Technical Appendix for *Social Security Reform in the Presence of Informality*

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This document presents supplementary details and sensitivity analysis to assist in the reading of the paper. The technical appendix is separated into 6 main sections: the equilibrium definition and computational details, the data sources, details of and sensitivity on the estimation of the parameters regarding market labor supply and home production, more details on the fit of the model, sensitivity on the model results, and additional details on informality in Chile.

Contents

Part I

Equilibrium Definition and Computation

1 Definition of the Equilibrium on a Balanced Growth Path

An equilibrium is given by government policies, a tax rate on consumption, τ_c, a labor income tax, τ_h, a Social Security contribution rate, τ_{ss}, a tax rate on corporate profits, τ_p, a tax rate on firm dividends, τ_d, transfers, T^j and ψ, and debt and government spending, B and G; an interest rate r and wage w; value functions, $V(a,\bar{y},S;\varepsilon)$; and allocations, $c_m(a,\bar{y},S,\varepsilon)$, $a'(a,\bar{y},S,\varepsilon)$, $d(a,\bar{y},S,\varepsilon)$, $h_f(a,\bar{y},S,\varepsilon)$, $h_i(a,\bar{y},S,\varepsilon)$, and $h_h(a,\bar{y},S,\varepsilon)$ such that:

1. Given the government policies, interest rate, and wage rate, the value functions and allocations solve the agent's maximization problem for the individual state variables, a and $\bar{y}$,and aggregate state variables S

2. Given the government policies, interest rate, and wage rate, the firm optimizes

3. The government budget constraint holds in each period

4. All markets clear

$$D = \sum_{j,\varepsilon} \mu^{j,\varepsilon} d^{j,\varepsilon}$$

$$K_m = \sum_{j,\varepsilon} \mu^{j,\varepsilon} a^{j,\varepsilon} - B$$

$$C_m = \sum_{j,\varepsilon} \mu^{j,\varepsilon} c_m^{j,\varepsilon}$$

$$H_f + H_i = \sum_{j,\varepsilon} \mu^{j,\varepsilon} (h_f^{j,\varepsilon} + h_i^{j,\varepsilon})\varepsilon$$

$$X_m = K_m^{'} - (1-\delta)K_m$$

$$f\left(K_m, H_f + H_i\right) = Y = C_m + D + X_m + G$$

Then, assuming that the capital and labor markets clear, it must also be the case that the household policy functions, $\left\{a' = g_j^a(S,\varepsilon)\right\}_j$ and $\left\{h_f = g_j^h(S,\varepsilon)\right\}_j$, imply the aggregate law of motion $S' = G(S)$, where the function G is taken as given by the private agents.

2 Computational Details

The algorithm is described for one productivity type. This is done to simplify notation. The algorithm can be expanded to handle additional productivity types. In Section 2.1 I discuss the algorithm to solve the model in a balanced growth path. In Section 2.2 I discuss what changes need to be made in order to extend this to the computation of the transition path.

2.1 Balanced Growth Path

I will find a fixed point in the interest rate, i, and the common transfer, ψ^c, using functional iteration.[1]

$$x^{k+1} = \omega x^k + (1-\omega)\left[x^k - \mathbb{R}\left(x^k\right)\right]$$

where x^k represents the k-th iteration of the unknown variables, $\omega \in [0,1]$ is a weighting parameter to help with convergence, and $\mathbb{R}\left(x^k\right)$ represents the first order conditions that must by satisfied by the choice of the unknown variables. In the context of this model, these first order conditions are the return to capital being equal to the marginal product of capital[2], $\mathbb{R}_1$ and the government budget constraint, $\mathbb{R}_2$.

Steps of Solution

1. Make an initial guess

   set the interest rate, i, as the first element of the guess and the per-capita transfer, ψ^c as the second element of the guess

   - From the firm problem in which firms maximize the discounted value of after-tax dividends, the interest rate is equated to the after-tax return on market capital net of depreciation

     $$i = (1-\tau_p)(r_m - \delta)$$

     Use this to calculate the market capital rental rate, r_m

     $$r_m = \frac{i}{1-\tau_p} + \delta$$

[1] Can be replaced with Newton-Rhapson. In NR is used to find the fixed point using the following equation

$$x^{k+1} = \omega x^k + (1-\omega)\left(\left[\frac{\partial \mathbb{R}(x)}{\partial x}\,|_{x^k}\right]^{-1}\mathbb{R}\left(x^k\right)\right)$$

[2] Could be replaced by the market clearing condition for market capital

- Using the optimality conditions from this firm problem, the market capital share and the return to market capital can be used to derive the ratio of capital stock to compensation

$$\frac{K_m}{w\left(H_f+H_i\right)}=\frac{\alpha}{(1-\alpha)\,r_m} \tag{1}$$

Then solve for the ratio of Y to $w\left(H_f+H_i\right)$

$$\frac{Y}{w\left(H_f+H_i\right)}=\frac{A\left(K_m\right)^{\alpha}\left(H_f+H_i\right)^{1-\alpha}}{w\left(H_f+H_i\right)}=\frac{A\left(K_m\right)^{\alpha}\left(H_f+H_i\right)^{1-\alpha}}{w\left(H_f+H_i\right)^{\alpha}\left(H_f+H_i\right)^{1-\alpha}}$$

$$\frac{Y}{w\left(H_f+H_i\right)}=A\left[\frac{K_m}{H_f+H_i}\right]^{\alpha}\left[\frac{1}{w}\right]^{1-\alpha}$$

$$\frac{Y}{w^{\alpha}\left(H_f+H_i\right)}=A\left[\frac{K_m}{H_f+H_i}\right]^{\alpha} \tag{2}$$

$$\frac{Y}{\left(H_f+H_i\right)}=Aw^{\alpha}\left[\frac{K_m}{H_f+H_i}\right]^{\alpha}$$

Because of PC in the market, $w=(1-\alpha)MPL$

$$w=(1-\alpha)Aw^{\alpha}\left[\frac{K_m}{w\left(H_f+H_i\right)}\right]^{\alpha}$$

$$w=\left[(1-\alpha)A\left(\frac{K_m}{w\left(H_f+H_i\right)}\right)^{\alpha}\right]^{1/(1-\alpha)} \tag{3}$$

Additionally,

$$\frac{K_m}{H_f+H_i}=\frac{K_m}{w\left(H_f+H_i\right)}\cdot w$$

$$\frac{Y}{\left(H_f+H_i\right)}=\frac{Y}{w^{\alpha}\left(H_f+H_i\right)}\cdot w^{\alpha}$$

2. Solve the household problem for each point of the asset grid $a\in[0,\bar{a}]$ and the grid of average annual taxable earnings $\bar{y}\in[0,\hat{y}]$

   (a) Set $V_{J+1}=0$ and solve the value function for each point of the asset grid

