Welfare Impacts of Social Security Reform: The Case of Chile in 1981*

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January 29, 2018

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Abstract

In May 1981, Chile became the first country to address the unsustainability of its pay-as-you-go Social Security program by reforming to a system of individual retirement accounts. In order to quantify the welfare impact of the Chilean reform, I use an overlapping generations model with three main components: multiple productivity types, a government policy modeled on the Chilean system, and a household decision to split working time between a taxed formal sector, an untaxed informal sector, and home production. Blue-collar workers, who pay lower payroll taxes but receive lower pensions prior to the reform, and white-collar workers, who pay higher taxes and receive more generous pensions, experience long-run welfare gains of roughly 25 and 30 percent, respectively. Transitional generations of both types experience welfare losses up to 1 percent. Economies without informality and home production exhibit lower long-run welfare gains. Excluding the options for households to work informally and at home decreases welfare gains for two reasons: (1) both informality and home production increase labor supply elasticity and cause the pay-as-you-go payroll tax to be more distortionary; and (2) informality allows workers to take advantage of long-run wage increases from the reform without facing the distortion caused by remaining labor taxation.

JEL Classification: H55, E13

Keywords: Social Security, retirement, Chile, informal labor, home production

*I am grateful to Ellen McGrattan, Loukas Karabarbounis, and Chris Phelan for their guidance and advice. Additionally, I would like to thank Anmol Bhandari, Kyle Herkenhoff, and workshop participants at the University of Minnesota for their comments. I would also like to thank all seminar participants at FRB of Atlanta for questions and comments that helped me improve the paper. All remaining errors are mine. Technical appendix can be found on my website: https://sites.google.com/a/umn.edu/kathleen-mckiernan/research

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1 Introduction

In May 1981, Chile transitioned its pay-as-you-go (PAYG) Social Security system to a mandatory savings program comprising private, individual retirement accounts. In the years that followed, this change has inspired other countries in Latin America, as well as countries throughout the world, to make changes to their own retirement systems. In the aftermath of the Chilean reform, ten other countries within Latin America took on reformed programs inspired by the new Chilean system.[1] Additionally, countries all across the globe have reformed their Social Security systems[2] to include individual retirement accounts.[3] Many other countries, including the United States, however, have not moved away from their pay-as-you-go systems. The case of Chile provides a case study of the impact of Social Security privatization.

Under the pay-as-you-go system prior to 1981, payroll tax income from current workers is used to fund the pensions of current retirees. Formal sector workers pay a payroll tax while they are in the labor force, and they are entitled to a government-funded pension during their retirement years. The value of the pension received is a function of two things: the type of employment the worker has (whether he is a manual laborer or salaried worker for example) and the average annual earnings received from work in the taxed, formal sector. Under the new private account system created after the 1981 reform, retirement consumption is funded with individual savings. Workers are required to save a portion of monthly earnings into an account from which they pull upon after retirement. The movement between these systems is represented as a decrease in the payroll tax that a worker faces and the elimination of a government-funded pension during retirement.

[1] The Latin American countries that reformed to systems inspired by the Chilean model are: Argentina (1994), Bolivia (1997), Colombia (1993), Costa Rica (1995), Dominican Republic (2003), El Salvador (1998), Mexico (1997), Panama (2008), Peru (1993), and Uruguay (1996).

[2] Countries included in this category are: Bulgaria (2000), Croatia (2001), Denmark (2002), Estonia (2002), Hungary (1998), Kazakhstan (1998), Kosovo (2002), Latvia (2001), Nigeria (2001), Poland (1999), Russia (2002), Singapore (1997), Slovakia (2005), and Sweden (1999).

[3] These countries may not have systems that are entirely funded by private accounts, but at least part of their retirement funding programs include private, individual retirement accounts.

As the economy moves between the two programs, the government must address issues on how to fund the transitional costs of reform. Because workers are automatically enrolled in the new program, income from payroll taxes drops as new workers are not subject to the contribution tax. However, the policy must compensate current workers and retirees for the contributions they had previously made to the pay-as-you program. Through the study of Chile, I measure the transitional welfare impact of such a reform.

To address the question I build an overlapping generations (OLG) model with three main components: age and productivity heterogeneity, a government policy based upon the specifics of the Chilean reform, and multiple sectors of production to represent the formal and informal sectors and home production. Each of these factors gives me the flexibility to address different questions related to the reform. With age and productivity heterogeneity I can study how people with different income levels and age at the time of the reform are impacted differently by the policy change. Modeling the specifics of the Chilean reform allows me to isolate how specific parts of the reform impact welfare. Finally, including the formal sector, the informal sector, and home production allows me to clarify the impact of reform, depending upon how labor moves between the various sectors.

I start by separating the household labor supply into two broad categories: market labor and home labor. Market labor receives a wage, and home labor is used as an input into a home production function. As wages change due to general equilibrium effects during the reform, the incentives for market and home labor supply change. Additionally, I separate market labor into two categories: formal labor and informal labor. Formal labor is defined as any contracted work which is subject to government regulation. This means that workers are required to pay labor income taxes and are entitled to pension benefits during retirement. Informal labor, on the other hand, evades such regulation; informal workers do not pay labor taxes and do not receive pensions from the government. Incentives for formal and informal labor supply will change due to changes in the labor income tax and pension benefits. Movements between these three sectors have different economic impacts. Changes in formal

labor supply over time affects government labor income tax revenue as well as the value of transfers to retirees. Changes in total market labor (the sum of formal and informal labor), on the other hand, impacts the wage. Because of these differences, the impact of changes in the pension program will be different based on how labor incentives change throughout the transition.

Using micro-data for the Chilean economy[4], I estimate the parameters that discipline the relationship between home production and market labor as well as those that discipline the relationship between formal and informal labor supply. In addition to using this micro-data, I ensure that the model is consistent with various macroeconomic aggregates and use the government policy to construct historical series for the fiscal variables. By using this data, I can quantitatively measure the welfare impact of the transition between the pay-as-you-go and the privatized system of individual accounts.

In order to measure these welfare gains, I simulate the economy in two situations: one in which the reform occurs as it did historically, and a second as if the economy remained in the pay-as-you-go system from 1980. The results of this experiment show that long-run welfare gains are present due to the reform: blue-collar workers, who pay lower contribution rates and receive less generous pay-as-you-go pensions, experience gains of roughly 25 percent of lifetime consumption and white-collar workers, who pay higher contribution rates and receive larger pensions prior to the reform, experience gains of nearly 30 percent. However, generations–of both productivity types–that live through the transition between the two programs experience welfare losses up to 1 percent of remaining lifetime consumption due to the lower pensions that come from the transitional policy used to compensate these generations for previous pay-as-you-go contributions. Because of falling labor tax income

[4]Esta investigación utilizó información de la Encuesta de Protección Social. El autor agradece a la Subsecretaría de Previsión social, propietaria intelectual de la Encuesta, la autorización para usar la Base de Datos Innominada. Todos los resultados del estudio son de responsabilidad del autor y en nada comprometen a dicha Subsecretaría.

This research used information from the Social Protection Survey. The author thanks the Subsecretary of Social Prevision, the intellectual owner of the Survey, for the authorization to use the anonymous database. All the results of the study are the responsibility of the author and not of the aforementioned Subsecretary.

due to the removal of the Social Security contribution rate, the government cannot use additional transfers to compensate for the loss in pension income.

In order to address the impact of the outside options to formal sector work, I study how the removal of informality and home production changes the results. In an economy without informality but with the option of home production, long-run welfare gains are around 13 percent; reform causes welfare gains of nearly 10 percent in an economy without both informality and home production. There are two causes for these lower welfare gains. First, both home production and informality increase labor supply elasticity by providing households with an outside option to the formal sector. This increased labor supply elasticity increases the distortionary nature of the Social Security payroll tax. Therefore, welfare gains are higher in economies that include home production and informality. Second, the presence of the informal sector provides households with a way to take advantage of wage increases without facing the distortions association with labor taxation that remains as the payroll tax decreases. This remaining labor tax is also more distortionary due to the increased elasticity. Because Social Security reform drives long-run wage increases and informal workers receive these higher wages without paying the labor tax, economies that include an informal sector achieve higher welfare gains from reform.

The paper precedes as follows. Section 2 introduces the related literature. Section 3 discusses the background of the Chilean pension system before and after the reform. Section 4 describes the model. Section 5 details how parameters are estimated from the data. Section 6 presents the results. Section 7 concludes.

2 Literature Review

The literature on privatization of Social Security systems is expansive. There are two areas of the Social Security reform literature most closely related to the work I present in this paper: welfare studies of Social Security reform and microeconomic studies on the impact of

the Chilean reform.

Most papers involving the transition to a system of individual accounts in the United States come to a similar conclusion that there are positive long-run gains to switching from a pay-as-you-go system to an individual account system. These papers, however, disagree on whether it is possible to devise a system in which the welfare gains of future generations are not financed by welfare losses for those living through the transition.

Huang, Imrohoroglu, and Sargent (1997) study a transition in which the government compensates the current generations by issuing debt. Although future taxes can be lowered, the taxes must remain high while the government pays off the debt. Kotlikoff, Smetters, and Walliser (1999) study many different policies and find that privatization has long-run gains that come with short-run costs. Finally, studies such as Conesa and Krueger (1999), Nishiyama and Smetters (2007), Huggett and Parra (2010), and Imrohoroglu and Kitao (2012) find that adding uncertainty makes the transition to privatization even more challenging due to losses in the insurance provided by the Social Security program.

On the other hand, papers such as McGrattan and Prescott (2017) are able to find a system in which all agents experience welfare gains by flattening the tax schedule and removing the difference between average and marginal tax rates. Although they disagree on the transitional dynamics, all these papers document the long-term welfare gains of a reform in the United States.

In this paper, I study the long-term and transitional welfare impact of a reform in a Chilean economy that exhibits very different properties than the economy in the United States, specifically the presence of large informal and home production sectors. Dotsey, Li, and Yang (2015) study how the inclusion of home production affects the transitional welfare results from Social Security reform. They find that the option to work at home increases labor supply elasticity and leaves the Social Security payroll tax more distortionary. Therefore, the inclusion of home production increases the long-run welfare gains from the reform. The addition of informal work introduces another outside option for household hours which is

present in the Chilean economy.

Feldstein (1998) presents a series of papers that discuss privatization of Social Security programs in various countries, including Chile. Edwards (1998) discusses the Chilean reform provides a background of the economy of Chile prior to and after the reform as well as transitional issues associated with the reform.[5]

In addition to this, much of the literature on the Chilean reform is concentrated on micro-level implications of the reform. Specifically, the literature focuses on details of the reform or on the labor force decisions of agents. Arenas de Mesa et. al. (2007) assesses the reformed system through studies of coverage, outcomes, and financial literacy 25 years after the reform; Acua and Iglesias (2001) address the impacts on similar variables after 20 years. Much work in this literature also comes in response to additional changes made to the Chilean system in 2008.[6] Behrman et. al. (2011) analyzes the effects of the minimum pension levels on the household income, labor choices, health status, and spending behavior of the individuals. Additionally, Joubert (2010) and Joubert (2015) study the relationship between the design of the pension system and how it impacts the labor decision of the agent. Joubert and Todd (2011) and Arenas de Mesa and Montecinos (1999) extends the work of the prior two papers to study how the design impacts men and women differently. Specific to the economy of Chile, these papers, as well as Attanasio, Meghir, and Otero (2011), examine the impact that the pension changes have on the labor force participation in both the formal and the informal sectors of the economy. They find that increases in self-financed pension wealth negatively affects labor force participation in the formal sector. In this paper, I include features such as a two-sector labor market in a macroeconomic model to capture the labor decisions noted in previous work.

