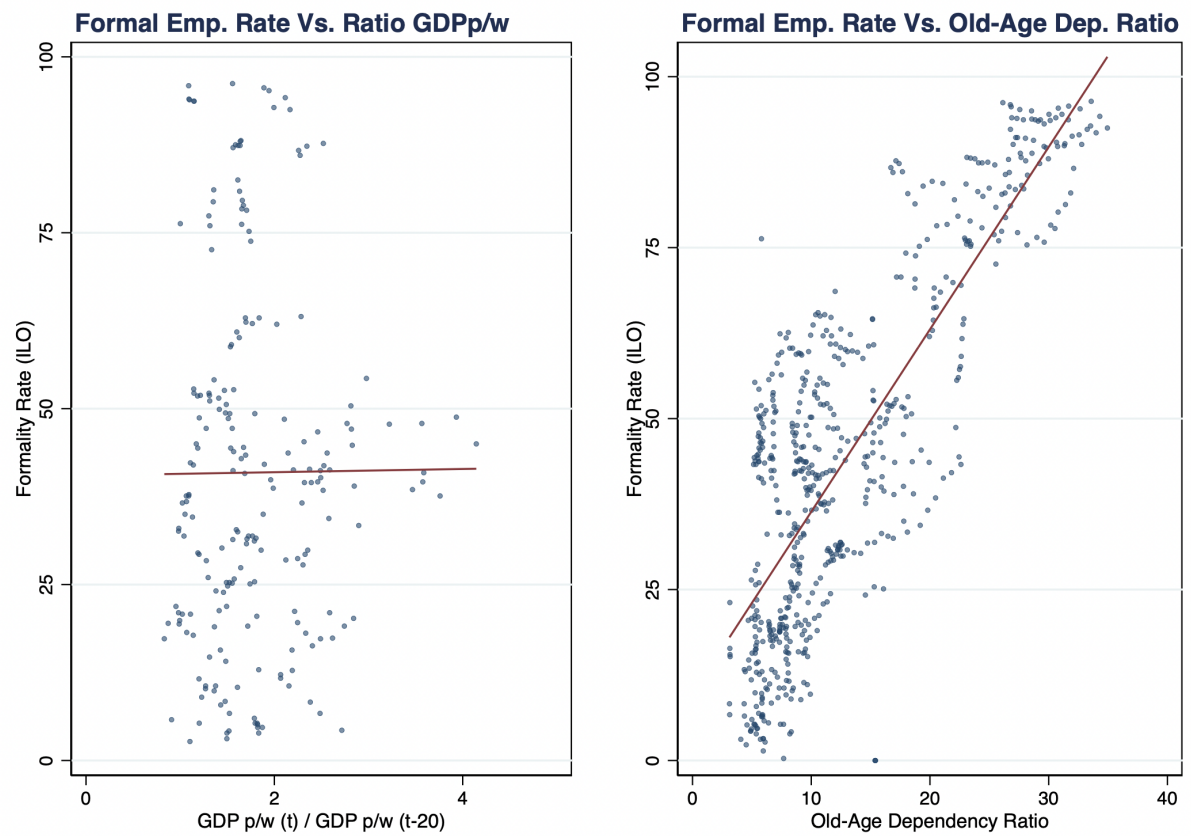

Figure 3.1: Correlation between long-term growth and labor formality.

The panel on the left panel of the figure shows the correlation between the rate of formal employment, FR (from ILOSTAT), and the ratio GDP per-worker of the year over GDP per-worker twenty years before (both at constant 2017 PPP values). The panel to the right of the figure shows the correlation between FR and the old-age dependency ratio. Data is for 63 countries between 1998 and 2019.

At this point, we need to assess what happens with the correlations obtained from raw data when adding some econometric complexity to the analysis. Specifically, we are particularly interested in estimating the correlation between labor formality, the Ratio GDP per-worker, and the old-age dependency ratio, after controlling for the potential impact of the economic cycle on formality (accomplished by including short-run economic growth as a control) and after accounting for country fixed-effects.

In particular, we specify the following econometric model to estimate the impact of sustained economic growth (SG_{ct}) and the old-age dependency ratio (D_{ct}^{WB}) on the labor formality rate (FR_{ct}^{ILO}), measured with the rate of formal employment that we access from ILOSTAT:

$$FR_{ct}^{ILO} = \alpha + \beta SG_{ct} + \delta D_{ct}^{WB} + \kappa_c + \phi_{ct} + \pi_{ct} \tag{3.23}$$

where κ_c is a vector of country fixed-effects; ϕ_{ct} is a matrix containing the economic growth rate of country c at year t (obtained from the WB database); and π_{ct} is the error term.