(b) By using backward induction, repeat step 2 for $j = J-1, \ldots 1$

i. Iteratively solve the value function

ii. At each step j, store the optimal decision functions

3. Compute the distribution of households by forward induction using the policy functions

4. Aggregate optimal choices for:

(a) Market consumption C_m

(b) Informal/durable spending D

(c) Formal hours H_f

(d) Informal hours H_i

(e) Home Hours H_h

(f) Assets A

5. Multiply $\frac{Y}{\left(H_f+H_i\right)}$ by $\left(H_f+H_i\right)$ to solve for total output

6. Define the aggregate market capital stock as the

$$A = V + B = V + \phi_B GNP = V + \phi_B Y$$

$$V = A - \phi_B Y$$

$$(1-\tau_d) K_m = A - \phi_B Y$$

$$K_m = \frac{A - \phi_B Y}{(1-\tau_d)} \tag{4}$$

7. Define investment. This definition is due to the fact that we are on a balanced growth path.

$$X_m = [(1+\eta) - 1 + \delta] K_m \tag{5}$$

8. Construct the analogues of GNP, accounting profits, and corporate dividends

$$GNP = Y \tag{6}$$

$$\Pi = Y - w\left(H_f + H_i\right) - \delta K_m \tag{7}$$

$$\Delta = Y - w\left(H_f + H_i\right) - X - \tau_p \Pi \tag{8}$$

9. Use GNP to construct the other variables for the government budget constraint

$$G = \phi_G GNP = \phi_G Y \tag{9}$$

$$B = \phi_B GNP = \phi_B Y \tag{10}$$

$$T = \sum_{j,\varepsilon} \mu^j T^j \left(w\varepsilon h_f\right) \tag{11}$$

10. Check the market clear condition and government budget constraint

$$\mathbb{R}_1(x) = r_m - \alpha \frac{Y}{K_m} \tag{12}$$

$$\mathbb{R}_2(x) = T + G - \tau_h H_f - \tau_p \Pi - \tau_d \Delta - B^{'} + (1+i)B - \tau_c C_m \tag{13}$$

11. If these conditions hold, an equilibrium is found. If not, update the initial guess and start again at step 1

2.2 Transition Path

Solving for the transition path is similar to the balanced growth path process described above. Particularly, the household problem is solved for each birth-year cohort. However, now I must keep track of time series for the unknown variables throughout the transition path. This is required as each cohort will face different prices and policies associated with where they are in the transition path between the steady states.

In additional to the unknown variables from the balanced growth path, wage is added as an unknown. This is because I can no longer solve for these variables in terms of other known variables. Specifically, an additional condition is added to the vector, $\mathbb{R}(x)$:

$$\mathbb{R}_3(x) = w - (1-\alpha)\frac{Y}{\left(H_f + H_i\right)} \tag{14}$$

The computation of the transition path is performed through utilization of parallel processing. Solving the problem is separated onto N different processors. Each processor n is assigned T_{max}/N cohorts for which to solve the life cycle problem, where T_{max} is the total number of time periods over which the transition path is solved. Once each processor n solves the problems of their assigned cohorts, the results are collected onto a single processor in order to calculate the aggregates at each time period of the transition path and the associated prices at those time periods. Important in the calculation of these aggregates is that different points in the transition are associated with different demographics.

Part II

Data Sources

3 Micro Data Sources

3.1 Encuesta de Ocupación y Desocupación en Gran Santiago (EOD)

EOD is an employment survey of the Greater Santiago area spanning from 1957-2014.[3] The June supplement is used in this paper. The survey contains information on the labor market decisions of the household head as well as the other members of the household. It contains information for those who participate in the labor market as well as those who are outside the market for any reason. Individuals do not need to be seeking employment to be included in the survey.

The survey contains information on the income of households. There are five categories of income reported in the survey: wage and salary income, income from independent activities, gifts and royalties, retirement income, and other income. These income variables are used to estimate the percentage of labor income that is held by the two types–blue collar and white collar–of households that are considered in the model.

In order to measure the percentage of workers of each type, I separate the groups based on the reported position held in their. jobs First of all, I exclude anyone who reported being in the armed forces. I exclude this group as they are not required to participate in the new pension program. Blue collar workers are defined as those who describe their positions as manual laborers. White collar workers are those who report their position as employee or manager. Based on this, I find

[3] It is shown later in the appendix that the Greater Santiago area is demographically representative of Chile

that 49 percent of workers are manual laborers and this group receives 21 percent of labor income, 44 percent of workers are employees and receive 52 percent of labor income; Managers make up 7 percent of the population and receive 27 percent of the labor income. Labor income here is defined as the sum of wage and salary income and income from independent activities. The sum of these two categories represents the income received from both formal and informal jobs.

I also use EOD to construct the average hourly wage for each type. Types are defined in the same way as above. The average wage is defined simply as the ratio of total working income earned divided by total working hours. These working hours are in either the formal or the informal sector as the model includes and assumption that wages in the sectors are the same. I find that the wages of managers are 7.1 times larger than the wages of manual laborers, the wages of managers are 4.0 times larger then those of manual laborers, and the wages of employees are 1.8 times larger than the wages of manual laborers.

3.2 Encuesta Nacional Sobre el Uso del Tiempo (ENUT)

ENUT is a two-part survey containing a household survey and a survey of time use. The household questionnaire collects the socioeconomic characteristics of the household. The time use survey contains information on the occupational characteristics and the time use information for household members over the age of twelve. While both are used in the analysis, the results of the time use survey are the key data used in this project.

The survey splits total work into work in five different areas:

1. Work in the market that is done for a third party in exchange for payment
2. Work in the market that is done for a third party without payment (goal is to gain experience)
3. Voluntary work done for a third party without pay
4. Work for production of goods and services for own consumption
5. Other undefined productive activities

These five areas are used to separate activities into market work and home work in the model. Market work is defined as work done for a wage. In order to classify activities as home work, I follow the methodology used in Aguiar and Hurst (2007a, b) and Aguiar, Hurst, and Kararbarbounis (2013). Table 1 shows the activities that will be put into each category.

Table 1: Categories of Home Work Activities

Core Home Production Activities	preparing food, cleaning, doing laundry, minor repairs to furniture and vehicles, household administration (paying bills etc.)
Activities Related to Home Ownership	care for plants, home repairs and construction, collecting wood
Obtaining Goods and Services	shopping for food and clothes for oneself or other household members and shopping for cleaning supplies/home goods
Caring for other Adults	care for household members needing permanent care due to health, care for household member 15-65,66+

3.3 Encuesta de Protección Social (EPS)

Encuesta de Protección Social is a longitudinal study with waves in 2002, 2004, 2006, 2009, 2012, 2015 with the main goal of collecting information on labor market activity and Social Security in Chile. This is the first longitudinal study done in Chile and has the longest time span. The first round, in 2002, was taken to be representative of those citizens affiliated under either the AFP or INP pension systems. The second wave, in 2004, and those that came after it were expanded to be representative of those who were part of the government pension program as well as those non-affiliated with either the pre-1981 system of the post-reform system. The survey represents a rich collection of information covering not only all areas of the country but also many different categories of information. Most important for this study are those concerning labor force variables and household spending. In particular, by asking respondents whether they have signed a contract at work, this study is able to identify differences in choices for formal and informal work. In addition to asking respondents whether they have a signed contract in their job, the survey also asks if an individual is actively contributing to a pension system. I choose the presence of a contract as my preferred definition for two reasons. First, there is a large overlap between these definitions so most people who report having a contract also contribute and vice versa. Second, since the question of whether a worker is contributing is at the individual level rather than the job level, using this to measure informality would not allow me to define informality for every job a worker has had in the last year. The presence of a contract, on the other hand, is reported for each

position held. Table 2 shows the overlap between these two definitions in 2004.

Table 2: 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)

This data set is also used to measure the annual spending of the household on both non-durable and durable goods. Spending on non-durable goods is constructed as the sum of reported annual spending on food, clothing, transportation, life and supplemental health insurance, education, and domestic service. Durable spending is constructed as the sum of spending on housing, appliances, and utilities. Each of these durable spending categories is measured based on reported spending as well as spending constructed from reports of appliances and house ownership. These categories are shown in Table 3.