[5] Additional details of the Chilean system before and after the reform can be found in Kritzer (2005, 2008) and Kritzer, Kay, and Sinha (2011).

[6] The 2008 changes to the Social Security system were made in response to problems with agents, specifically women, not being able to accumulate a sufficient pension. The additional reforms made it possible for women to receive benefits without working 20 years, allowed her to be entitled to half of her husband's pension after a divorce, and gave a credit to a woman's for having a child. I will not consider the details of this reform when I analyze the impacts of the 1981 reform.

In addition to the literature on Social Security reform, I also contribute to the empirical literature on home production. I contribute by using micro-data to empirically measure the elasticities of substitution associated with home production in Chile. A large literature, including Benhabib, Rogerson, and Wright (1991), has studied home production and the implications of including home production in economic models. Additionally, previous literature has also used data to measure the parameters that drive the interaction between market and home production. Using data from the United States, various papers such as Rupert, Rogerson, and Wright (1995), McGrattan, Rogerson, and Wright (1997), Chang and Schorfheide (2003), Fang and Zhu (2012), and Aguiar, Hurst, and Kararbarbounis (2013), estimate the elasticity of substitution between market and home production to be between 1.81 and 2.3. I use micro-data for Chile in order to estimate the same elasticities for the Chilean economy.

3 Background of the Chilean Economy

In order to study the impact of the Social Security reform in Chile, important details of the Chilean economy need to be included in the analysis. In the context of this project, these important details are related to the labor market and government Social Security policy. Specifically, this paper includes details of formal and informal sectors of the economy and the Social Security systems before and after the 1981 reform.

3.1 Formal and Informal Sectors

Many countries, including Chile, have economies that are characterized by informal sectors. Informality is defined as a sector of the economy which evades the regulation of and does not receive the benefits or protection of the government programs. While informality originally was used to describe self employment, the definition has been extended to cover wage positions in unprotected jobs.

When looking at the Chilean data, informality can be defined in two ways: a worker being hired without an employment contract or a worker (with or without a contract) not contributing to a social protection or pension system. In 2004, 73 percent of workers had a signed employment contract, and 63 percent of workers contributed to some pension program.[7] Table 1 shows overlap between these two definitions. Most people with a signed contract also contribute to a pension program and most people who are not actively contributing also do not have a signed contract. Only around 3 percent of workers in 2004 have a signed contract but do not contribute. Additionally, another 3 percent of workers who do not have a contract contribute to a pension system. Because of the overlap, I choose a single definition of informality. In this paper, I will use the first definition of informality; a worker is classified as informal if he or she does not have a signed employment contract in their position.

Table 1: Overlap Between Definitions of Informality

	Contributing to a pension system	Not Contributing to a pension system
Has a signed contract	70.17	2.87
Does not have a signed contract	3.42	23.55

Source: Encuesta de Protección Social (2004)

The presence of an informal sector is a challenge for the design of a Social Security program. In the context of a Social Security system, workers in the informal sector do not pay the Social Security payroll tax and do not receive a pension during retirement. The size of the informal sector directly impacts the payroll tax income received and the transfers paid by the government.

[7] In 2006, 75 percent of workers had a signed employment contract, and 67 percent of workers contributed to some pension program.
Source: Encuesta de Protección Social (2004, 2006)

3.2 Social Security Before the 1981 Reform

The Chilean Social Security reform of 1981 replaced a pay-as-you-go system with a retirement age of 65 for men and 60 for women. This old system (called the INP system[8]) was comprised of many different pension institutions. Each of these institutions, known as *Cajas de Prevision,* covered the pensions for a subset of the population. Because each of the *Cajas de Prevision* was independent, the pensions were dependent on the employer. Each institution had its own contribution and indexation rates, benefit levels, and requirements for retirement. However, 94 percent of the population was covered under one of three main systems for salaried workers (white-collar), manual laborers (blue-collar), and government employees. Other smaller funds had fewer than 1,000 members each. The agents were required to contribute to the system, through a payroll tax, for 20 years before they were eligible for pension benefits.[9]

Although each pension institution had different a indexation rate for calculating benefits, all institutions calculated benefits as a percentage of average earnings. Average earnings were calculated over the five years prior to retirement. This was constant over all funds; retirees could receive different percentages of this average depending on the institution. Due to the reform, the system was heavily simplified by introducing a single method of retirement funding for everyone.[10]

3.3 Social Security After the 1981 Reform

The new system, called the AFP system[11], began in May 1981. The INP system was immediately closed to new entrants, and all workers who entered the workforce after this date were automatically enrolled in the new AFP system. Workers who had already made contri-

[8] INP=*Instituto de Normalizacion Previsional*

[9] Agents were not required to contribute for 20 consecutive years. Rather agents must contribute for a total of 80 quarters prior to retirement in order to receive the Social Security benefits.

[10] Government and military workers have their own pension system and are exempt from enrolling in the AFP system.

[11] AFP=*Administradoras de Fondos de Pensiones*

butions to the INP system were given five years to decide whether they would switch to the AFP program. In order to induce workers from the old system to switch to the new system, workers were offered two things. First, workers were offered a one time 17 percent increase in net income.[12] Second, those who switched were given a recognition bond to represent the contributions they had made to the old INP system. These inducements encouraged 90 percent of the workers covered under the old system to switch to the reformed system by 1986.

After the reform occurred in 1981, the rules changed. The payroll tax is eliminated, but the workers are now required to contribute 10 percent of monthly earnings up to a ceiling.[13] These contributions are tax-deferred and difficult to draw from before retirement.[14] In addition to the mandatory savings, Chilean workers are required to contribute 7 percent of monthly earnings for health insurance and around 3 percent of monthly earnings for survivor and disability insurance as well as administrative fees. The worker can choose to invest his funds in one of the AFP firms who manage and invest the contributions. These firms compete amongst themselves. Those that do not perform sufficiently for the workers' funds are dissolved.

Specifically, the Chilean government imposes a lower and upper limit on the returns an AFP must pay its members. If a fund over-performs[15], excess returns are placed in a profitability reserve. If the fund then under-performs in future years, reserves[16] are used to

[12]The Chilean government mandated firms to give this income raise to workers who switched. Firms were willing to give such an increase as the employer contribution included in the old system was removed when moving to the reformed system. High inflation during this time raises questions on whether this caused any real increase in worker income.

[13]The ceiling for monthly contributions is 66 Unidades de Fomento (UF). Unidades de Fomento is a Chilean unit of account constantly adjusted to inflation so that the value of the UF remains constant or nearly constant during times of low inflation. As of 2015, 66 UF is equivalent to nearly $2500. Agents also have the option to contribute up to an additional 48 UF tax-deferred if they choose.

[14]There are very strict restrictions on withdrawing funds from the account before retirement. These restrictions are more restrictive than those on US 401K plans.

[15]Under-performing in this context is if the AFP fund achieves a return of 50 percent of 2 percentage points lower than the average across AFPs. Over-performing, on the hand, occurs if the fund acheives a return of 50 percent or 2 percentage points higher than the average across AFPs.

[16]In addition to the profitability reserve, AFPs must hold an investment reserve of that amounts to at least 1 percent of the total value of the fund and is invested in a portfolio that exactly mimics that of the fund.

make up the difference between the actual return and the minimum return guaranteed by the state. If the AFP cannot meet the requirements with its reserves, it is liquidated, the government makes up the difference between the return and the minimum guarantee, and all contributors transfer their funds to another AFP.

Individuals can access their retirement savings funds at age 65 for men and age 60 for women. The law permits early retirement if the worker has accumulated an amount greater than 110 percent of the minimum pension guaranteed by the government. The pension must be greater than 50 percent of the average of taxable income over the last ten years. Non-contributory retirement income is available either through a welfare pension that is independent of contribution history or through a minimum pension guarantee that is available only to workers who contributed sufficiently but whose funds were not able to fund a higher pension. All workers over age 65 are eligible for a welfare pension, called PASIS. The PASIS pension is around one-third of the minimum wages. If an agent has made more than 20 years of contributions, he is eligible for the minimum pension guarantee (MPG). This pension is about twice the PASIS pension.

4 Model

I use an overlapping generations model with heterogeneous households to analyze the impact of the 1981 Chilean Social Security reform. The economy is populated by households that differ in age and productivity. Productivity is constant throughout a household's lifetime. Time since entry into the workforce is called the age of the household and denoted by j. A measure $\mu_t^{1,\varepsilon}$ enter as working age (age 1) households with skill level ε at the beginning of period t. $\mu_t^{j,\varepsilon}$ is the measure of households of age j and skill level ε. There is no survival uncertainty in the economy, and all households die at age J. All households retire at age R, $R < J$.

4.1 State Vector

The state vector of the economy is defined as:

- t: the time period
- $a^{j,\varepsilon}, \mu^{j,\varepsilon}$: the assets of an age j and skill level ε household and the measure $\mu^{j,\varepsilon}$ of these households
- $\overline{y}^{j,\varepsilon}, \mu^{j,\varepsilon}$: the average annual taxable earnings of an age j and skill level ε household and the measure $\mu^{j,\varepsilon}$ of these households
- B : the government debt owned by the households
- K_m : the aggregate stock of market capital

In what follows, $S_t = (B_t, K_{mt})$ is defined as the aggregate state of the economy in period t

4.2 Household's Problem

The value function of an agent of age $j \epsilon \{1, ..., J\}$ with skill or productivity level ε is given by:

$$V_j(a_t, \overline{y}_t, S_t; \varepsilon) = \max_{a_{t+1}, c_{mt}, d_t, h_{ft}, h_{it}, h_{ht}} u(c_t, l_t) + \beta V_{j+1}(a_{t+1}, \overline{y}_{t+1}, S_{t+1}; \varepsilon)$$

Households of age j and productivity ε enter period t with asset holdings a_t and average taxable income $\overline{y}_t$ as well as an aggregate state S_t. Utility takes consumption and leisure as inputs into the function $u(\cdot)$.

$$c_t = h(c_{mt}, c_{ht})$$

$$l_t = 1 - h_{mt} - h_{ht}$$

Consumption is defined by a function, h, of consumption of a tradable market good, c_{mt}, and consumption of a non-trabable home produced good, c_{ht}. Leisure is a linear function

of hours spent working in the market, h_{mt}, and hours spent working at home, h_{ht}. Market labor is a function of the time spent working in the formal sector and the time spent working in the informal sector of the economy.

$$h_{mt} = \Gamma\left(h_{ft}, h_{it}\right)$$

The household maximizes utility subject to budget constraints for market and home produced goods. The budget constraint for market goods is given by the following:

$$\left(1+\tau_{ct}\right)\left(c_{mt}+d_t\right)+a_{t+1} = \left(1+r_t\right)a_t + w_t\varepsilon\left(h_{ft}+h_{it}\right) - T_t^j\left(w_t\varepsilon h_{ft}, \overline{y}_t\right)$$

Households choose consumption of the market consumption good, c_{mt}, and spending on durable goods, d_t. The household pays a consumption tax, τ_{ct}, on consumption of both goods. Additionally, the household chooses savings for period $t+1$, a_{t+1}. The income side of the market budget constraint is made up of three items. First, the household receives interest on the savings from the previous period. Second, the household receives a wage, w_t, for hours worked in the formal and informal sectors. Finally, the household pays taxes and receives transfers according to a net tax function, T_t^j. This net tax function is given by the following equation:

$$T_t^j = \tau_{ht} w_t \varepsilon h_{ft} - \psi_j^R\left(\overline{y}_t\right) - \psi^c$$

The household pays a labor income tax, τ_{ht}, on the income received for work in the formal sector of the economy. It then receives a retirement transfer, $\psi^R\left(\overline{y}_t\right)$ which is dependent on the average taxable earnings in period t. Finally, the household receives a common transfer, ψ^C which is independent of age, skill, and lifetime labor supply decisions. During working years, the value of the retirement transfer is 0. During retirement, households do not work in the market. Therefore, labor tax paid during retirement is 0 and the function simplifies to only the transfers.