Table 3.3 shows the results of estimating equation 3.23 in two different samples. The independent variables of interest, for which we present the estimated coefficients, are 1) the ratio GDP per-worker of the year over GDP per-worker twenty years before (both at constant 2017 PPP values), and 2) the old-age dependency ratio. In column (1), the fixed-effect regression is estimated considering all the countries in our sample, while in column (2), only Latin American countries are considered.

Considering only Latin American (LA) countries has two advantages vis-à-vis the model's prediction. First, as seen from the derivation of a different model in the Appendix, the results that higher long-term economic growth generates lower labor formality depend on some aspects of policy design that are not easy to identify in the data. Specifically, we show that when we do not allow for the existence of a basic pension given to low-income workers and instead allow for redistribution to be made within the contributory pension scheme, as is the case in many developed countries with traditional pay-as-you-go pension schemes featuring defined benefits, higher inequality may lead to higher formality. In this context, by limiting the analysis to countries in Latin America, we ensure that this is not the case because contributory pension schemes in the overwhelming majority are fully-funded defined-contribution pension schemes.

Second, recall that the political economy mechanism is based on a probabilistic voting scheme, which means that it should be representative of a democratic regime. Even though the probabilistic voting scheme boils down to the weighted welfare maximization of agents alive, and this may still be the same objective function governing policy decisions of an autocratic regime, this discussion is beyond the focus of the paper. Throughout the period of analysis (1999 to 2019), every country in the Latin American sample had a democratic regime in place.

	(1)	(2)
	FE(all)	FE(LA)
	b/se	b/se
Ratio GDP p/w	-2.4327	-9.1946**
	(2.30)	(4.17)
Dep.Ratio(old)	1.9584***	5.3091***
	(0.49)	(1.61)
Constant	20.8511***	-6.1685
	(7.23)	(15.49)
Country FE	Yes	Yes
Ec. Growth	Yes	Yes
R-sqr	0.70	0.49
Obs	184	91

t statistics in parentheses

* 0.1, ** 0.05, *** 0.01

Table 3.3: Cross-country regression results.

The rate of formal employment is the dependent variable, which comes from the ILO database. The independent variables of interest are 1) the ratio GDP per-worker of the year over GDP per-worker twenty years before (both at constant 2017 PPP values), and 2) the old-age dependency ratio. Both independent variables of interest obtained from the WB database. In column (1) the fixed-effect regression is estimated considering all the countries in our sample, while in column (2) only Latin American countries are considered. The period of analysis is from 1999 to 2019 and there are 63 countries in our sample

As evident from the estimated coefficients presented in Table 3.3, the rate of formal employment (FR) consistently exhibits a positive relationship with the old-age dependency ratio, with precise estimates across both samples. This aligns with the prediction of our theoretical model in Section III.

The results for long-term economic growth are somewhat less robust. The calibrated model in Section III predicts that higher long-term economic growth negatively affects labor formality. Initially, analyzing the raw data reveals a correlation between the Ratio GDP per-worker and FR that is virtually zero. Subsequently, when controlling for economic growth of the year and country fixed-effects, a negative correlation emerges but fails to reach statistical significance when considering the whole sample of countries. However, when running the country-fixed effect regression in the sub-sample of Latin

American countries, the estimated coefficient for the Ratio GDP per-worker is negative and statistically significant.

Overall, we contend that the results presented in this section support the prediction of our calibrated model in Section III, indicating that labor formality exhibits a positive correlation with the share of retired workers in the economy and a negative correlation with long-term economic growth. The evidence for the former correlation appears robust, with a consistently positive correlation between the rate of formal employment (FR) and the old-age dependency ratio evident in both raw data and the econometric analysis. Moreover, it remains robust when controlling for country fixed-effects, the rate of economic growth in the country for a given year, and when analyzing the whole sample or just the sub-sample of Latin American countries.

At this point, it is important to mention that we do not consider the above results indicative of a causal effect of long-term economic growth and the share of retired workers in the economy on labor formality, as our model suggests. Making this assertion would require further analysis beyond the scope of the present paper.