The survey includes a measure of imputed monthly rent for both home owners and those renting. This number is used for a measure of spending on housing for all households. Additionally, the survey also has a measure of spending on monthly utilities for the household. The construction of spending on appliances uses measures of average cost of an appliance as well as the average lifetime of the appliance. The survey reports the number of appliances– defined as refrigerators, washing machines, stoves, microwaves, computers, and internet connections– owned by a household. I assume that spending on the appliance is split equally across the life of the appliance. Additionally, it is assumed that if a household is renting the home appliances such as refrigerators, washing machines, stoves, and microwaves, are included in the rent. Homeowners are assumed to pay for these appliances.

4 Macro Data Sources

4.1 National Accounts

National Accounts are sparse for the years extending back to 1980. The limited available series are: domestic demand, investment, trade balance, and GDP. Selected time series for these variables

Table 3: Categories of Non-durable and Durable Spending

Non-durable Spending	Durable Spending
Food	Housing
Clothing	Appliances
Transportation	Utilities
Insurance (Life, Supplemental Health)	
Education	
Domestic service	

Table 4: National Accounts (1960-1990)

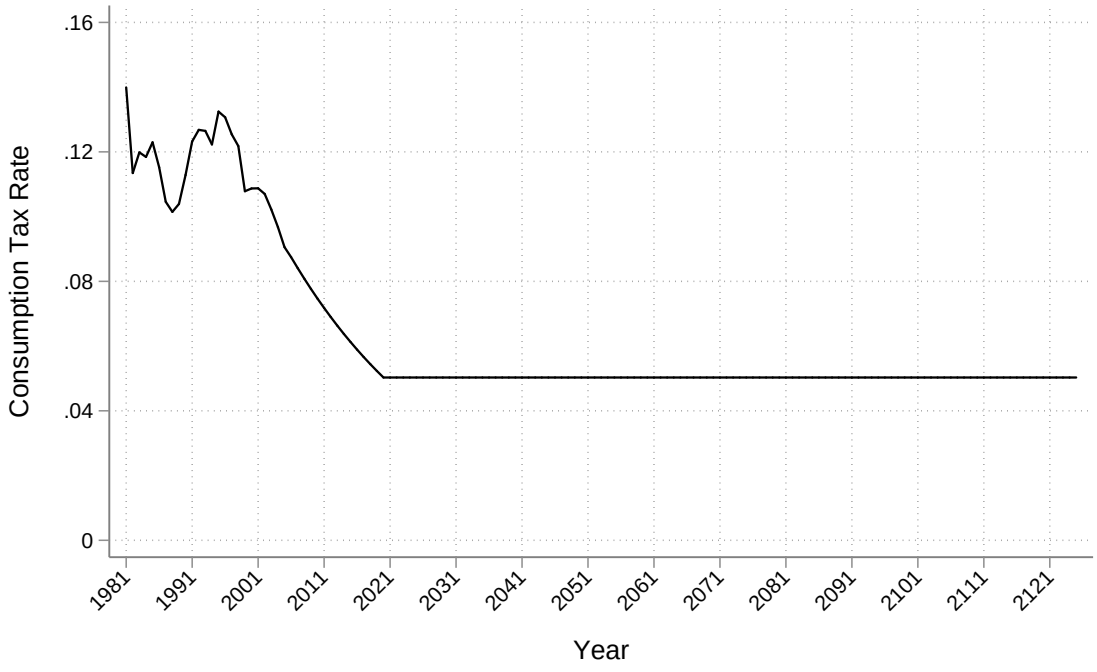
	Domestic Demand	Investment	Exports	Imports	GDP
1960	12,430,090	2,013,443	1,550,398	1,700,648	13,326,609
1965	14,846,787	2,328,074	1,903,463	1,993,864	16,032,079
1970	19,590,631	3,004,178	2,205,249	3,032,634	20,287,272
1975	15,723,911	2,027,116	2,898,126	2,043,989	18,569,749
1980	23,784,955	3,333,106	5,850,901	4,947,577	26,908,865
1985	20,697,614	2,666,412	6,411,049	3,092,556	26,183,750
1990	29,279,473	5,056,578	10,599,468	5,906,956	35,865,469

* Note: Reference year: 2008; unit: millions of Chilean pesos (CLP)

are shown in the table below.

By accumulating the time series of investment, I construct a series for the capital stock. I follow the process set out in Borgoeing, Kehoe, and Kehoe (2002) in order to construct this series. Two assumptions are made in order to construct this series. I make assumptions on the depreciation rate and an assumption on the initial capital stock in the year 1960. I test the following depreciation rates: $\delta = 0.05$, $\delta = 0.06$, $\delta = 0.07$, $\delta = 0.08$, $\delta = 0.09$. Following Borgoeing, Kehoe, and Kehoe (2002), I choose $\delta = 0.05$ as higher levels of the depreciation rate imply implausibly low values for the capital-output ratio. In regards to the assumption on the initial capital stock, I set the initial stock so that the capital to output ratio in 1960 is equal to the average of the capital to output ratio for the years 1960-1980.

Figure 1: Consumption Tax (1980-2125)



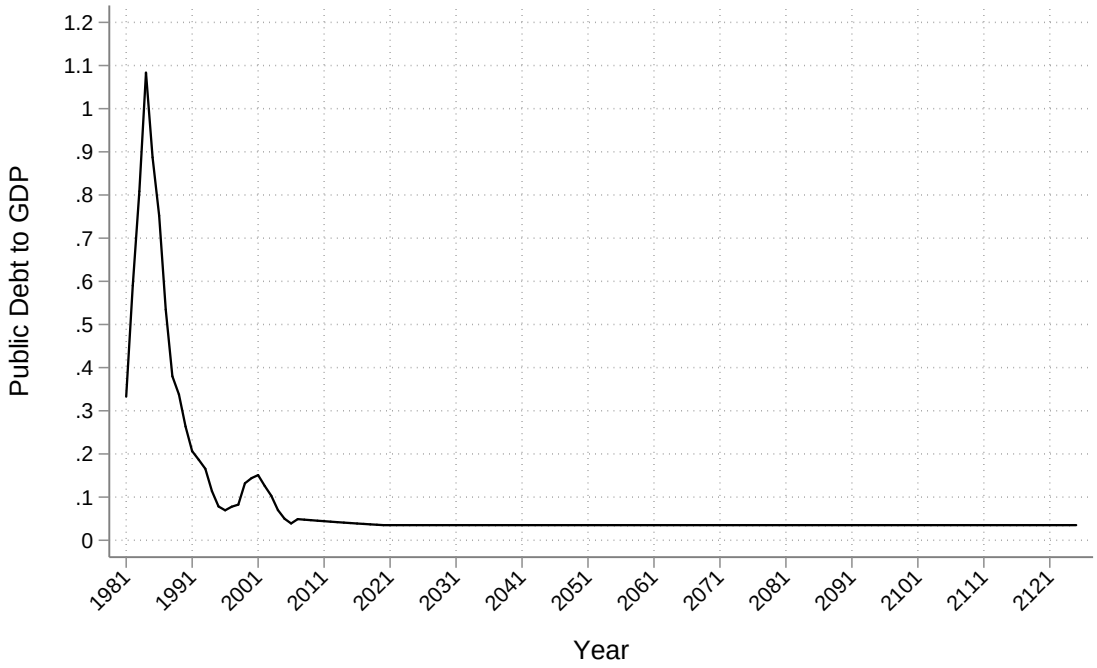
4.2 Economía Chilena 1810-1995: Cuentas Fiscales (Wagner, Jofré, Lüders 2000)

The work of Jofré, Lüders, Wagner (2001) compiles time series for fiscal variables extending back to 1810. This work is used in order to construct time series for some of the fiscal policy variables. In particular, I use the series for the income from sales taxes, historical debt series, and series for social spending to construct the consumption tax, government debt, and the per-capita transfer used in the analysis. Figures 1, 2, 3, and 4 show these time series.