Spending on durable goods, d_t, from the market budget constraint and the hours spent working in the home production sector are used as inputs into the production of the non-tradable home produced good. The budget constraint for home production states that consumption of the home produced good must be equal to the output of the home production function, g.

$$c_{ht} = g(d_t, h_{ht})$$

The individual states, a_t and $\overline{y}_t$, evolve based on the choices of savings, a_{t+1}, and formal sector work, h_{ft}. Specifically, savings are set as the chosen asset holdings for period $t+1$ and average taxable income evolves based on the following equation:

$$\overline{y}_{t+1} = \begin{cases} \frac{(j-1)\overline{y}_t + w_t \varepsilon h_{ft}}{j} & ,\text{if } j \leq R \\ \overline{y}_t & ,\text{if } j > R \end{cases}$$

The aggregate states of the economy evolve with a function, G, that is assumed to be known by the household.

$$S_{t+1} = G\left(S_t\right)$$

4.3 Technology

The production function for the market sector good is given as follows:

$$Y_t = f\left(K_{mt}, H_{ft} + H_{it}\right)$$

Formal sector production uses aggregate market capital and aggregate market labor supply, where aggregate market labor supply is the sum of aggregate formal labor and aggregate informal labor. Additionally, capital evolves according to the following equation, where δ represents depreciation and X_{mt} is investment in market capital.

$$K_{mt+1} = (1-\delta)K_{mt} + X_{mt}$$

Prices, consisting of the return on capital and the wage, are set equal to the marginal products of capital and labor, respectively, in the market sector.

$$r_t = f_K\left(K_{mt}, H_{ft} + H_{it}\right) - \delta$$

$$w_t = f_H\left(K_{mt}, H_{ft} + H_{it}\right)$$

4.4 Government

Government policy is defined as a series of sequences, $\{\tau_{ct}, \tau_{pt}, \tau_{dt}, T_t^j(\cdot), B_t, G_t\}$. τ_{ct} denotes a tax rate on consumption. τ_{pt} represents a tax on accounting profits of the firm. τ_{dt} is a tax on distributions of the firm.

In order to define the budget constraint of the government, profits and firm distributions must be defined. Accounting profits of the firm, Π_t, and the distributions of these firms, Δ_t, are given by the following equations:

$$\Pi_t = Y_t - w_t\left(H_{ft} + H_{it}\right) - \delta K_{mt}$$

$$\Delta_t = \left(1 - \tau_{pt}\right)\Pi_t - K_{mt+1} + K_{mt}$$

Additionally, $T_t^{j,\varepsilon}(\cdot)$ represents the net tax function from the household problem which combines the payroll tax, retirement transfers, and common transfers. B_t denotes government debt, and G_t represents government consumption of a pure public good.

The government budget constraint is defined as:

$$B_{t+1} + \tau_{ct}\left(C_{mt} + D_t\right) + \tau_{pt}\Pi_t + \tau_{dt}\Delta_t + \sum_{j,\varepsilon} \mu_t^{j,\varepsilon} T_t^{j,\varepsilon}\left(w_t \varepsilon h_{ft}, \overline{y}_t\right) = \left(1 + r_t\right)B_t + G_t$$

On the revenue side of the government budget constraint are issuance of new debt, B_{t+1}, and collection of taxes. These taxes are the consumption tax on market consumption and durable

spending, the profit tax on accounting profits of the firm, the distributions tax on the firm's distributions, and the outcome of the net tax function. The budget constraint requires that revenue must be equal to government spending. Government spending is the sum of interest paid on the debt from the previous period, $(1 + r_t) B_t$ and government spending on a pure public good, G_t.

Assume that government debt and government spending are a percentage of output. Specifically,

$$B_t = \phi_B Y_t$$

$$G_t = \phi_G Y_t$$

4.5 Equilibrium

An equilibrium is given by government policies, prices, and allocations such that:[17]

1. Given the government policies, interest rate, and wage rate, the value functions and allocations solve the household's maximization problem given the state variables
2. The price of each factor is equal to its marginal product
3. The government budget constraint holds in each period
4. All markets clear

5 Parameters

I will use data and prior literature to set three categories of parameters. First, the details of the pension reform policy and aggregate data on government revenue and spending is used to set government policy parameters and fiscal policy time series. Second, survey data is used to estimate the parameters governing home production and market labor supply decisions.

[17] Detailed equilibrium definition is given in the appendix.

Finally, other model parameters will be internally calibrated to aggregate data or set based on prior literature.

5.1 Government Policy Parameters and Fiscal Series

Prior to 1981, pension benefits were dependent on employment. Different types of workers faced different rules in regards to contribution rates and indexation rates. The two largest funds were those covering manual laborers and salaried workers. Based on this, I choose to model the details of the pension programs for two groups: blue-collar workers, who represent manual laborers, and white-collar workers, who represent salaried workers. The program for blue-collar workers is known as Servicio de Seguro Social (SSS), and the program for white-collar workers is called Caja de Empleados Particulares (EMPART).

Contribution Rates

Prior to the reform, each of the two main systems had differing contribution rates for both employees and employers. Employees paid a percentage of earnings and employers contributed a percentage of the payroll bill to the pension fund. Table 2 shows these contribution rates. Prior to the reform, blue-collar employees pay 7.25 percent of income to pension funds; employers contribute 15.95 percent of payroll. Under the program for white-collar workers, employees contribute 16.67 percent and employers contribute 10.83 percent. I assume that the employer contributions are passed through to workers and are combined into the payroll tax of the agent. After the reform occurred, agents who switched between the programs faced different tax rates from those who chose to stay under the pay-as-you-go program. Those who switched now only pay the tax used for survivor and disability insurance. This rate is 7 percent. Workers who stayed under the previous program, on the other hand, now faced higher tax rates. Blue-collar workers now must contribute 18.9 percent to the pension program while white-collar workers contribute 19.9 percent.

Retirement Transfers

Table 2: Contribution Rates by Type of Employment

Effective Date and Type of Worker	% paid by –	
	Employee	Employer
Old System		
Before 1981,		
Servicio de Seguro Social (SSS)	7.25	15.95
Caja de Empleados Particulares (EMPART)	16.67	10.83
After 1981,		
SSS	18.9	0.0
EMPART	19.9	0.0
New System		
	7*	0.0

* Note: the 7% contribution rate under the new system is calculated based on the contribution for health insurance and disability insurance.

The form of the Social Security transfers received by the retired households will be dependent on the time period in question, whether the cohort was in the labor force at the time of the reform, and whether a household chooses to switch between the programs. This work assumes that all agents immediately switch to the individual account system.[18] Therefore, the government transfers will be dependent only on the time period and the birth-year cohort of the household. Note that for any worker who is not of retirement age, $\psi_t^R = 0$. Consider the transfers for retired workers in 3 different cases:

$$\psi_t^R = \begin{cases} \zeta^{\varepsilon}\overline{y}_t & \text{Before the reform} \\ \frac{1}{J-R}\left[0.8\overline{y}_t\left(\frac{t^*-t_0}{35}\right)\nu_G\nu_A(1.04)^{R-t^*}\right] & \text{Cohorts who entered the workforce prior to the reform and switched} \\ \max\left\{0, \underline{c} - \left(\frac{R-1}{J-R}\right) * (0.1\overline{y}_t)\right\} & \text{Cohorts who entered the workforce after to the reform} \end{cases}$$

Case 1: Prior to the reform

[18] This is a reasonable assumption as 77 percent of workers covered until the PAYG system had chosen to switch to the new system by 1983; 90 percent of workers had chosen to switch by 1986.

$$\zeta^{\varepsilon}\overline{y}_t$$

Under the pay-as-you-go Social Security system, agents are entitled to some percentage ζ^{ε}, known as the indexation rate, of working-age income. This working-age income is calculated as the average income over the five years prior to retirement.[19] Additionally, the indexation rate varies by profession, or skill in the model. SSS entitles blue-collar households to receive up to 70 percent of pensionable wages during retirement.[20] EMPART gives white-collar workers 100 percent of pensionable wages during retirement.[21]

$$\zeta^{\varepsilon} = \begin{cases} 0.70 & , \ SSS \\ 1.00 & , \ EMPART \end{cases}$$

Note that this case would also cover those workers who entered the workforce prior to the reform but chose not the switch to the new program.

Case 2: Agents who entered the workforce before the reform

$$\frac{1}{J-R}\left[0.8\overline{y}\left(\frac{t^*-t_0}{35}\right)\nu_G\nu_A(1.04)^{R-t^*}\right]$$

Households who entered the workforce prior to the reform and chose to change to the new system receive transfers that represent the recognition bond. The value of this bond is given by the formula above. t^* represents the time period in which the reform occurred, and t_0 represents the year a particular agent entered the workforce. This recognition bond represents the Social Security payouts the agent should receive for the contributions that had already been made. This formula is calculated from three elements: 80 percent of pensionable salaries[22], a correction for years of contributions, and a correction for age and

[19] Rather than using average income for the 5 years prior to retirement, I use an average over total working life in order to calculate benefits. I do this in order to simplify the transfers through the transition. By using this, I can use the same state variable to calculate transfer under all three cases.

[20] Under SSS, agents receive 50 percent of pensionable wages after 10 years of contributions to the program and 1 percent for each year of contributions over 10 years. This is capped at 70 percent of pensionable wages. Under this system, pensionable salary is calculated as the average of salary for the 5 years prior to retirement. This value is not indexed to inflation.

[21] Under EMPART, pensionable wages are calculated as the average of the wages for the five years prior to retirement where the most recent two years are indexed to inflation.

[22] In the calculation of the recognition bond, pensionable salaries are calculated based on all earnings received prior to April 1979.

gender.

It is assumed that 35 years is the number of contribution needed to receive a normal pension. Therefore, the calculation of 80 percent of the average earnings for the twelve months prior to June 1979 is multiplied by the ratio of the years contributed to 35.