3.5 Final remarks

In this paper, we have explored the relationship between informality and sustained economic growth, a topic that has been widely debated in the literature. While the prevailing theoretical view suggests that rapid economic growth should lead to significant reductions in the size of informal markets, recent empirical studies have found either a weak or non-existent connection (La Porta & Shleifer, 2014; Rutkowski, 2018). To explain the stagnant formality rates in the face of long-term economic growth, we propose a politico-economic explanation.

Our theoretical framework diverges from the dual-market explanations of informality, as we do not consider the informal sector to be entirely separate from the formal sector. Instead, in our simplified model, the labor formality status is solely determined by whether a worker contributes to social security. In this context, we argue that a substantial portion of labor informality can be attributed to political economy incentives that discourage politicians from enforcing social security contributions. In other words, we argue that,

in many countries, there is a lack of political incentives to reduce labor informality—a trend common to many developing countries in the past few decades.

developing countries in the past few decades. Firstly, sustained economic growth ends up generating an increase in inter-generational income inequality. Secondly, there is a rise in the share of retired workers in the economy due to sharp declines in birth rates and improvements in life expectancy. Based on this dynamic, we propose a political economy model where politicians have stronger incentives to enforce labor formality when the share of retired workers in the economy increases, but weaker incentives when long-term economic growth is higher. We argue that these opposing incentives counteract each other, ultimately leading to stagnant labor formality rates in many countries. It should be noted that we do not intend to argue that informality is solely determined by political incentives in reality. As argued by Ulyssea (2018), the theoretical perspectives to understand informality complement each other, and the political economy explanation proposed in this paper is only one of them.

To test our proposed intuitive dynamic and the predictions of the calibrated model, we conduct cross-country regressions. The findings indicate that long-term growth, as measured by the ratio of GDP per worker in the current year to GDP per worker twenty years before, is associated with lower labor formality, as measured by the formal employment rate available from ILOSTAT. Additionally, a higher old-age dependency ratio is linked to a higher rate of formal employment in the data.

Finally, our proposed political economy mechanism offers a justification for the enduring presence of significant informal sectors, even with advancements in technology that enable the detection of shadow activities (Boeri & Garibaldi, 2005). Consequently, our approach addresses the so-called "shadow puzzle."

There are several possible extensions to the analysis in this paper that we intend to pursue in future research. A very straightforward one is to analyze the optimality of the political economy allocation.

CHAPTER 4
CONCLUSION: POLICY DISCUSSION AND EXTENSIONS

Policy discussion

The present research offers several policy insights. A direct consideration revolves around addressing the question of what can be done within the frameworks presented in this dissertation to influence political incentives and, consequently, reduce labor informality. The most straightforward response involves adjusting the contribution rate to social security, which is assumed to be fixed in the modeled environment. It is important to recall that we argue that changing the contribution rate is more politically costly for politicians (e.g., changes usually require approval from the congress) than adjusting the level of enforcement of labor formality, which is a more straightforward administrative decision.

The recommendation would be to explore ways to enhance the flexibility of the rate of contribution to social security so that changes in the environment ultimately influence the determination of the contribution rate instead of directly impacting labor formality. As argued throughout the chapters of this dissertation, these environmental changes, likely to significantly influence the incentives politicians face in enforcing labor formality, are associated with shifts in income inequality and the share of retired workers in the economy. In this context, it seems preferable to adjust the contribution rate instead of allowing downturns in labor formality (or preventing upturns) because there is evidence that informality may have serious consequences for both individuals and the state. By allowing the contribution rate to flexibly adjust, formality is not adversely affected, and while adjusting the contribution rate might have serious consequences for financing already stressed social security schemes, these can be mitigated by compensating with other sources of funding.

In line with the previous idea lies a slightly different one. In the model in chapter 2, allowing for a differentiated contribution rate between workers with different income

levels makes it less harmful for politicians to enforce labor formality among large groups of the population, namely middle and low-income workers. In this context, it is useful to contrast the case of Chile, where there is a relatively high and flat social security contribution rate, and the government allows large groups of voters to access statutory exemptions to the mandate to contribute to pensions:[1] That is to say, large groups that are "legally informal." Table 1 indicates that, on average, 73% of the annual work time without social security contributions in Chile is attributed to statutory exemptions determined by politicians. Furthermore, the table reveals that individuals with at most a primary education are significantly more exposed to exempt jobs in a calendar year compared to those with some college attainment (2.9 months vs. 1.7 months on average).