The consumption tax rate is calculated based on the total income from sales taxes divided by aggregate consumption. Figure 1 shows this time series from 1980-2008. Included in the measure of total income from consumption tax is three categories: income from sales tax and IVA, income from alcohol tax, and income from tobacco tax. The income from the alcohol tax and the tobacco tax are included since they impact the non-durable consumption decisions of the household. However, as income from alcohol and tobacco taxes are around 15% of the total income, whether or not these taxes are included does not significantly impact the consumption taxes.

The second series used in the time series for debt as a percentage of GDP (Figure 2). The time series for debt is calculated as the total debt of the government: this includes domestic as well as

Figure 2: Ratio of Total Government Debt to GDP (1980-2125)

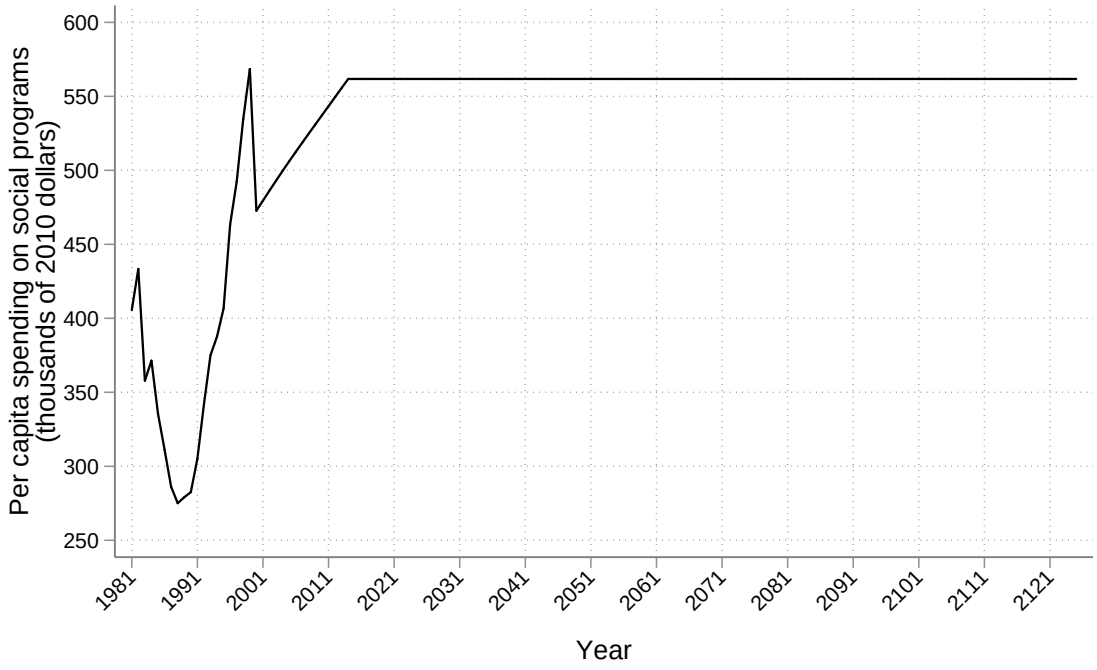


external debt. Both domestic and external debt are included due to the fact that the majority of the debt held by Chilean government is foreign. Using only domestic debt would not be an accurate measure of the holding of the government.

The next series from the this work is the series for social spending (Figure 3). In particular, total social sending includes spending on health, housing, previsions, education, employment programs, and other social functions such as subsidy programs. These series will be used to construct a measure of per-capita social spending. This is included to control for social programs, other than Social Security, received by citizens. This is an imperfect measure of the manner in which social spending impact citizens. In reality, social spending is received disproportionately by different groups and types of people. For example, welfare spending is received by low income citizens. However, I do not have detailed data on recipients of social programs. Therefore, the per-capita measure is included to get a correct quantitative measure for the government budget constraint. It does not, however, address the issue of distributional impact of social spending.

The final series constructed, the series of government spending on defense, is shown in Figure 4. This will be used as the measure of government spending on public goods. This measure starts around 4.5% of GDP in 1980 and decreases to 2% by 2010.

Figure 3: Per-Capital Social Spending (1980-2125)



4.3 1982 Census

The 1982 Census is used in order to test whether it is appropriate to assume that the population of Santiago can be used as representative of the entire country of Chile. Tables 5, 6, and 7 show various demographic statistics and how they differ between Santiago and the entire country of Chile. First, the percentage of the population which is male differs only slightly between all Chile, urban Chile, and Santiago. Additionally, the percentage of the population that is working-age is nearly the same across Chile and Santiago. The statistic in which Santiago differs from all Chile is education. Urban Chile is more educated. However, while these numbers differ between the areas, I do not believe assuming Santiago to be demographically representative of the whole country is restrictive.

4.4 Population Growth from World Development Indicators

The population growth rate in the Chilean economy is calculated from the population numbers in the World Bank's World Development Indicators.

Figure 4: Defense Spending as a % of GDP (1980-2125)

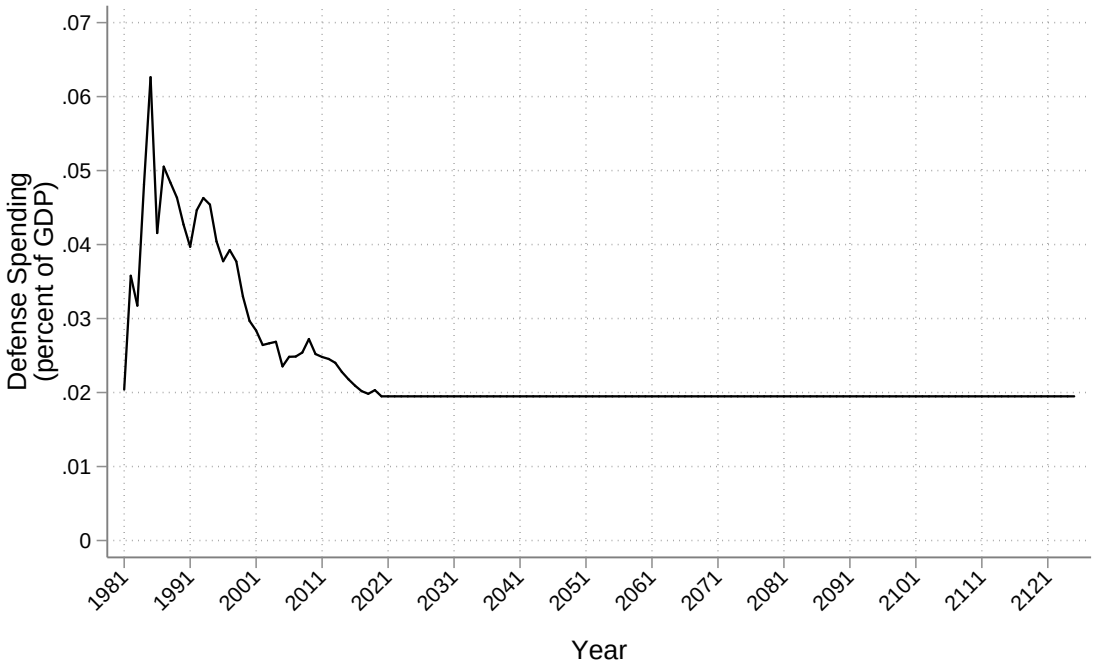


Table 5: Populations by Geographic Area

		All Chile	Urban	Santiago
Total		11,329,736	9,316,120	4,318,097
	Male	5,553,409	4,484,287	2,058,281
	Female	5,776,327	4,851,753	2,259,516
		49.0% male	48.1% male	47.7% male