The value of the recognition bond is then also corrected for both age and gender. ν_G corrects for gender. This value is 10.35 for men and 11.36 for women. I use a value of 11. ν_A varies based on both the age and gender of the agent.[23] It varies between 1 and 1.11 for men and 1 and 1.31 for women.[24] I will use a value of 1.15 for the family.[25]

The recognition bond received a 4 percent real return. Therefore, interest on the bond is compounded based on the years between the reform and the time period that the agent retires. This interest is added to the amount the agent receives.

This calculation gives the total sum of money received by the worker as a representation of the previous contributions to the pay-as-you-go system. I assume that an equal amount is paid out to the retiree in each period of retirement. Therefore, this total is divided by the number of years spent in retirement, $J - R$.[26]

Case 3: Agents who entered the workforce after the reform

All agents who entered the workforce after the reform occurred are immediately enrolled in the new system. Under this system, retirement consumption is funded through individual savings. The government, however, guarantees a minimum pension if accumulated savings are not sufficient. If agents accumulate sufficient assets, transfers in this case are 0. This policy is top-up in construction. This means that if savings are not sufficient to fund a higher pension, government transfers are equal to the difference between the savings of the

[23]This correction is set so that men who enter the new system at age 61 or older and women who enter at age 42 or older receive additional benefit.

[24]In 1980, there were no pension benefits for married couples. Therefore, I model the pension of an agent rather than the pension of a household.

[25]Future versions of the paper will contain sensitivity on how the value of this parameter changes results.

[26]This is a simplifying assumption. I do not allow household to receive the bond as lump sum and save in assets that receive higher returns. This is an extension that will be added in future versions.

agent and the minimum guaranteed by the government. The minimum pension guarantee is around two-thirds the minimum wage.[27]

$$\max\left\{0, \underline{c} - \left(\frac{R-1}{J-R}\right) * (0.1\overline{y}_t)\right\}$$

The second term in the max function represents the amount that would be received if savings cannot fund a sufficient pension. $\underline{c}$ represents the lower bound the government set on retirement consumption. $\left(\frac{R-1}{J-R}\right) * (0.1\overline{y}_t)$ represents the retirement savings of the household split equally between the years of retirement. I assume all agents save the 10 percent of wages required by law. This 10 percent of taxable income is multiplied by the number of years spent working, $R-1$, and divided by the years of retirement, $J-R$.

Fiscal Variables

Additionally, time series for government debt, government spending on defense, aggregate spending on social programs and consumption taxes are calculated from the data.[28]

5.2 Home Production and Market Labor Supply Parameters

In this stage, instrumental variables regression analysis is used to estimate the parameters governing home production and market labor supply. In particular, I estimate the parameters of the following CES functions.

$$c_t = h\left(c_{mt}, c_{ht}\right) = \left\{a_1 c_{mt}^{b_1} + \left(1-a_1\right) c_{ht}^{b_1}\right\}^{1/b_1}$$

$$h_{mt} = \Gamma\left(h_{ft}, h_{it}\right) = \left\{a_2 h_{ft}^{b_2} + \left(1-a_2\right) h_{it}^{b_2}\right\}^{1/b_2}$$

$$c_{ht} = g\left(d_t, h_{ht}\right) = \left\{a_3 d_t^{b_3} + \left(1-a_3\right) h_{ht}^{b_3}\right\}^{1/b_3}$$

[27] In 1980, minimum wage was around 48,000 Chilean pesos.

[28] More discussion on the time series for these government policy variables is included in the technical appendix.

5.2.1 Data and Sample

Data for this estimation comes from two sources. First is Encuesta Nacional Sobre el Uso del Tiempo (ENUT) – a time use survey that contains a representative sample of the Chilean population. The 2015 survey is used in the analysis. The second data source used in the Encuesta de Protección Social (EPS). This is a longitudinal study which contains a representative sample of the national population. The 2004, 2006, and 2009 waves are used in the estimation.[29] The data from the first survey, ENUT, is used in order to estimate how the hours of home work vary across various observable characteristics which are present in both data sets. The results are then used to impute values of home work for individuals present in the EPS. The EPS data with imputed home work is then used to estimate the parameters $a_1, b_1, a_2, b_2, a_3, b_3$.

ENUT is a two-part survey. The first part is a household questionnaire containing demographic and socioeconomic information for the individual and the household. The second part of the survey is a time use questionnaire in which the respondent answers the amount of time spent on various activities in the last day. They are surveyed on one week day and one weekend day. My sample contains only individuals who responded to both the household questionnaire and the time use questionnaire. 21,960 individuals responded to both questionnaires. The final sample used is the subset of these respondents who are between the age of 25 and 80 who reported that nothing out of the ordinary occurred in the last week. The final sample contains 13,614 individual. This comes out to 62 percent of the the total sample.

The estimation sample from the EPS is constructed as a combination of the household responses from the 2004, 2006, and 2009 waves of the survey.[30] A sample from each cross-

[29]The 2002 waves of the EPS is representative of only those individuals and household that are affiliated with the pension system. As of the 2004 waves, the survey was corrected to be representative of the population as a whole. I choose to use the nationally representative 2004, 2006, and 2009 waves as I want to consider the impact of informal laborers who are not necessarily affiliated with the pension system.

[30]Results from the estimation of the parameters of cross-sections from each year are also included in the appendix.

section is first constructed. The final sample is created as a panel of households observed in at least two consecutive cross-sections. The three waves of the survey contain 16,727; 16,443; and 14,463 households respectively. The final sample for each year cross-section contains the responses for households in which the head of the household is working age[31] and works at least 30 hours per week for at least 40 weeks per year. This assumption is made as data on income support programs and their interaction with the labor supply is not included. The final sample also includes all households with non-zero spending on non-durable and durable consumption. The final samples for 2004, 2006, and 2009 contain 7,985 households (48 percent of the original sample), 7,055 households (43 percent of the original sample), and 5,322 households (37 percent of the original sample). The final panel sample contains 8,996 households.

5.2.2 Estimation and Results

The following regression equations are derived from the first order conditions of structural model. This procedure builds upon the methodology used in the literature related to home production.[32] The extension here includes the derivation of an equation relating formal labor supply to informal labor supply. The results of estimating these equations gives an understanding of the how households substitute between various decisions. At the same time, estimation of these equations gives a relation between the data and the parameters of the structural model. These equations are derived from three marginal conditions of the structural model: the relationship between the marginal utility of formal labor and informal labor, the relationship between the marginal utility from home hours and durable spending, and the relationship between the marginal utility gained from market consumption and durable spending.[33] Households substitute between decisions based on relative prices and

[31]By excluding agents who are not working age, I also remove agents who receive minimum pensions from the government. This is done because data on this pension transfer and its impact on labor supply is not included in the analysis.

[32]Papers in this literature include Rupert, Rogerson, and Wright (1994) and Fang and Zhu (2012).

[33]Derivation of these regression equations is described in the technical appendix.

the substitutability of other decisions.

$$\ln\left[\frac{h_f}{h_i}\right] = \beta_0 + \beta_1 \ln\left[1-\tau_h\right] + \varepsilon_1 \tag{1}$$

where $\beta_0 = \frac{1}{b_2-1}\ln\left[\frac{1-a_2}{a_2}\right]$ and $\beta_1 = \frac{1}{b_2-1}$

$$\ln\left[\frac{h_h}{d}\right] = \beta_2 + \beta_3 \ln\left[\frac{\left(1-\tau_h\right)w\varepsilon}{\left(1+\tau_c\right)}\right] + \beta_4 \ln\left[1+\frac{1-a_2}{a_2}\left(\frac{h_i}{h_f}\right)^{b_2}\right] + \varepsilon_2 \tag{2}$$

where $\beta_2 = \frac{1}{b_3-1}\ln\left[\frac{a_3}{1-a_3}\right] - \frac{1}{b_2(b_3-1)}\ln\left[a_2\right]$, $\beta_3 = \frac{1}{b_3-1}$, and $\beta_4 = \frac{b_2-1}{b_2(b_3-1)}$

$$\ln\left[\frac{c_m}{d}\right] = \beta_5 + \beta_6 \ln\left[1+\frac{1-a_3}{a_3}\left(\frac{h_h}{d}\right)^{b_3}\right] + \varepsilon_3 \tag{3}$$

where $\beta_5 = \frac{1}{b_1-1}\ln\left[\frac{1-a_1}{a_1}\right] + \frac{b_1}{b_3(b_1-1)}\ln\left[a_2\right]$ and $\beta_6 = \frac{b_2-b_3}{b_3(b_1-1)}$

A few issues must be discussed in the estimation procedure. First, the log-linear structure of the regressions limits the estimation to observations without corner solutions. These corner solutions can occur in both labor supply and consumption decisions. The number of corner solution in consumption (durable and non-durable) and home work hours are minimized by the way in which the data is constructed. First, zero spending on consumption is minimized by aggregating the data to the household level and including housing spending in the measure of durable consumption. Also, because hours of home work is imputed based on the observables available there are no corner solutions in home work hours. For these reasons, I am not concerned with bias caused by the omission of corner solutions in these equations. Only 25 percent of households in 2004, 22 percent in 2006, and 16 percent of households in 2009 have positive number of annual hours in both the formal and informal sectors. Therefore, there is reason to be concerned about bias caused by the exclusion of the corners in this first regression. While inclusion of these corner solutions changes the estimates, the magnitude of these changes is minimal.[34]

[34]Sensitivity analysis on including these corner solutions is included in the technical appendix.

Another issue of the estimation that must be considered is whether the independent variables are correlated with the error term. For example, it is reasonable to believe that the labor income tax rate is correlated with the amount of work in the formal sector but also things such as education level. For this reason, I used an instrumental variables approach. The instruments used are: age of the head of household, age of the head of household squared, education of the head of household, age of the spouse, age of the spouse squared, education of the spouse, a dummy for whether the household resides in Santiago, and lagged values of formal work, durable spending, and market consumption.[35] These instruments based upon the instruments used by Rupert, Rogerson, and Wright (1994)[36]. The validity of these instruments is verified with a Hausman test at standard significance levels.

Table 3 shows the results of the instrumental variables regressions; Table 4 shows the structural parameters constructed from these regression results. Formal and informal hours have equal weight in market hours and the two types of work are nearly perfect substitutes.[37] Home production is heavily weighted towards hours while total consumption is weighted to home consumption. The elasticities of substitution between durable spending and home hours in home production and market consumption and home consumption in total consumption show that these inputs are much less substitutable than formal and informal hours are in market hours. The standard errors for estimates on the parameters for total consumption and market hours are low, indicating precise estimate for the parameters. Standard errors for the home production function, however, are quite large. While these parameters may not be precisely estimated from the data, the values are comparable to estimates found

[35]By including the age of spouse and education of spouse as instruments in the IV regression, the sample excludes households consisting of a single member or households with only one parent. 69 percent of population in 2004 was in a married or co-habitating relationship.

[36]Due to differences in the data and modeling, these are not the exact instruments used in Rupert, Rogerson, and Wright (1994). They use age of husband, age of husband squared, age of wife, age of wife squared, the wife's education, lagged consumption, lagged wife's home work, and dummies for whether living in a SMSA, whether covered by a union, and whether living in the South in order to estimate the home production elasticity.