	Fraction of the year the average individual:			
	Is employed	Works in an exempt job	Works evading contributions	Contributes to social security
Primary education	74%	24%	12%	38%
Secondary education	80%	20%	8%	52%
College education	81%	14%	4%	63%
Total	79%	19%	7%	53%

Table 4.1: The average employment status among Chilean workers within a calendar year.

Survey data is from the Chilean EPS panel (rounds 2002, 2004, 2006, 2009, 2012, and 2015). Admin. Data of monthly contributions to pensions is from the HPA panel (since May 1981). Columns show averages across both individuals and the 14 calendar years of the sample. Column (2) is constructed by adding participants in two categories of principal employment that were legally exempt from contributing to social security, as reported to the EPS: the self-employed and employers.

In contrast to the case of Chile, we find the case of the Netherlands, where the rate of formal employment is extremely high (94.8% according to ILOSTAT). The case of the Netherlands is a very special one, even among developed countries where informality is very low, because of key features of the design of its pension scheme. Like many developed countries, the Netherlands has a multi-pillar pension scheme in which the first pillar corresponds to a flat basic non-contributory pension for everyone, funded with

[1] In particular, workers with lower income, as documented in great detail in one of my working papers with Salvador Valdes-Prieto (available at https://sites.google.com/view/leytonsamuel).

payroll taxes (thus, its funding still depends on labor formality, differently from the main model in this dissertation). What is more special is its second pillar, comprised of a fully-funded contributory pension for which the contribution rate is differentiated by the earnings of the worker.

More specifically, in the Netherlands' second pillar, contributions are only paid on the part of individual earnings exceeding 39%, and then they increase in a piece-wise manner. This is a feature shared by Switzerland too, where contributions are only paid on the part of individual earnings exceeding 27% (note that in Switzerland's case, labor formality is 98.4%). This does not mean that having a differentiated contribution rate will make Chile, or any other developing country, reach the formality levels observed in the Netherlands or Switzerland, especially since there are other countries not having differentiated contribution rates that show very high levels of labor formality too (e.g., Denmark at 92.4% or Germany at 96.8%).[2] But it supports the suggestion that having a contribution rate differentiated by earnings may be a good idea for preventing the negative incentives that politicians face for enforcing labor formality among low-income workers.

Extension of the analysis

The most important extension for this work is to include developed countries for the analyses in both chapters 2 and 3. Here, we are only considering developing countries, and the environment in both models resembles the one most likely to be found in a developing country. That is to say, countries having relatively small defined-contribution pension schemes (usually fully-funded), in combination with a basic pension, usually funded with taxes different from payroll taxes.[3] In the (still incomplete) Appendix to chapter 2, we propose a model in which income redistribution is done by politicians within the contributory pension pillar (i.e., is done with resources raised with payroll taxes, which depend on labor formality), and we see that the implications of the model are different. In particular, higher inequality generates higher labor formality in this case

[2] Data regarding nominal contribution rates can be found at the OECD website data regarding employment (in)formality rates can be found at ILOSTAT.

[3] Developing countries, especially in LA, are heavily dependent on VAT because it is relatively easier to levy, and because it does not depend on having a highly formalized labor market

because the only way that politicians can get resources for redistributing —which helps them win elections, according to probabilistic voting— depends on labor formality.

The next steps in this context are to fully derive the very simple version of a political economy equilibrium in the context of a PAYG pension scheme featuring defined benefits, present in the Appendix of chapter 2. Then, the plan is to include OECD countries in the sample and repeat the empirical analysis we have done for developing countries with a specific focus on countries featuring pension schemes with the aforementioned characteristics.

A second extension is more structural, and relates to address the discussion between causality between inequality and informality. In this context, it is convenient to make the model more complex and allow for inequality to be endogenous by, for example, allowing workers to invest in education.

Appendix

APPENDIX A

Appendix to Chapter 2

A.1 Political equilibrium with PAYG pensions

In the present appendix we will show that the main theoretical result of the paper, i.e., the degree of enforcement of contributions to social security by politicians, is robust to assuming a different design for the pension and re-distributive scheme. Specifically, we assume that there is a PAYG pension scheme comprised of a transfer that is uniformly distributed among retire workers. The transfer is financed with a proportional tax on labor income of active workers. The contribution rate (i.e., the payroll tax rate) is exogenous, but the government decides in a probabilistic voting framework on the degree of enforcement, which is specific to the worker's productivity type. In summary, politicians have three policy tools, but they can freely decide on two of them and the balanced budget condition determines the third one.