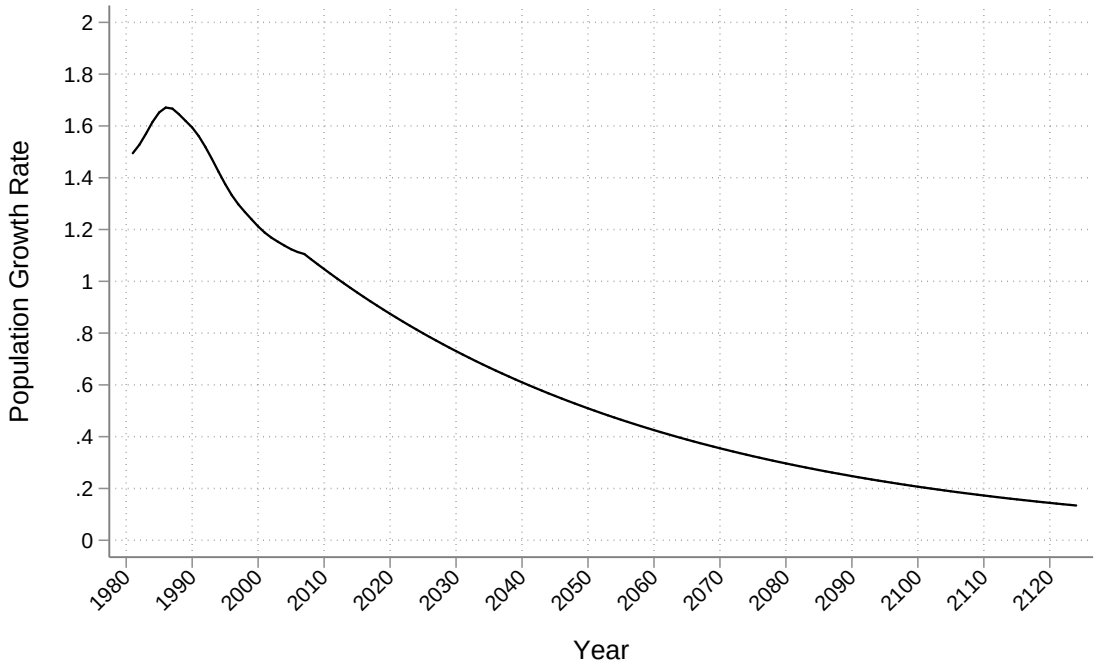
Table 6: Age Demographics of Chile and Santiago (1982)

	All Chile		Santiago	
	Totals	Percentages	Totals	Percentages
0-14	3,653,113	32.2	1,368,806	31.7
15-64	7,017,106	61.9	2,711,914	62.8
65+	659,517	5.8	247,574	5.7
Total	11,329,736		4,318,097	

Table 7: Education Demographics of All Chile and Urban Areas (1980)

	All Chile		Urban Chile	
	Totals	%	Totals	%
0-3 years	1,457,754	19.0	947,174	14.8
4-8 years	3,104,129	40.4	2,485,920	38.9
9-12 years	2,569,300	33.5	2,421,497	37.9
13+ years	545,440	7.1	528,385	8.3

Figure 5: Population Growth Rate (1981-2125)



Part III

Estimation Details

5 Derivation of Regressions for Estimation

Use the first-order conditions to derive the regressions used for the estimation. First, derive four equations which measure marginal utilities in terms of the consumption good. The first three give the marginal utility of formal labor, informal hours, and home hours in terms of the consumption good. The final equation is the marginal utility of home consumption in terms of the consumption good.

$$\frac{\partial u}{\partial l_t}\frac{\partial h_{mt}}{\partial h_{ft}} = \frac{(1-\tau_{ht})w_t\varepsilon}{1+\tau_{ct}}\frac{\partial u}{\partial c_{mt}} \tag{15}$$

$$\frac{\partial u}{\partial l_t}\frac{\partial h_{mt}}{\partial h_{it}} = \frac{w_t\varepsilon}{1+\tau_{ct}}\frac{\partial u}{\partial c_{mt}} \tag{16}$$

$$\frac{\partial u}{\partial l_t} = \frac{\partial u}{\partial c_{ht}} \frac{\partial g}{\partial h_{ht}} \tag{17}$$

$$\frac{\partial u}{\partial c_{mt}} = \frac{\partial u}{\partial c_{ht}} \frac{\partial g}{\partial d_t} \tag{18}$$

Use the equations to set the marginal utility (in terms of the consumption good) of formal labor equal to the marginal utility of informal labor. This will allow me to identify the share of formal labor and the elasticity of substitution between formal and informal labor.

$$\frac{a_2}{1-a_2}\left[\frac{h_{ft}}{h_{it}}\right]^{b_2-1} = (1-\tau_{ht})$$

$$h_{ft}^{b_2-1} = \frac{1-a_2}{a_2}(1-\tau_{ht})\, h_{it}^{b_2-1}$$

Take logs to derive the regression equation that will be used in the estimation.[4]

$$\ln\left(h_f\right) = \frac{1}{b_2-1}\ln\left(\frac{1-a_2}{a_2}\right) + \frac{1}{b_2-1}\ln\left(1-\tau_{ht}\right) + \ln\left(h_i\right) \tag{19}$$

Use the first and third equations to set the the marginal utility of formal labor equal to the marginal utility of home labor. Given the elasticity of substitution b_2 identified previously, this equation allows me to identify the share of home hours in home production and the elasticity of substitution between durables and home labor in the production of the home consumption good.[5]

$$\frac{\partial h_{mt}}{\partial h_{ft}} = \frac{(1-\tau_{ht})\, w_t \varepsilon}{(1+\tau_{ct})} \frac{\partial u/\partial c_{mt}}{\partial u/\partial c_{ht}}$$

$$\frac{\partial h_{mt}}{\partial h_{ft}} = \frac{(1-\tau_{ht})\, w_t \varepsilon}{1+\tau_{ct}} \frac{\partial g/\partial d_t}{\partial g/\partial h_{ht}}$$

$$\left[a_2 h_{ft}^{b_2} + (1-a_2)\, h_{it}^{b_2}\right]^{1/b_2-1} a_2 h_{ft}^{b_2-1} = \frac{(1-\tau_{ht})\, w_t \varepsilon}{1+\tau_{ct}} \frac{a_3}{1-a_3}\left[\frac{d_t}{h_{ht}}\right]^{b_3-1}$$

[4]Time subscripts have been removed from the regressions equation variables since I assume preference parameters to be constant across time. These equations will be estimated on cross-sectional data.