[37]The elasticity of substitution in these equations is given by $\varepsilon = \frac{1}{1-b_i}$. A value of $b_i = 1$ is associated with perfect substitutes, $b_i = 0$ is Cobb-Douglas, and $b_i = -\infty$ is associated with perfect complements.

Table 3: Regression Results

	(1)	(2)	(3)
constant	0.248**	0.835	0.001
	(0.107)	(1.358)	(0.424)
$\ln[1-\tau_h]$	−11.221**		
	(5.586)		
$\ln\left[\frac{(1-\tau_h)w\varepsilon}{(1+\tau_c)}\right]$		−0.930***	
		(0.170)	
$\ln\left[1+\frac{1-a_2}{a_2}\left(\frac{h_i}{h_f}\right)^{b_2}\right]$		0.039	
		(0.039)	
$\ln\left[1+\frac{1-a_3}{a_3}\left(\frac{h_h}{d}\right)^{b_3}\right]$			0.418**
			(0.207)
N	7012	9236	9236

Source: Encuesta Nacional Sobre el Uso del Tiempo (2015), Encuesta de Protección Social (2004, 2006, 2009)

*$p \leq 0.1$, **$p \leq 0.05$, ***$p \leq 0.01$

in studies of the United States.[38] Therefore, this should not bias my results.

5.3 Other Parameters

The remaining parameters are either set outside the model based on previous literature or internally calibrated to match macroeconomic aggregates. These parameters are shown in Table 5.

5.3.1 Parameters Set Outside the Model

Coefficient of Relative Risk Aversion

In order to set a value for the coefficient of relative risk aversion, I look to other papers which use a utility function that is non-separable between consumption and leisure as well

[38] I performed the same estimation procedure on data for the United States. In this exercise, I find estimates in the ranges of the estimates found by other researchers. Details on this test is in the technical appendix.

Table 4: Estimated Parameter Values

Function	Estimate (SE)		Estimate (SE)	
$\left\{a_1 c_m^{b_1} + (1-a_1)\, c_h^{b_1}\right\}^{1/b_1}$	$a_1 =$	0.228 (0.003)	$b_1 =$	0.208 (0.058)
$\left\{a_2 h_f^{b_2} + (1-a_2)\, h_i^{b_2}\right\}^{1/b_2}$	$a_2 =$	0.506 (0.005)	$b_2 =$	0.911 (0.044)
$\left\{a_3 d^{b_3} + (1-a_3)\, h_h^{b_3}\right\}^{1/b_3}$	$a_3 =$	0.162 (0.176)	$b_3 =$	0.311 (0.197)

as papers in the home production literature. In these literatures, σ is usually set between 1.5 and 4[39]. I set $\sigma = 2$ in the analysis that follows.

Production Parameters

I choose a Cobb-Douglas function for the market production function:

$$Y_t = (K_{mt})^{\alpha} (H_{ft} + H_{it})^{1-\alpha}$$

The weight of capital in market consumption, α, and the depreciation rate of capital, δ, are also set outside the model. In accordance to other literature, I set $\alpha = 0.33$ and $\delta = 0.05$ in the analysis.[40]

5.3.2 Internally Calibrated

In the final stage of the estimation, three parameters are internally calibrated to match macroeconomic aggregates in 1980. The discount factor, β, the weight of consumption in utility, γ, and the productivity term by type, ε, are set so as to match the capital-output

[39] Auerbach et. al. (1999), for example, uses a value of $\sigma = 4$ while Dotsey, Li, and Yang (2015) sets $\sigma = 1.5$. Results for $\sigma = 4$ are shown in the appendix.

[40] More discussion of the choice for the depreciation rate is in the construction of the capital stock series.

Table 5: Other Parameters

Parameter	Description	Value	Target	Source
β	Discount rate	0.925	$\frac{K}{Y} = 1.678$	National Accounts
γ	Weight of consumption in utility	0.456	Annual hours worked per worker = 2572	OECD
ε	Productivity	$\{0.60, 1.00\}$	$\frac{w\varepsilon_1\left(H_f^1+H_i^1\right)}{w\varepsilon\left(H_f+H_i\right)} = 0.640$	EOD 1980
α	Weight of capital in production	0.33		
δ	Depreciation	0.05		
σ	Risk aversion	2		

ratio of the economy, the aggregate hours worked, and the fraction of total labor income received by each of the types.

The aggregate data used to calculate the target moments come from three sources. First of these sources is historical Chilean National Accounts. The capital-to-output ratio is calculated from this source. National account data provides time series for investment and GDP that are used in this calculation. A time series for the capital stock is constructed using this data.[41] The calculation returns a ratio of capital-to-output of 1.678 for 1980.

The second data source, OECD aggregates, is used for the measure of annual hours worked per worker. Data shows that annual hours worked per worker in Chile was 2,572 hours per year. I assume discretionary time per week is 100 hours. Therefore, the fraction of time spent working is 0.495.

Finally, productivity terms in the model are chosen in order to match the fraction of labor income received by each of the types in the model. As described above, these types represent blue-collar and white-collar workers. The employment survey Encuesta de Ocupación y

[41] Details on the construction of the capital stock series is discussed in the technical appendix.

Desocupación en El Gran Santiago (EOD) is used to calculate the percentage of labor income received by each type.[42] Blue-collar workers are defined as workers, manual laborers, and domestic employees[43]; white-collar workers are defined as employers. Blue-collar workers make up 76 percent of the Chilean population in 1980 and receive 64 percent of the labor income. White-collar workers make up 24 percent of the population and receive 36 percent of labor income. The model reproduces these fractions when $\varepsilon = \{\varepsilon_1, \varepsilon_2\} = \{0.60, 1.00\}$

6 Results

In order to assess the impact of the 1981 Chilean reform, I perform an experiment in which I compare the transition path of the economy under two scenarios. First, I consider an economy in which the pre-1981 pay-as-you-go Social Security system continued unchanged. In order to consider this case, I make an assumption that the government would have been able to continue to pay the pensions of retirees at the same rates without changing the payroll tax.[44] It is assumed that a per-capita lump sum transfer is adjusted in order to balance the government budget. Because historic data is used to form the other variables in the government budget constraint, this term represents the sum of two different items. One is the implicit transfer that is caused because I use marginal labor tax rates rather than average rates.[45] The other is measurement error or missing categories of data in the government budget constraint. Second, I compare the results of continuing the PAYG system with the results of the change to the mandatory savings program that occurred in Chile.

The transition path and the welfare impact of the policy change is reported. In both cases, the initial state is given by the steady state distributions of household asset holdings

[42] EOD is an employment survey for the Greater Santiago area. Demographic information from the 1982 Chilean census indicate the Santiago is representative of the national population. Therefore, the results from study of EOD are used as representative of the country. More information is contained in the appendix.

[43] While not a perfect translation, these types are classified as obreros, trabajadores, and empleados domesticos in the data.

[44] This is a strong assumption considering that most reform occur in response to failures or unsustainabilities in the system. Future versions of the paper will change this assumption.

[45] More on this implicit transfer is discussed in McGrattan and Prescott (2017).

and household average annual taxable income as well as the level of government debt in 1980. In the transition paths, historical data is used as inputs for the years 1980 to 2010. These inputs are: government debt; tax rates on consumption, labor income, and corporations; defense spending; and the population growth rate. After 2010, it is assumed that these variables grow or decline at a rate equal to the average growth from the years 2000-2010. I assume $t = 0$ is the year 1981, the year in which the Chilean reform occurred. I calculate the welfare impact on households of all ages and productivity levels that are in the labor force or retired at the time at the reform and for all new generations that enter the workforce after the reform. I assume that the policy change is unexpected, and that households operate under perfect foresight.

6.1 Continuation of PAYG Policy

Table 6 shows the evolution of aggregate variables, prices, and government revenue and spending on the transition path. Aggregate variables, interest rates, and wage rates are shown relative to the pre-reform steady state, which is normalized to 1. Government revenue and government spending variables are reported as percentages of GNP.

In the transition path in which the economy stays under the pay-as-you-go Social Security plan, output drops drastically. Much of this drop is driven by a drop in both formal and informal hours. Both types of market labor drop nearly 50 percent over the transition path. Note that both hours variables drop by the same amount. As the tax system does not change in this simulation, the trade-off between formal sector work and informal sector work stays constant. Therefore, as the incentives for home work increase due to the drop in the wage, total market work drops and there is no substitution between the sectors.

The substitution out of the market sector and into home production has two impacts on the government pension program. First, as household work fewer formal sector hours and receive less formal sector income, the revenue collected from the Social Security contribution tax decreases. However, due to the same decrease in formal hours, the average taxable earn-

ings of households entering retirement decrease. Therefore, the pensions these households receive also decrease. As the population ages throughout the transition path, the decreasing pensions received by households do not overcome the decreasing revenue collected due to fewer workers and fewer formal hours. The percentage of GNP spent on funding these pensions increases from 5.1 percent to 13.9 percent.

The continuation of this policy will be used as the reference point for the welfare comparison of the impact of the Chilean reform.

6.2 Transition from PAYG System to Private Account System

The results from the transition path associated with continuing the pay-as-you-go policy are compared with the transition path from the policy change due to the 1981 Chilean reform. The aggregate variables in this experiment are shown in Table 7.

The reform considered had two key impacts: one on the Social Security contribution rate and another on the transfers received by the retirees. First, the contribution rate fell to 0 for all household in the labor force and all future cohorts.[46] Second, the retirement transfer changes from the pay-as-you-go pension to the recognition bond for all those households in the workforce at the time of the reform or 0 (or the value of the minimum pension guarantee) for those households that enter the workforce after the reform occurred.

Even in the long, run, there is large increase in informal hours worked. This is due to two things. First, the wages increases throughout the transition, causing households to substitute from home production to the market sector. However, since only the contribution tax and not the general labor tax is removed, there is still a distortion on the labor decision of the agent. Therefore, these households who substitute into the market move to the informal sector. Households also substitute out of the formal sector and into the informal sector throughout the transition. However, unlike the transition in which the PAYG system continues, formal hours drop initially but increase throughout the transition path to a new steady state.

[46] The contribution rate falls to 0 for all household in the workforce due to the assumption that all household immediately switch between the programs at the time of the reform.

Table 6: Aggregates, Prices, and Government Budget through the Transition

Continue PAYG Policy

		1980	1981-1995	1996-2010	2011-2030	Steady State
Output		1.000	0.849	0.911	0.724	0.808
Capital Stock		1.000	0.781	0.867	0.939	0.701
Hours		1.000	0.762	0.754	0.695	0.711
	Formal Hours	1.000	0.558	0.589	0.483	0.528
	Informal Hours	1.000	0.631	0.663	0.544	0.595
	Home Hours	1.000	1.231	1.132	1.188	1.133
Consumption		1.000	0.893	0.845	0.866	0.892
	Market Consumption	1.000	0.869	0.833	0.845	0.899
	Durable Spending	1.000	0.870	0.838	0.847	0.910
	Home Consumption	1.000	0.907	0.852	0.879	0.888
Investment		1.000	0.737	1.132	0.791	0.603
Interest Rate		1.000	1.017	1.005	1.018	1.008
Wage		1.000	0.924	0.942	0.882	0.915
Consumption Tax		0.071	0.080	0.059	0.056	0.058
Labor Tax		0.211	0.197	0.195	0.189	0.192
Corporate Tax		0.047	0.078	0.063	0.075	0.091
Retirement Transfer		0.051	0.077	0.077	0.120	0.139
	PAYG Pension	0.051	0.077	0.077	0.120	0.139
	Recognition Bond	0.000	0.000	0.000	0.000	0.000
	MPG	0.000	0.000	0.000	0.000	0.000
Per-capita transfer		0.207	0.024	0.066	0.026	0.027

Note: Values for aggregates and prices are reported relative to the pre-reform steady state.
Values for government revenue and spending variables are reported as a percentage of GNP.