We have the same four agent types: active high-productivity workers, active low- productivity workers, retired high-productivity workers, and retired low-productivity workers. The proportion of high-productivity workers within a generation remains constant at μ. Differently to the case where we assume a FF-DC pension scheme, here there is no need to a non-contributory transfer for retired workers (financed with lump sum taxes on active workers), because redistribution can be done within the contributory pension scheme.

A.1.1 Consumption and life-time utility of workers

Active workers (indexed by y) in generation t, characterized by productivity levels $j \in \{h(high); l(low)\}$ receive an exogenous wage w_t^j. Workers can avoid paying payroll taxes by working in the informal sector, thus it is the responsibility of the government to

determine the fraction p_t^j of time (i.e., the degree of enforcement) during which these workers engage in jobs where they pay the social security contribution rate θ.

$$c_t^{y,j} = w_t^j(p_t^j(1-\theta) + (1-p_t^j)) - a_{t+1}^j \tag{A.1}$$

where a_{t+1}^j is the amount of private savings.

Consumption of retired workers (indexed by o) in the same generation, exhibiting productivity j, is the following:

$$c_{t+1}^{o,j} = a_{t+1}^j(1+r) + B_{t+1} \tag{A.2}$$

where B_{t+1} is a pension benefit financed with payroll taxes paid by current active workers in the formal sector.

Given that workers are forced to retire from the labor market at the end of the first period of their lives, we can define consumption of retired workers of generation $t-1$, as follows:

$$c_t^{o,j} = a_t(1+r) + B_t \tag{A.3}$$

Finally, for simplicity we assume a logarithmic utility function and that labor supply is inelastic and normalized to one. We can represent life-time utility of young workers of productivity type j, belonging to generation t, as follows:

$$V_t^{y,j}(c_t^{y,j}, c_{t+1}^{o,j}) = log(c_t^{y,j}) + \beta log(c_{t+1}^{o,j}) \tag{A.4}$$

where β is the subjective discount factor.

The utility of retired workers of productivity type j that belong to generation $t-1$, is the following:

$$V_t^{o,j}(c_t^{o,j}) = log(c_t^{o,j}) \tag{A.5}$$

A.1.2 Solving the optimization problem of the individual

Active workers of productivity type j that belong to generation t, maximize their life-time utility by choosing their inter-temporal consumption allocation:

$$\max_{c_t^{y,j}, c_{t+1}^{o,j}} V_t^{y,j}(c_t^{y,j}, c_{t+1}^{o,j}) \tag{A.6}$$

subject to a non-negativity constraint on savings, implying that they cannot burrow money:

$$a_{t+1}^j \geq 0 \tag{A.7}$$

After solving, we get the following expressions comprising the solution to the individual decision problem:

$$c_t^{y,j} = \frac{(1+r)w_t^j(1-p_t^j\theta) + B_{t+1}}{(1+r)(1+\beta)} \quad \forall t, j \tag{A.8}$$

$$c_{t+1}^{o,j} \leq \beta\frac{(1+r)w_t^j(1-p_t^j\theta) + B_{t+1}}{(1+r)(1+\beta)} \quad \forall t, j \tag{A.9}$$

Retired workers solved an analogous problem the previous period (i.e., when they were active in the labor market). However, they do not face any decisions while they are retired; their consumption is residual, but can be increased by the government through the pension transfer B_t.

A.1.3 The political economy equilibrium

In the political equilibrium, policy is determined through a two-candidate probabilistic voting model *à la* Lindbeck and Weibull (1987), that boils down to the weighted maximization of life-time utility of all agents alive at period t. The "political" aggregation of preferences of voters in the economy can be summarized by expression W, which entails the assumption that agents across two different generations exert the same political influence.

$$W = \mu V_t^{y,h} + (1-\mu)V_t^{y,l} + \mu V_t^{o,h} + (1-\mu)V_t^{o,l} \tag{A.10}$$

The political parties maximize expression W with respect to p_t^j (degree of enforcement of labor formality) and with respect to B_t (the uniform pension transfer). The government faces a budget constraint that we assume has to be balanced every period t:

$$\mu p_t^h w_t^h \theta + (1-\mu) p_t^l w_t^l \theta = \mu \epsilon B_t \tag{A.11}$$

where ϵ is the population weight of retired workers relative to active workers.