[5]These parameters can also be estimated using a regressions derived from setting the marginal utility of informal labor equal to the marginal utility of home labor. I choose the regression based on whether after-tax or pre-tax income is reported in the data. The regression derived from this alternated equation is:

$$\ln(h_h) = \frac{1}{b_3-1}\ln\left(\frac{a_3}{1-a_3}\right) - \frac{1}{b_2(b_3-1)}\ln(1-a_2) + \frac{1}{b_3-1}\ln\left(\frac{w\varepsilon}{1+\tau_c}\right) + \ln(d) + \frac{1-b_2}{b_2(b_3-1)}\ln\left[1+\frac{a_2}{1-a_2}\left(\frac{h_f}{h_i}\right)^{b_2}\right]$$

$$a_2^{1/b_2}\left[1+\frac{1-a_2}{a_2}\left(\frac{h_{it}}{h_{ft}}\right)^{b_2}\right]^{1-b_2/b_2}=\frac{(1-\tau_{ht})\,w_t\varepsilon}{1+\tau_{ct}}\frac{a_3}{1-a_3}\left[\frac{d_t}{h_{ht}}\right]^{b_3-1}$$

$$h_{ht}^{b_3-1}=a_2^{-1/b_2}\left[1+\frac{1-a_2}{a_2}\left(\frac{h_{it}}{h_{ft}}\right)^{b_2}\right]^{b_2-1/b_2}\frac{(1-\tau_{ht})\,w_t\varepsilon}{1+\tau_{ct}}\frac{a_3}{1-a_3}d_t^{b_3-1}$$

Again, take logs to derive the regressions equation:

$$\ln(h_h)=\frac{1}{b_3-1}\ln\left(\frac{a_3}{1-a_3}\right)-\frac{1}{b_2(b_3-1)}\ln(a_2)+\frac{1}{b_3-1}\ln\left(\frac{(1-\tau_h)\,w\varepsilon}{1+\tau_c}\right)+$$
$$+\ln(d)+\frac{b_2-1}{b_2(b_3-1)}\ln\left[1+\frac{1-a_2}{a_2}\left(\frac{h_i}{h_f}\right)^{b_2}\right] \quad (20)$$

The third, and final regression equation is derived from the condition that the marginal utility of market consumption is equal to the marginal utility of durable investment. This equations allows me to identify the share of market consumption versus home consumption and the elasticity of substitution between the two, given the other parameters previously estimated.

$$\frac{a_1}{1-a_1}\left[\frac{c_{mt}}{c_{ht}}\right]^{b_1-1}=c_{ht}^{1-b_3}a_3d_t^{b_3-1}$$

$$\frac{a_1}{1-a_1}c_{mt}^{b_1-1}=c_{ht}^{b_1-b_3}a_3d_t^{b_3-1}$$

$$c_{mt}^{b_1-1}=\frac{1-a_1}{a_1}a_3^{b_1/b_3}d_t^{b_1-1}\left[1+\frac{1-a_3}{a_3}\left(\frac{h_{ht}}{d_t}\right)^{b_3}\right]^{b_1-b_3/b_3}$$

Take logs to derive the regression equation.

$$\ln(c_m)=\frac{1}{b_1-1}\ln\left(\frac{1-a_1}{a_1}\right)+\ln(d)+\frac{b_1}{b_3(b_1-1)}\ln\left[1+\frac{1-a_3}{a_3}\left(\frac{h_h}{d}\right)^{b_3}\right] \quad (21)$$

.

6 Imputation of Hours of Home Work

Imputation of the hours of home work is done in the ENUT data set. I use a sample of individuals who responded to the time use survey and responded that nothing out of the ordinary occurred that

week. I then measure the hours of home work performed based upon observables present in both data sets. I do this estimation in two ways: estimate a linear regression and measure the average number of home hours worked per week for various bins of observables.

Using the first method, I estimate a linear regression to measure how hours of home work vary with observables that are present in both data sets. The tables show the regression with various controls and different measures of market work. First, I perform the regression where the the measure of market work is total hours spent working formally and informally for a wages. In the second specification, I include a measure of working income in addition to the measure of hours used in the previous regression. The predictive power of these regressions is low, with R^2 values ranging between 0.1799 and 0.2487. However, most of these variables are significant, showing the power these variables have in predicting the hours of home work done.

In the second method, I create categorical variables of the observables used in the linear regression. I then measure the average weekly hours worked within these bins. This method gives similar values for the fit of the measure.

7 Sample

Table 10 shows the summary statistics for the data population as well as the sample used in the estimation. The comparison of these generally shows that the estimation sample represents the population well.

While in general these statistics match well across the sample and the population, there are some differences. In the sample, the household head and the spouse are general slight younger with the average age of the head being 47 years old in the sample and 52 years old in the population and the average age of a spouse being 44 years old in the sample and 48 years old in the population. In addition to small age differences, the sample features households with slightly higher education and slightly higher number of family members. The sample and the population also feature similar percentages of people who live an urban environment.

The biggest difference is in income and hours between the sample and the population. The sample features households who earn more than the population average; average total earnings in the sample are 4,460,000 CLP annually while this value is 3,059,000 CLP annually in the population. Additionally, the household in the sample work more hours–3544 hours per year in the sample and 2498 hours per year in the population. This discrepancy is driven by the property that the sample features only households with positive hours and earnings.

Therefore, I consider a subset of the population where the values are positive. For example, when we consider the average total income, the population is restricted to only observations in which values of total income are strictly positive. When the 0 values are left out, the summary

Table 8: Predicting Hours of Weekly Non-Market Work

	Estimate			
	(SE)			
market hours	-0.099^{***}	-0.087^{***}	-0.055^{***}	-0.061^{***}
	(0.006)	(0.006)	(0.007)	(0.007)
active in the the labor market			2.374^{***}	4.951^{***}
			(0.669)	(0.716)
education	0.351	0.512	0.941^{***}	0.540^{*}
	(0.325)	(0.324)	(0.325)	(0.325)
age	1.648^{***}	1.328^{***}	0.049^{***}	1.301^{***}
	(0.059)	(0.056)	(0.015)	(0.064)
age^2	-0.016^{***}	-0.013^{***}		-0.013^{***}
	(0.001)	(0.001)		(0.001)
relation to household head			-2.252^{***}	-2.069^{***}
			(0.236)	(0.231)
marital status		-1.184^{**}	8.141^{***}	-2.224^{***}
		(0.582)	(0.549)	(0.620)
gender	16.368^{***}	10.118^{***}	18.030^{***}	9.630^{***}
	(0.425)	(0.530)	(0.426)	(0.527)
marital status*gender		12.931^{***}		13.760^{***}
		(0.836)		(0.848)
urban			0.991^{*}	0.973^{*}
			(0.549)	(0.555)
constant	-14.530^{***}	-8.382^{***}	13.996^{***}	-5.517^{***}
	(1.259)	(1.219)	(1.415)	(1.824)
N	16,786	16,786	16,786	16,786
R^2	0.2122	0.2395	0.2032	0.2487

Source: Encuesta Nacional Sobre el Uso del Tiempo (2015)

$^{*}p \leq 0.1$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$

Table 9: Predicting Hours of Weekly Non-Market Work

	Estimate			
	(SE)			
market hours	-0.107^{***}	-0.101^{***}	-0.097^{***}	-0.102^{***}
	(0.009)	(0.009)	(0.008)	(0.009)
income from primary occupation	$-1.93e^{-06***}$	$-1.92e^{-06***}$	$-2.19e^{-06***}$	$-2.29e^{-06***}$
	$(3.8e^{-07})$	$(3.89e^{-07})$	$(4.07e^{-07})$	$(4.29e^{-07})$
education	0.691^{*}	0.728^{*}	0.779^{*}	0.631
	(0.394)	(0.396)	(0.399)	(0.394)
age	1.092^{***}	0.929^{***}	0.041^{*}	0.735^{***}
	(0.095)	(0.094)	(0.023)	(0.099)
age^2	-0.011^{***}	-0.009^{***}		-0.008^{***}
	(0.001)	(0.001)		(0.001)
relation to household head			-1.922^{***}	-2.060^{***}
			(0.279)	(0.287)
marital status		-0.137	4.282^{***}	-1.394^{**}
		(0.609)	(0.599)	(0.652)
gender	14.976^{***}	10.448^{***}	16.195^{***}	9.942^{***}
	(0.511)	(0.691)	(0.515)	(0.696)
marital status*gender		9.008^{***}		10.356^{***}
		(1.105)		(1.121)
urban			1.179^{*}	1.163^{*}
			(0.609)	(0.617)
constant	-0.718	2.286	21.192^{***}	11.677^{***}
	(2.038)	(1.978)	(1.722)	(2.393)
N	9,528	9,528	9,528	9,528
R^2	0.1799	0.1971	0.1856	0.2040