Consumption of both the market good and the home produced good increase in the long-run and through the transition. Most of the increase in consumption come from the market good, but spending on the durable input increases more than the increase in the market good consumption. While spending is put into the home production sector, the substitution of household hours into the market sector leads home production consumption to increase less than spending on durables.

Figure 1: Welfare Gains by Cohort

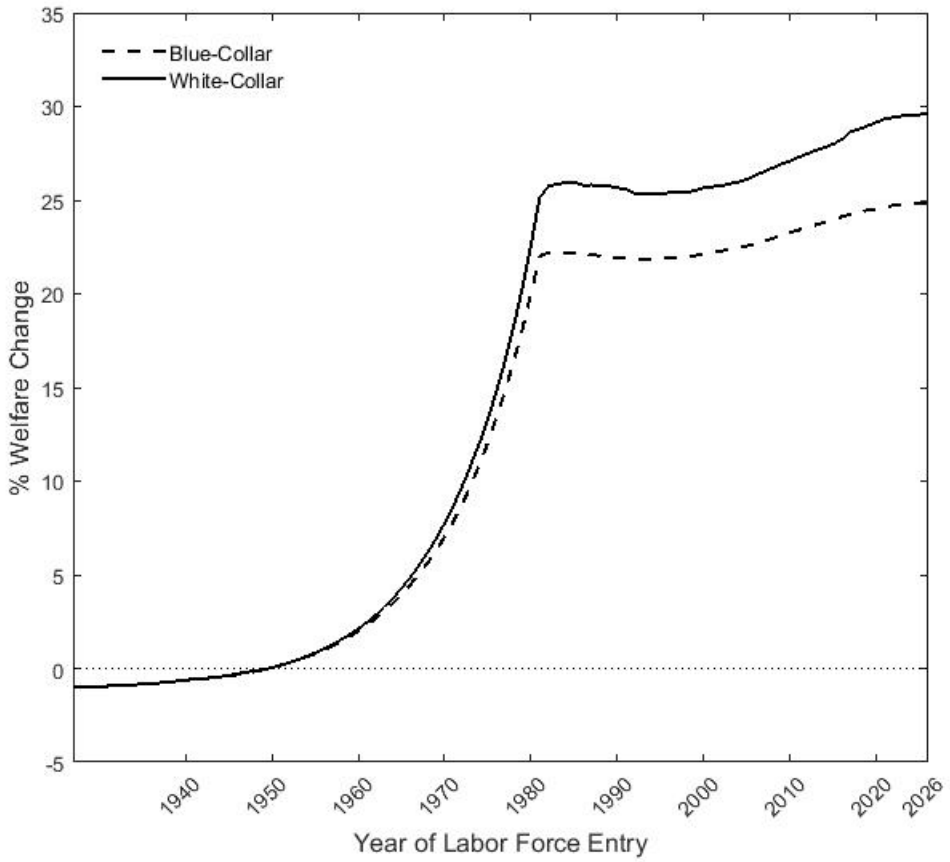


Figure 1 hows the welfare results from the movement to the mandatory savings program. Welfare is measured as the a percentage of remaining lifetime consumption for generations alive at the time of the reform and as a percentage of lifetime consumption for cohorts that enter the workforce after the reform has occurred. Due to the reform, future generations, and many generations that are in the workforce at the time of the reform, experience welfare

Table 7: Aggregates, Prices, and Government Budget through the Transition

Transition from PAYG to Current Chilean Policy

		1980	1981-1995	1996-2010	2011-2030	Steady State
Output		1.000	1.209	1.259	1.346	1.447
Capital Stock		1.000	0.782	0.854	0.924	1.103
Hours		1.000	0.760	0.737	0.735	0.730
	Formal Hours	1.000	0.577	0.569	0.595	0.611
	Informal Hours	1.000	1.172	1.156	1.210	1.242
	Home Hours	1.000	1.057	0.999	0.922	0.866
Consumption		1.000	1.064	1.060	1.072	1.123
	Market Consumption	1.000	1.161	1.183	1.234	1.339
	Durable Spending	1.000	1.192	1.224	1.289	1.414
	Home Consumption	1.000	1.010	0.991	0.980	1.001
Investment		1.000	1.732	1.802	2.204	1.984
Interest Rate		1.000	1.012	0.997	0.993	0.985
Wage		1.000	0.949	0.973	1.013	1.089
Consumption Tax		0.071	0.082	0.068	0.053	0.054
Labor Tax		0.211	0.126	0.124	0.126	0.129
Corporate Tax		0.047	0.071	0.076	0.065	0.067
Retirement Transfer		0.051	0.062	0.085	0.053	0.000
	PAYG Pension	0.051	0.000	0.000	0.000	0.000
	Recognition Bond	0.000	0.062	0.085	0.053	0.000
	MPG	0.000	0.000	0.000	0.000	0.000
Per-capita transfer		0.207	0.027	0.084	0.108	0.165

Note: Values for aggregates and prices are reported relative to the pre-reform steady state.
Values for government revenue and spending variables are reported as a percentage of GNP.

gains due to lower payroll taxation, higher wages, and higher lump-sum transfers from the government. White-collar workers receive higher welfare gains in the long-run as they faced higher Social Security contribution rates prior to the reform.

However, those cohorts that are retired at the time of the reform, in particular those who enter the workforce between the years of 1926 and 1950 (and therefore die between 1980 and 2004), experience slight welfare losses as pensions are lower than under pay-as-you-go and falling labor revenue does not allow transfers to increase to compensate for lower retirement income.

The structure of the bond used to compensate these workers who had contributed to the PAYG program drives these lower pensions. Recall the formula used to calculate the value of the per-period recognition bond received by the workers.

$$\frac{1}{J-R}\left[0.8\overline{y}\left(\frac{t^*-t_0}{35}\right)\nu_G\nu_A(1.04)^{R-t^*}\right]$$

where $\nu_G = 11$ and $\nu_A = 1.15$

While the formula for the bond is impacted by many different factors, the payout per period can be simplified to a percentage of average taxable earnings, $\overline{y}$. I will call this percentage the implied replacement rate of the recognition bond policy.[47] This implied replacement rate by cohort is shown in Figure 2. In addition to the function of the replacement rate, horizontal lines on the graph also show the replacement rate received by blue-collar workers prior to the reform (70 percent) and the replacement rate received by white-collar workers under the pay-as-you-go program (100 percent).

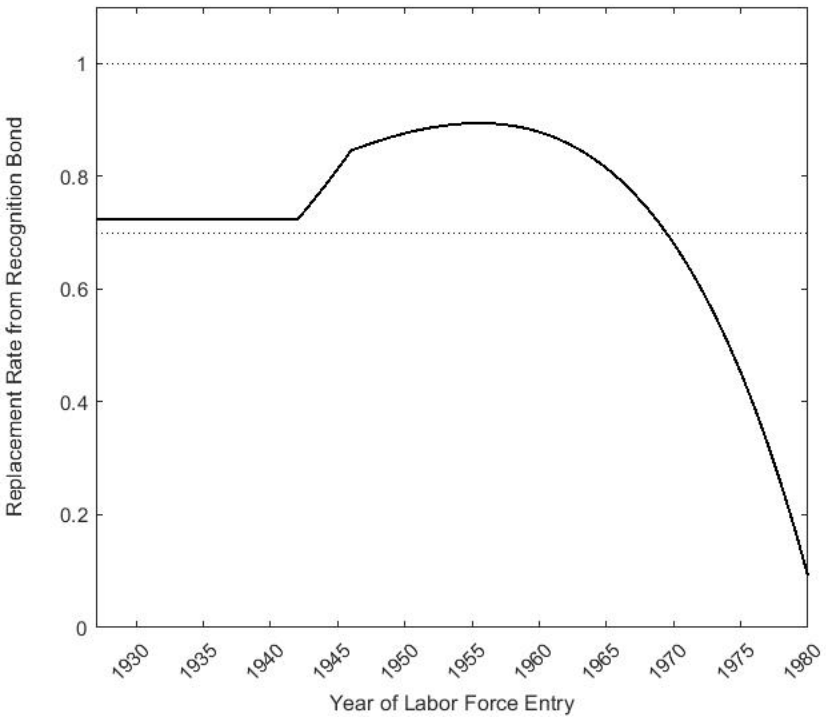
Notice that for the retired cohorts who experience the largest welfare losses, the implied replacement rate is 72.29 percent, only slightly above the pay-as-you-go replacement rate

[47] The implied replacement rate is calculated based on the following formula:

$$IRR = \frac{1}{J-R}\left[0.8\left(\frac{t^*-t_0}{35}\right)\nu_G\nu_A(1.04)^{R-t^*}\right]$$

Note that this is only the replacement rate for the recognition bond. Households who overlap between the two programs will also receive retirement income from the mandatory savings program.

Figure 2: Implied Replacement Rate from the Recognition Bond Policy



received by blue-collar workers, and well below the replacement rate received by white-collar workers prior to the reform. Since this implied replacement rate is higher than the rate received by blue-collar workers prior to the reform but lower than the rate given to white-collar workers, white-collar workers are hurt more by this falling pension wealth. Blue-collar households in these cohorts, on the other hand, receive slightly larger pensions due to the recognition bond policy. Later cohorts do not rely solely on the recognition bond for retirement income as they were able to build up private savings during working years. Therefore, later cohorts can receive welfare gains despite receiving pensions smaller than they would under PAYG.

By constructing a transitional policy that pays a flat rate that is below the average rate paid out under pay-as-you-go, the government burden is reduced. However, decreasing labor income revenue caused by the loss of the Social Security contribution rate, as well as the decrease in formal hours, causes lower per-capita transfers. These transfers must be lower

Table 8: Government Policy Data through the Transition

	1980-1985	1986-1990	1991-1995	1996-2000	2001-2008
Consumption Tax	0.125	0.108	0.126	0.119	0.095
Debt	0.647	0.454	0.150	0.101	0.079
Defense Spending	0.037	0.046	0.043	0.035	0.026
Per-capital Social Spending	375.73	286.81	363.21	506.35	502.59

Note: Consumption tax is reported as a percentage, debt and defense spending as a percentage of GDP, and the per-capita social spending in thousands of 2010 pesos.

in order to fund the pensions in the presence of the falling tax revenue. Since the per-capita transfer represents a larger fraction of the blue-collar households' incomes, the lower transfers hurt these low-productivity workers relatively more.

The losses for transitional generations are smaller than those reported in previous literature. The recognition bond policy combined with policy decisions reflected in the data cause these losses to be smaller than in previous research on Social Security privatization. First, the recognition bond policy allowed the government to immediately decrease its pension burden. As discussed above, the average percentage of taxable income paid out in the recognition bond is below the average paid under pay-as-you-go. This, combined with the fact that all households are immediately switched to the new program, decreases how much the government must pay. Because the path of future pension payments is smaller, transfers do not have to fall as much as they would under other reform alternatives.