Generally speaking, the "monitoring" cost (i.e., we may refer to it as the real cost of enforcement) is given by function C_t, that in this case we assume to be equal to zero, regardless of the productivity type of workers:

$$C_t(p_t^j) = 0 \quad \forall t, j \tag{A.12}$$

While this assumption may not be very realistic, making it is even more demanding for our purposes; in fact, we want to show that, due to political-economy considerations, the degree of enforcement of labor formality that the government exerts may still be different from one, even in a frictionless environment.

Finally, to obtain an analytical solution, we make the assumption of no wage growth, i.e., $w_t^j = w_{t+1}^j = w^j$ for all periods t and productivity types j. This assumption renders the political problem static, meaning that $p_t^h = p_{t-1}^h = p^h$, $p_t^l = p_{t-1}^l = p^l$, and $B_{t+1} = B_t = B$.

The first order conditions of the problem are the following, where λ is the Lagrange multiplier for the budget constraint of the PAYG pension scheme:

$$[p^h] : \frac{(1+\beta)(1+r)}{(1+r)(1-p^h\theta)w^h + B} = \lambda \tag{A.13}$$

$$[p^l] : \frac{(1+\beta)(1+r)}{(1+r)(1-p^l\theta)w^l + B} = \lambda \tag{A.14}$$

$$[B]: \frac{\mu(1+\beta+\epsilon\gamma)}{(1+r)(1-p^h\theta)w^h+B}+\frac{(1-\mu)(1+\beta+\epsilon\gamma)+}{(1+r)(1-p^l\theta)w^l+B}=\lambda\epsilon \tag{A.15}$$

Working with the first two first order conditions, we reach that the following relation between p_t^h and p_t^l must be satisfied at all time:

$$(1-p^h\theta)w^h=(1-p^l\theta)w^l \tag{A.16}$$

Under Assumption 2 and Assumption 3, defined in the main text, we will have an interior solution for p^h and p^l. It is straightforward to see that in the case of an interior solution, if $w^h > w^l$ —which is always true by definition— $p^h > p^l$.

A.2 Political equilibrium with FF-DC pensions and flat lump-sum taxes

A.2.1 Consumption and life-time utility of workers

Active workers (indexed by y) in generation t, characterized by productivity levels $j \in \{h(high); l(low)\}$ receive an exogenous wage w_t^j. Workers can avoid paying payroll taxes by working in the informal sector, thus it is the responsibility of the government to determine the fraction p_t^j of time (i.e., the degree of enforcement) during which these workers engage in jobs where they pay the social security contribution rate θ.

$$c_t^{y,j}=w_t^j(p_t^j(1-\theta)+(1-p_t^j))-a_{t+1}^j-\tau_t \tag{A.17}$$

where a_{t+1}^j is the amount of private savings and τ_t is a lump sum tax on active workers.

Consumption of retired workers (indexed by o) in the same generation, exhibiting productivity j, is the following:

$$c_{t+1}^{o,j}=a_{t+1}^j(1+r)+A_{t+1}^j+T_{t+1}^j \tag{A.18}$$

where A_{t+1} is a pension asset that equals the amount of money the worker contributed to social security in the past (i.e., FF-DC pension scheme); T_{t+1}^j is a transfer for retire

workers, which is specific to the worker's type, and is financed with the lump sum tax on active workers.

Given that workers are forced to retire from the labor market at the end of the first period of their lives, we can define consumption of retired workers of generation $t-1$, as follows:

$$c_t^{o,j} = a_t(1+r) + A_t^j + T_t^j \tag{A.19}$$

Finally, for simplicity we assume a logarithmic utility function. Thus, we can represent life-time utility of young workers of productivity type j, belonging to generation t, as follows:

$$V_t^{y,j}(c_t^{y,j}, c_{t+1}^{o,j}) = log(c_t^{y,j}) + \beta log(c_{t+1}^{o,j}) \tag{A.20}$$

where β is the subjective discount factor.