Source: Encuesta Nacional Sobre el Uso del Tiempo (2015)

$^{*}p \leq 0.1$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$

Table 10: Summary Statistics

		Sample	Population	
		mean	mean	
		(s.d.)	(s.d.)	
age of HH head		46.70	52.38	
		(10.07)	(14.86)	
age of spouse		44.03	47.93	
		(10.41)	(13.60)	
education of HH head		1.83	1.71	
		(0.70)	(0.70)	
education of spouse		1.77	1.69	
		(0.68)	(0.67)	
percentage urban		0.43	0.42	
		(0.02)	(0.02)	
number of family members		2.28	2.18	
		(1.24)	(1.23)	
				if > 0
income (annual, 1000s CLP)	*total*	4460	3059	3966
		(5646)	(4870)	(5211)
	formal	3501	2369	3834
		(4149)	(4292)	(4919)
	informal	959	690	2252
		(2695)	(2361)	(3832)
hours (annual)	*total*	3544	2498	3229
		(1780)	(2147)	(1897)
	formal	2512	1754	2835
		(1748)	(1829)	(1530)
	informal	1031	744	2171
		(1525)	(1349)	(1489)

statistics for the population are much closer to the sample. Households earn on average 3,966,000 CLP annually and work 3,229 hours per year.

8 Results and Sensitivity

The following section presents results and sensitivity for the estimation.

8.1 Formality Estimation Results

The structure of the theoretical model leads to a problem in which the estimation of the substitutability between formality and informality can be done independently of the estimation of the substitution parameters involving the home production decision. Therefore, I first present the results for the estimation of formal versus informal decision.

In this estimation, I include various control variables. In the regressions I will include controls for demographic information such as the education, industry, and regions. In particular, I control for the education level of the head of the household and the spouse, the industry in which the head of household works, and the the region of country in which the household resides.[6] In addition to these demographic variables, I also control for year. Finally, it is possible that there is something intrinsic to a household which makes it more or less likely to work in the formal or informal sector of the economy. In order to control for this, I include a control for lagged formal sector work.[7]

8.1.1 Baseline

In the baseline estimation, I use a sample in which data is pooled from the three available waves. This is done in order to minimize the impact of variation over time. Since the model assumes that the parameters governing the substitution between the sectors in constant over time, using all years available helps to obtain an estimate that is representative of all time periods. In the next section, I show the results for each year. Table 11 shows the results of the pooled regressions with various controls; Table 12 shows the structural parameters associated with these regression results.

The tables above show the results of the regressions and the structural parameters associated with these results. Each column of the tables shows the results associated with different sets of control variables: the first column shows the results without any control variables, the second column shows the results with only year controls, and the final column shows the results including all demographic and year controls.

[6] Rather than region in which the household lives, I have also done the test in which I control for whether the household lives in an urban area. The results are not sensitive to this distinction.

[7] Due to the structure of the data, I do not have sufficient data to include an household fixed effect. Therefore, I include the lagged formal sector work in order to control for some household specific effects.

Table 11: Informality Regression Results

	Coefficient (SE)		
	(1)	(2)	(3)
$\ln(1-\tau_h)$	-4.126^{***}	-4.082^{***}	-7.634^{***}
	(0.779)	(0.777)	(1.742)
constant	0.443^{***}	0.401^{***}	-1.639
	(0.032)	(0.029)	(1.113)
Controls			
Education (head)	No	No	Yes
Education (spouse)	No	No	Yes
Industry	No	No	Yes
Urban Area	No	No	Yes
Number of Family Members	No	No	Yes
Year	No	Yes	Yes
Lagged Formal Work	No	No	Yes
N	4,585	4,585	1,143

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

$^{*}p \leq 0.1$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$

Table 12: Informality Parameter Estimates

	Estimate (SE)		
	(1)	(2)	(3)
a_2	0.527	0.525	0.447
	(0.006)	(0.006)	(0.039)
b_2	0.757	0.755	0.869
	(0.046)	(0.047)	(0.030)
Controls			
Education (head)	No	No	Yes
Education (spouse)	No	No	Yes
Industry	No	No	Yes
Urban Area	No	No	Yes
Number of Family Members	No	No	Yes
Year	No	Yes	Yes
Lagged Formal Work	No	No	Yes

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

Table 13: Informality Regression Results (2004)

	Coefficient (SE)	
	(1)	(2)
$\ln(1-\tau_h)$	-3.960^{***}	-3.975^{***}
	(1.042)	(1.227)
constant	0.403^{***}	1.819^{***}
	(0.030)	(0.652)
Controls		
Education (head)	No	Yes
Education (spouse)	No	Yes
Industry	No	Yes
Urban Area	No	Yes
Number of Family Members	No	No
Lagged Formal Work	No	Yes
N	2,150	1,727

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

$^{*}p \leq 0.1$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$

The results show that the controls for the year alone do not change results from the regression without any controls. However, including the other demographic controls does change the estimate. Overall, these estimates are very similar. Each specification shows that formality and informality represent nearly equal weight in the CES aggregation. They also all demonstrate that the two types of market labor are very substitutable but not perfect substitutes.

8.1.2 Variation over Time

In addition to measuring the parameters using the pooled data across the three waves, I also perform the regression on each year independently. The results are shown in the Tables 13-18.

These tables show there is substantial variation in these estimates over time. In particular, in the year 2006 the estimates for the weight of formal work in total market hours, a_2, is higher and the estimation for the parameter which governs the substitution between formality and informality, b_2, is lower than it is the other two waves. This result implies that in 2006 households were working formally more and the variation in formal hours across various tax brackets was low.

Table 14: Informality Parameter Estimates (2004)

	Estimate (SE)	
	(1)	(2)
a_2	0.525	0.612
	(0.008)	(0.053)
b_2	0.747	0.748
	(0.066)	(0.078)
Controls		
Education (head)	No	Yes
Education (spouse)	No	Yes
Industry	No	Yes
Urban Area	No	Yes
Number of Family Members		
Lagged Formal Work	No	Yes

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

Table 15: Informality Regression Results (2006)

	Coefficient (SE)	
	(1)	(2)
$\ln(1-\tau_h)$	-2.683^{***}	-2.166
	(0.941)	1.350
constant	0.481^{***}	1.066
	(0.048)	(1.220)
Controls		
Education (head)	No	Yes
Education (spouse)	No	Yes
Industry	No	Yes
Urban Area	No	Yes
Number of Family Members		
Lagged Formal Work	No	Yes
N	2,282	1,279

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

$^{*}p \leq 0.1$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$

Table 16: Informality Parameter Estimates (2006)

	Estimate (SE)	
	(1)	(2)
a_2	0.545	0.621
	(0.017)	(0.174)
b_2	0.627	0.538
	(0.131)	(0.288)
Controls		
Education (head)	No	Yes
Education (spouse)	No	Yes
Industry	No	Yes
Urban Area	No	Yes
Number of Family Members		
Lagged Formal Work	No	Yes

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

Table 17: Informality Regression Results (2009)