Second, the Chilean government planned to deal with some of these costs through the choices of other fiscal variables. In particular, the paths of government debt and spending on social programs helped the government to decrease transitional welfare losses. Data for the paths of these variables is shown in Table 8. By increasing government debt and decreasing the spending on social programs, particularly through the years between 1980 and 1995, the government bolstered its revenue so transfers did not have to fall as much. An important

note here is that these series are used in both the transition where pay-as-you-go continued and the transition in which the reform occurred. Therefore, the falling social spending occurs in both the reference transition as well as the reformed transition so households do not experience welfare losses due to this spending. By using the same fiscal series in both transitions, the welfare losses generated by the model are minimized.

6.3 Impact of Informality and Home Production

The options of informality and home production are important elements to include for understanding the dynamics of the Chilean economy. The impact of these outside labor supply options hold important lessons for understanding the choices of households. In this section I will explore how first removing the option of working informally and second removing the options of working informally and working at home impact the evolution of aggregates as well as the welfare of the households. I consider an aggregate welfare impact in these experiments; I do not separate the population into blue-collar and white-collar workers. Similar to the previous experiment, welfare comparisons are made in reference to a transition path in which the economy remains under the pre-1981 pay-as-you-go program. Note that reference transition will change depending on the economy. For example, the transition path with the reform in an economy without informality is compared to a transition path in which pay-as-you-go continued in an economy without informality.

Both informal work and home production give households an outside option to working in the formal sector, and specifically an outside option to participating in the government Social Security system. However, the presence of the informal sector gives households an outside option to the governmental taxes and benefits while also receiving the market wage. Other papers have considered the impact of home production on Social Security programs[48], but in this paper, I will consider not only the impact of informality but also the interaction between informality and home production.

[48]See, for example, Dotsey, Li, and Yang (2015).

Table 9: Long-Run Changes in Baseline and Alternative Economies

Continue PAYG Policy

	Output	Capital Stock	Hours			Consumption	
			Formal	Informal	Home	Market	Home
Baseline	0.808	0.701		0.711		0.892	
			0.528	0.595	1.133	0.899	0.888
No Informal	0.643	0.758		0.876		0.895	
			0.721	—	1.116	0.805	0.962
No Informal or Home Production	0.842	0.918		0.857		1.095	
			0.857	—	—	1.095	—

* All values are reported relative to the pre-reform steady state.

Consideration of this interaction is important due to the overlap between the sectors. Some informal work can be classified into either of these two sectors. This paper defines informality as paid work that is done without a contract and evades regulation. However, any work that is done independently for monetary gain will be classified into home production. For example, a household that produces a good at home but sells that good in the market will not be classified as informal in my model. Rather, this activity will fall into home production. Since these activities are not classic home production activities, this sector in my model will contain activities that overlap between informality and home production. By considering removal of both informality and home production, I can address all of these activities.

Tables 9 and 10 show the long-run change in aggregates that occurs in the baseline economy as well as in the two alternative economies: an economy without the informal sector and an economy without an informal sector or a home production sector. Table 9 shows the results if the pay-as-you-go system had continued; Table 10 presents the transition path from the pay-as-you-go system to the individual account system.

The key feature that differentiates these three economies is that impact that the presence

Table 10: Long-Run Changes in Baseline and Alternative Economies

Transition from PAYG to Current Chilean Policy

	Output	Capital Stock	Hours			Consumption	
			Formal	Informal	Home	Market	Home
Baseline	1.447	1.103		0.730		1.123	
			0.611	1.242	0.866	1.339	1.001
No Informal	0.856	1.094		0.912		0.973	
			0.882	—	0.939	0.953	0.989
No Informal or Home Production	0.997	1.188		0.927		1.143	
			0.927	—	—	1.143	—

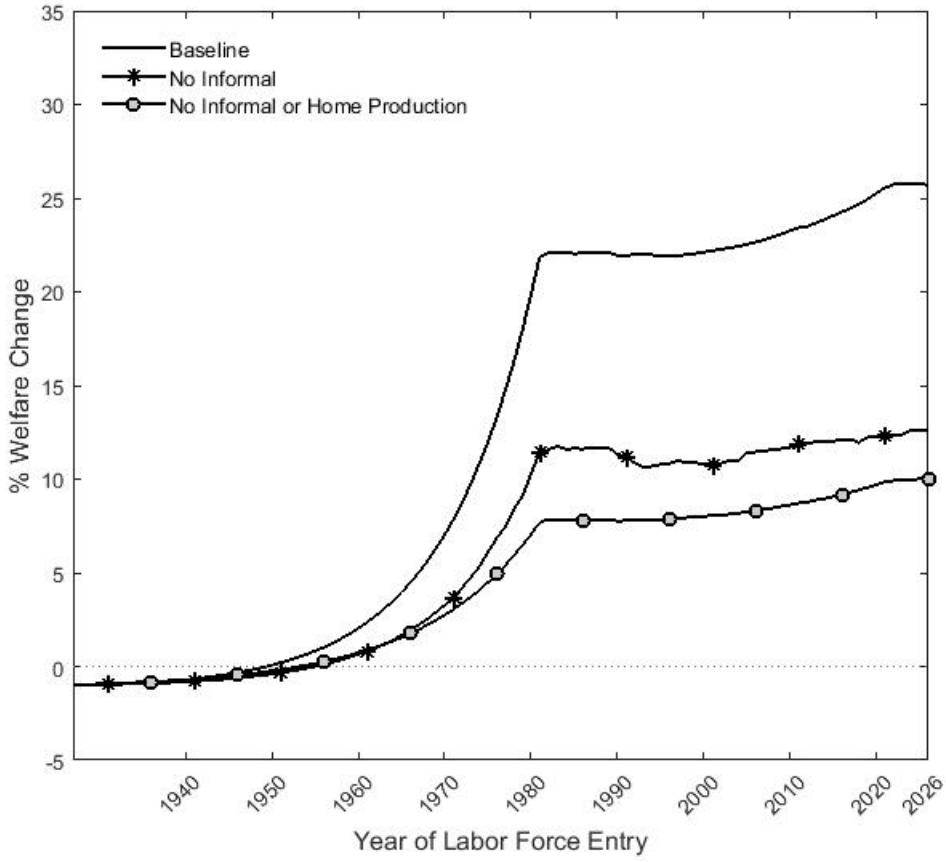
* All values are reported relative to the pre-reform steady state.

of home production and informality have on the elasticity of the labor supply. Previous work has shown that the presence of home production makes labor more elastic and renders the payroll tax more distortionary. I find this is true of the informal sector as well, but that wage effects also drive increasing welfare gains in an economy with an informal sector.

Figure 3 shows the welfare gains under all three economies. The baseline economy experiences the highest welfare gains because the presence of the informal sector gives household two options to fund consumption without the distortion of the payroll tax. Because of this increased labor supply elasticity, the payroll tax is more distortionary. As with previous literature, this increases welfare gains from Social Security reform. Second, the welfare gains in the baseline economy are higher than those in the economy without informality but with home production because of the wage effects. In addition to the gains that come from removing the distortion, the households can take advantage of wage gains without the distortion of the formal sector. These effects are discussed in more detail below.

Consider first the economy in which there is no informal sector and no option of home production. In this economy, working formally, and therefore paying the associated tax, is the only way to fund consumption. Therefore, there is no option to avoid the distortion of

Figure 3: Welfare Gains by Cohort without Informality and Home Production



the labor tax. Households in this economy still receive long-run welfare gains from reform as they are made better of by removal of the distortion and the increasing government transfers. However, including options for work in an informal sector or home production sector lead to higher gains. The presence of both informality and home production drives the highest welfare gains for two reasons:

1. *Higher labor supply elasticity increases the distortion caused by the payroll tax.*

   The presence of informality and home production implies a higher Frisch elasticity than in the alternative economies.[49] Because the baseline exhibits higher labor elasticity,

[49] In the baseline the Frisch elasticity is 0.97 while is falls to 0.66 and 0.91 in the economies without either informality or home production and without informality, respectively. These numbers are significantly lower than the Frisch elasticity found in the similar economies in the United States. It is reasonable to assume that in a Chilean economy where there is less wealth, there is also lower elasticities of the labor supply.

the payroll tax from the pay-as-you-go Social Security system is more distortionary. By having the outside option to the formal sector, agents increase informal and home work to avoid this distortion. Therefore, a reform that decreases the payroll tax leads to higher welfare gains in economies that have informal or home production sectors.

The impact of this effect, caused by the inclusion of home production, drives the gaps between the long-run welfare gains in the economy without informality and without home production and the economy only without informality.

2. *Informality allows households to receive higher long-run wages without facing distortions caused by remaining labor taxation.*

   In addition to the higher labor supply elasticity, the inclusion of informality also increases welfare gains due to wage effects. The pay-as-you-go Social Security system crowds out savings and keeps interest rates high. The reform, which increases private savings, is accompanied by a fall in the interest rate and an increase in the wage. Additionally, while the reform removes the distortion caused by the Social Security contribution rate, the distortion of general income taxation remains constant across both scenarios. Due the same increased labor supply elasticity discussed above, this taxation is also more distortionary in an economy with outside options to working formally. The presence of the informal sector allows households to achieve the higher wage without this distortion.

   The addition of this effect, caused by including an informal sector, causes the increase in long-run welfare gains between the economy with only a home production sector (labeled No Informal in the graph) and the economy with both a home production sector and an informal sector (the Baseline economy).

These two effects work together to produce the highest welfare gains in the baseline economy that includes both home production and informality.

7 Conclusion

As the first country to deal with the unsustainability of its pay-as-you-go Social Security system, this paper uses the case study of Chile in order to quantify the welfare impact of a transition between an unfunded, pay-as-you-go system and a mandatory savings program consisting of individual retirement accounts. With more than thirty years of data since the reform occurred, I am able study and learn from the experience of a country that has been through the transition that many countries, including the United States, have considered, and will continue to consider, as populations continue to age.

This paper uses an overlapping generations model including features which are important to the understand of the experience of Chile: age and productivity heterogeneity, a government policy based on the reform that occurred in 1981, and multiple sectors of production to represent formal work, informal work, and home production. I use micro-data to estimate the parameters governing the trade-offs between the three sectors of production and macro data to ensure that the model is consistent with various aggregates. I then use the model to quantify the welfare impact of the transition path between the programs.

I find long-run welfare gains for both blue-collar and white-collar worker. Blue-collar workers receive welfare gain of around 25 percent in the long-run; white-collar workers experience gains of roughly 30 percent. The transitional generations, however, experience welfare losses up to 1 percent. Informality and home production both give households options to substitute away from payroll taxation; a reform in an economy without either of these sectors causes welfare gains of nearly 10 percent. Informality, however, also provides the option of a market wage without the distortion caused by taxation. A reform in an economy without an informal sector but with a home production sector experiences welfare gains of roughly 13 percent.