The utility of retired workers of productivity type j that belong to generation $t-1$, is the following:

$$V_t^{o,j}(c_t^{o,j}) = log(c_t^{o,j}) \tag{A.21}$$

A.2.2 Solving the optimization problem of the individual

Active workers of productivity type j that belong to generation t, maximize their life-time utility by choosing their inter-temporal consumption allocation:

$$\max_{c_t^{y,j}, c_{t+1}^{o,j}} V_t^{y,j}(c_t^{y,j}, c_{t+1}^{o,j}) \tag{A.22}$$

subject to a non-negativity constraint on savings, implying that they cannot burrow money:

$$a_{t+1}^j \geq 0 \tag{A.23}$$

After solving, we get the following expressions comprising the solution to the individual decision problem:

$$c_t^{y,j} = \frac{(1+r)[w_t^j(1-p_t^j\theta)-\tau_t]+A_{t+1}^j+T_{t+1}^j}{(1+r)(1+\beta)} \quad \forall t,j \tag{A.24}$$

$$c_{t+1}^{o,j} \leq \beta\frac{(1+r)[w_t^j(1-p_t^j\theta)-\tau_t]+A_{t+1}^j+T_{t+1}^j}{(1+\beta)} \quad \forall t,j \tag{A.25}$$

Similarly, the amount of private savings as function of the parameters of the model and the policy variables, is the following:

$$a_{t+1} = \frac{\beta(1+r)[w_t^j(1-p_t^j\theta)-\tau_t]+(1+\eta)(A_{t+1}^j+T_{t+1}^j)}{(1+r)(1+\beta)} \quad \forall t,j \tag{A.26}$$

Retired workers solved an analogous problem the previous period (i.e., when they were active in the labor market). However, they do not face any decisions while they are retired; their consumption is residual, but can be increased by the government through the transfer T_t^j.

A.2.3 The political economy equilibrium

In the political equilibrium, policy is determined through a two-candidate probabilistic voting model *à la* Lindbeck and Weibull (1987), that boils down to the weighted maximization of life-time utility of all agents alive at period t.

$$W = \mu V_t^{y,h} + (1-\mu)V_t^{y,l} + \mu V_t^{o,h} + (1-\mu)V_t^{o,l} \tag{A.27}$$

The political parties maximize expression W with respect to p_t^j (degree of enforcement of labor formality) —which determines A_{t+1}— and with respect to T_t^j (the non-contributory transfer allocated to current retired workers). The government faces a budget constraint that we assume has to be balanced every period t:

$$\tau_t = \epsilon\mu T_t^h - \epsilon(1-\mu)T_t^l \tag{A.28}$$

We assume that there is a FF-DC pension scheme in place, meaning that the government gives back to workers the contributions they made to social security when they where working in the first period of their lives:

$$p_t^j \theta w_t^j = A_{t+1}^j \quad \forall t, j \tag{A.29}$$

Generally speaking, the "monitoring" cost (i.e., we may refer to it as the real cost of enforcement) is given by function C_t, that in this case we assume to be equal to zero, regardless of the productivity type of workers:

$$C_t(p_t^j) = 0 \quad \forall t, j \tag{A.30}$$

While this assumption may not be very realistic, making it is even more demanding for our purposes; in fact, we want to show that, due to political-economy considerations, the degree of enforcement of labor formality that the government exerts may still be different from one, even in a frictionless environment.

Finally, to obtain an analytical solution, we make the assumption of no wage growth, i.e., $w_t^j = w_{t+1}^j = w^j$ for all periods t and productivity types j. This assumption renders the political problem static. By solving the political problem we reach the following solution for the size of the non-contributory pension scheme:

$$T^l = (1+r)\frac{(1+r)\epsilon\mu(w^h - w^l) + w^l}{(1+r)\epsilon - 1} \tag{A.31}$$

$$T^h = (1+r)\frac{w^h - (1+r)\epsilon(1-\mu)(w^h - w^l)}{(1+r)\epsilon - 1} \tag{A.32}$$

$$\tau = \epsilon(1+r)\frac{\mu w^h - (1-\mu)w^l}{(1+r)\epsilon - 1} \tag{A.33}$$

Then, under Assumption 1 to Assumption 3, the government chooses the level of enforcement, p^j, that perfectly substitutes private savings for each agent of productivity type j. In this context, the main theoretical result in this paper holds, i.e., $p^h > p^l$, as long as $T^l > T^h$, which is a condition that is always satisfied when $w^h > w^l$ and $(1+r)\epsilon > 1$.

List of Tables

List of Figures

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