In 2008, Chile enacted an secondary reform to address the issue of low pension wealth due to poverty and lack of regular contributions to the private account system. Due to the structure of this model, the lower bound on pension wealth is not binding in this economy

and the change to the minimum pension does not impact the results. Extensions to this paper and future work will address the issue of the impact of this additional reform.

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Table 11: Aggregates, Prices, and Government Budget through the Transition

Continue PAYG Policy

No Informal Sector

		1980	1981-1995	1996-2010	2011-2030	Steady State
Output		1.000	0.624	0.693	0.661	0.643
Capital Stock		1.000	0.789	0.832	0.794	0.758
Hours		1.000	0.867	0.889	0.893	0.876
	Formal Hours	1.000	0.698	0.770	0.742	0.721
	Informal Hours	1.000	—	—	—	—
	Home Hours	1.000	1.131	1.072	1.128	1.116
Consumption		1.000	0.824	0.833	0.861	0.895
	Market Consumption	1.000	0.715	0.747	0.761	0.805
	Durable Spending	1.000	0.702	0.737	0.752	0.801
	Home Consumption	1.000	0.905	0.898	0.936	0.962
Investment		1.000	0.773	0.945	0.803	0.708
Interest Rate		1.000	0.998	0.997	0.997	0.999
Wage		1.000	0.758	0.771	0.748	0.759
Consumption Tax		0.072	0.073	0.057	0.052	0.054
Labor Tax		0.230	0.171	0.173	0.169	0.172
Corporate Tax		0.097	0.118	0.108	0.117	0.117
Retirement Transfer		0.050	0.084	0.082	0.099	0.122
	PAYG Pension	0.050	0.084	0.082	0.099	0.122
	Recognition Bond	0.000	0.000	0.000	0.000	0.000
	MPG	0.000	0.000	0.000	0.000	0.000
Per-capita transfer		0.233	0.052	0.105	0.075	0.068

Note: Values for aggregates and prices are reported relative to the pre-reform steady state.
Values for government revenue and spending variables are reported as a percentage of GNP.

Table 12: Aggregates, Prices, and Government Budget through the Transition

Transition from PAYG to Current Chilean Policy

No Informal Sector

		1980	1981-1995	1996-2010	2011-2030	Steady State
Output		1.000	0.661	0.694	0.734	0.856
Capital Stock		1.000	0.787	0.826	0.929	1.094
Hours		1.000	0.847	0.874	0.869	0.912
	Formal Hours	1.000	0.730	0.753	0.785	0.882
	Informal Hours	1.000	—	—	—	—
	Home Hours	1.000	1.018	1.049	0.983	0.939
Consumption		1.000	0.864	0.902	0.900	0.973
	Market Consumption	1.000	0.792	0.826	0.841	0.953
	Durable Spending	1.000	0.796	0.835	0.859	0.982
	Home Consumption	1.000	0.918	0.959	0.944	0.989
Investment		1.000	0.844	0.947	1.193	1.031
Interest Rate		1.000	0.999	0.996	0.993	0.987
Wage		1.000	0.776	0.796	0.818	0.866
Consumption Tax		0.072	0.078	0.064	0.050	0.049
Labor Tax		0.230	0.132	0.133	0.135	0.137
Corporate Tax		0.097	0.111	0.104	0.094	0.101
Retirement Transfer		0.050	0.087	0.111	0.068	0.000
	PAYG Pension	0.050	0.000	0.000	0.000	0.000
	Recognition Bond	0.000	0.087	0.111	0.068	0.000
	MPG	0.000	0.000	0.000	0.000	0.000
Per-capita transfer		0.233	0.055	0.136	0.163	0.215

Note: Values for aggregates and prices are reported relative to the pre-reform steady state.
Values for government revenue and spending variables are reported as a percentage of GNP.

Table 13: Aggregates, Prices, and Government Budget through the Transition

Continue PAYG Policy

No Informal or Home Production Sectors

		1980	1981-1995	1996-2010	2011-2030	Steady State
Output		1.000	0.911	0.939	0.882	0.842
Capital Stock		1.000	0.903	1.038	0.962	0.918
Hours		1.000	0.944	0.950	0.904	0.857
	Formal Hours	1.000	0.944	0.950	0.904	0.857
	Informal Hours	1.000	—	—	—	—
	Home Hours	1.000	—	—	—	—
Consumption		1.000	1.020	1.037	1.042	1.095
	Market Consumption	1.000	1.020	1.037	1.042	1.095
	Durable Spending	1.000	—	—	—	—
	Home Consumption	1.000	—	—	—	—
Investment		1.000	1.184	1.127	0.915	0.867
Interest Rate		1.000	1.006	0.995	0.995	0.995
Wage		1.000	0.923	0.932	0.896	0.918
Consumption Tax		0.074	0.073	0.061	0.054	0.058
Labor Tax		0.234	0.196	0.193	0.188	0.191
Corporate Tax		0.052	0.085	0.092	0.103	0.099
Retirement Transfer		0.058	0.069	0.079	0.103	0.136
	PAYG Pension	0.058	0.069	0.079	0.103	0.136
	Recognition Bond	0.000	0.000	0.000	0.000	0.000
	MPG	0.000	0.000	0.000	0.000	0.000
Per-capita transfer		0.232	0.078	0.133	0.094	0.074

Note: Values for aggregates and prices are reported relative to the pre-reform steady state.
Values for government revenue and spending variables are reported as a percentage of GNP.

Table 14: Aggregates, Prices, and Government Budget through the Transition

Transition from PAYG to Current Chilean Policy

No Informal or Home Production Sectors

		1980	1981-1995	1996-2010	2011-2030	Steady State
Output		1.000	0.919	0.948	0.966	0.997
Capital Stock		1.000	0.918	1.089	1.098	1.188
Hours		1.000	0.957	0.945	0.941	0.927
	Formal Hours	1.000	0.957	0.945	0.941	0.927
	Informal Hours	1.000	—	—	—	—
	Home Hours	1.000	—	—	—	—
Consumption		1.000	1.097	1.144	1.138	1.143
	Market Consumption	1.000	1.097	1.144	1.138	1.143
	Durable Spending	1.000	—	—	—	—
	Home Consumption	1.000	—	—	—	—
Investment		1.000	1.307	1.198	1.272	1.120
Interest Rate		1.000	1.007	0.990	0.985	0.976
Wage		1.000	0.918	0.943	0.979	1.050
Consumption Tax		0.074	0.078	0.067	0.050	0.051
Labor Tax		0.234	0.149	0.147	0.149	0.152
Corporate Tax		0.052	0.081	0.090	0.086	0.086
Retirement Transfer		0.058	0.073	0.101	0.064	0.000
	PAYG Pension	0.058	0.000	0.000	0.000	0.000
	Recognition Bond	0.000	0.073	0.101	0.064	0.000
	MPG	0.000	0.000	0.000	0.000	0.000
Per-capita transfer		0.232	0.719	0.136	0.163	0.235

Note: Values for aggregates and prices are reported relative to the pre-reform steady state.
Values for government revenue and spending variables are reported as a percentage of GNP.

Table 15: Calibration to Match Data Moments

Baseline

Moments	Model	Data
Capital output ratio	1.678	1.697
Aggregate hours worked	0.495	0.482
Fraction of GNP spent on social programs	0.144	0.142
Fraction of labor income earned by blue-collar workers	0.644	0.657

Table 16: Calibration Results

Alternate Economies

Parameter	No Informal	No Informal or Home Production
β Discount factor	0.949	0.9415
γ Weight of consumption in utility	0.603	0.547

Table 17: Calibration to Match Data Moments

No Informal Sector

Moments	No Informal		No Informal or Home Production	
	Model	Data	Model	Data
Capital output ratio	1.678	1.720	1.678	1.717
Aggregate hours worked	0.495	0.435	0.495	0.460
Fraction of GNP spent on social programs	0.144	0.131	0.144	0.142

Table 18: Aggregates, Prices, and Government Budget through the Transition

Continue PAYG Policy

$\sigma = 4$

		1980	1981-1995	1996-2010	2011-2030	Steady State
Output		1.000	0.884	0.947	0.725	0.760
Capital Stock		1.000	1.041	1.282	1.728	1.608
Hours		1.000	0.936	0.958	0.861	0.860
	Formal Hours	1.000	0.888	0.926	0.753	0.762
	Informal Hours	1.000	0.888	0.926	0.753	0.762
	Home Hours	1.000	1.056	1.037	1.126	1.101
Consumption		1.000	1.061	1.086	1.154	1.222
	Market Consumption	1.000	1.063	1.103	1.164	1.262
	Durable Spending	1.000	1.064	1.107	1.166	1.275
	Home Consumption	1.000	1.060	1.075	1.147	1.192
Investment		1.000	0.509	0.611	0.739	0.501
Interest Rate		1.000	1.000	1.000	1.008	1.003
Wage		1.000	1.005	1.006	0.953	0.989
Consumption Tax		0.073	8.13	6.61	7.40	7.62
Labor Tax		0.179	17.97	17.77	17.66	17.70
Corporate Tax		0.038	3.87	4.66	4.20	2.68
Retirement Transfer		0.050	7.00	7.30	11.07	12.14
	PAYG Pension	0.050	7.00	7.30	11.07	12.14
	Recognition Bond	0.000	0.00	0.00	0.00	0.00
	MPG	0.000	0.00	0.00	0.00	0.00
Per-capita transfer		0.041	4.74	9.52	5.62	3.70

Note: Values for aggregates and prices are reported relative to the pre-reform steady state.

Values for government revenue and spending variables are reported as a percentage of GNP.

Table 19: Aggregates, Prices, and Government Budget through the Transition

Transition from PAYG to Current Chilean Policy

$\sigma = 4$

		1980	1981-1995	1996-2010	2011-2030	Steady State
Output		1.000	0.978	1.014	1.064	1.254
Capital Stock		1.000	0.864	1.107	1.278	1.237
Hours		1.000	0.990	0.997	0.982	1.016
	Formal Hours	1.000	0.974	0.989	0.997	1.091
	Informal Hours	1.000	0.974	0.989	0.997	1.091
	Home Hours	1.000	1.026	1.015	0.947	0.842
Consumption		1.000	1.048	1.082	1.116	1.134
	Market Consumption	1.000	1.056	1.104	1.172	1.235
	Durable Spending	1.000	1.058	1.111	1.191	1.270
	Home Consumption	1.000	1.042	1.066	1.074	1.059
Investment		1.000	0.529	0.698	0.649	0.527
Interest Rate		1.000	1.001	0.994	0.984	0.967
Wage		1.000	1.009	1.028	1.074	1.163
Consumption Tax		0.073	7.73	6.63	5.80	5.21
Labor Tax		0.179	18.00	17.91	17.99	18.06
Corporate Tax		0.038	7.25	5.91	6.29	7.81
Retirement Transfer		0.050	6.91	9.25	5.79	0.00
	PAYG Pension	0.050	0.00	0.00	0.00	0.00
	Recognition Bond	0.000	6.91	9.25	5.79	0.00
	MPG	0.000	0.00	0.00	0.00	0.00
Per-capita transfer		0.041	6.31	13.96	16.20	21.13

Note: Values for aggregates and prices are reported relative to the pre-reform steady state.

Values for government revenue and spending variables are reported as a percentage of GNP.

Figure 4: Welfare Gains by Cohort with Varying Values of σ