	Coefficient (SE)	
	(1)	(2)
$\ln(1-\tau_h)$	-4.031^{***}	-4.171^{***}
	(1.423)	(1.520)
constant	0.382^{***}	0.058
	(0.059)	(0.825)
Controls		
Education (head)	No	Yes
Education (spouse)	No	Yes
Industry	No	Yes
Urban Area	No	Yes
Number of Family Members		
Lagged Formal Work	No	Yes
N	1,116	797

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

$^{*}p \leq 0.1$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$

Table 18: Informality Parameter Estimates (2009)

	Estimate (SE)	
	(1)	(2)
a_2	0.524	0.503
	(0.010)	(0.049)
b_2	0.752	0.760
	(0.088)	(0.087)
Controls		
Education (head)	No	Yes
Education (spouse)	No	Yes
Industry	No	Yes
Urban Area	No	Yes
Number of Family Members		
Lagged Formal Work	No	Yes

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

8.1.3 Including Corner Solutions

As mentioned, the structure of the estimation excludes those observations where the household works all their time in either the formal sector or the informal sector. In order to check the impact of these observations, I replace any observations with 0 hours in one of the sectors with 1 hour. As I study this at an annual frequency, this is adding only a single hour for the year and does not significantly alter the household's ratio of formal hours to informal hours. Tables 19 and 20 repeat the baseline estimation with these corner solutions included.

Overall these results show that including the corner solutions pushes the estimate closer to perfect substitutes–the estimates of b_2 move closer to 1.000. This is due to the fact that those households that work entirely in one sector or the other act in a way that makes formal and informal work perfectly substitutable. Specifically, if the sectors are perfectly substitutable households will choose to work in whichever sector have a lower relative cost. Therefore, including these observations in the estimation is equivalent to including households for which formality and informality are perfectly substitutable. This causes estimates which are closer to 1.000.

In addition to the baseline estimation, I also repeat the estimations for a single year. These results are shown in Tables 21 to 26. The same pattern of returning estimates which are closer to perfect substitutes holds in each year.

Table 19: Informality Regression Results Including Corner Solutions

	Coefficient (SE)		
	(1)	(2)	(3)
$\ln(1-\tau_h)$	-25.867^{***}	-25.881^{***}	-19.173^{***}
	(1.499)	(1.484)	(2.453)
constant	3.316^{***}	2.900^{***}	0.116
	(0.066)	(0.075)	(3.236)
Controls			
Education (head)	No	No	Yes
Education (spouse)	No	No	Yes
Industry	No	No	Yes
Urban Area	No	No	Yes
Number of Family Members			
Year	No	Yes	Yes
Lagged Formal Work	No	No	Yes
N	20,381	20,381	4,997

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

$^{*}p \leq 0.1$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$

Table 20: Informality Parameter Estimates Including Corner Solutions

	Estimate (SE)		
	(1)	(2)	(3)
a_2	0.532	0.528	0.502
	(0.002)	(0.002)	(0.042)
b_2	0.961	0.961	0.948
	(0.002)	(0.002)	(0.007)
Controls			
Education (head)	No	No	Yes
Education (spouse)	No	No	Yes
Industry	No	No	Yes
Urban Area	No	No	Yes
Number of Family Members			
Year	No	Yes	Yes
Lagged Formal Work	No	No	Yes

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

Table 21: Informality Regression Results Including Corner Solutions (2004)

	Coefficient (SE)	
	(1)	(2)
$\ln(1-\tau_h)$	-26.395^{***}	-22.983^{***}
	(2.956)	(3.440)
constant	2.892^{***}	5.989^{***}
	(0.084)	(1.646)
Controls		
Education (head)	No	Yes
Education (spouse)	No	Yes
Industry	No	Yes
Urban Area	No	Yes
Number of Family Members		
Lagged Formal Work	No	Yes
N	0.524 (0.010)	8,313	6,243

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

$^{*}p \leq 0.1$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$

Table 22: Informality Parameter Estimates Including Corner Solutions (2004)

	Estimate (SE)	
	(1)	(2)
a_2	0.527	0.565
	(0.004)	(0.021)
b_2	0.962	0.956
	(0.004)	(0.007)
Controls		
Education (head)	No	Yes
Education (spouse)	No	Yes
Industry	No	Yes
Urban Area	No	Yes
Number of Family Members		
Lagged Formal Work	No	Yes

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

Table 23: Informality Regression Results Including Corner Solutions (2006)

	Coefficient (SE)	
	(1)	(2)
$\ln(1-\tau_h)$	-21.718^{***}	-18.354^{***}
	(1.606)	(2.098)
constant	2.150^{***}	5.478^{***}
	(0.069)	(1.299)
Controls		
Education (head)	No	Yes
Education (spouse)	No	Yes
Industry	No	Yes
Urban Area	No	Yes
Number of Family Members		
Lagged Formal Work	No	Yes
N	14,836	6,185

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

$^{*}p \leq 0.1$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$

Table 24: Informality Parameter Estimates Including Corner Solutions (2006)

	Estimate (SE)	
	(1)	(2)
a_2	0.525	0.574
	(0.002)	(0.019)
b_2	0.954	0.946
	(0.003)	(0.006)
Controls		
Education (head)	No	Yes
Education (spouse)	No	Yes
Industry	No	Yes
Urban Area	No	Yes
Number of Family Members		
Lagged Formal Work	No	Yes

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

Table 25: Informality Regression Results Including Corner Solutions (2009)

	Coefficient (SE)	
	(1)	(2)
$\ln(1-\tau_h)$	-43.300^{***}	-32.388^{***}
	(5.682)	(7.120)
constant	2.544^{***}	9.375^{***}
	(0.097)	(1.292)
Controls		
Education (head)	No	Yes
Education (spouse)	No	Yes
Industry	No	Yes
Urban Area	No	Yes
Number of Family Members		
Lagged Formal Work	No	Yes
N	10,347	5,555

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

$^{*}p \leq 0.1$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$

Table 26: Informality Parameter Estimates Including Corner Solutions (2009)

	Estimate (SE)	
	(1)	(2)
a_2	0.515	0.572
	(0.002)	(0.019)
b_2	0.977	0.969
	(0.003)	(0.007)
Controls		
Education (head)	No	Yes
Education (spouse)	No	Yes
Industry	No	Yes
Urban Area	No	Yes
Number of Family Members		
Lagged Formal Work	No	Yes

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

Table 27: Home Production Function Regression Results

	Coefficient (SE)		
	consumer durables + housing	consumer durables	housing
$\ln\left[\frac{(1-\tau_h)w\varepsilon}{(1+\tau_c)}\right]$	-0.551^{***}	-0.805^{***}	-0.551^{***}
	(0.079)	(0.061)	(0.106)
$\ln\left[1+\frac{1-a_2}{a_2}\left(\frac{h_i}{h_f}\right)^{b_2}\right]$	0.100^{***}	0.156^{***}	0.062
	(0.033)	(0.029)	(0.040)
constant	-2.014^{***}	1.717^{***}	-1.714^{**}
	(0.595)	(0.464)	(0.787)
N	4,712	3,746	4,712

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

$^{*}p \leq 0.1$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$

8.2 Home Production Estimation Results

Given the results from the estimation of the parameters relating to the trade-off between formality and informality, I can then use these values as inputs in order to estimate the parameters related to the home production decisions. These home production estimates will depend upon the values estimated for formality and informality. In what follows, I will use the estimates from the regression in which data is pooled across the three waves and all demographic and year controls are included: $a_2 = 0.447$, $b_2 = 0.869$.

8.2.1 Estimation of the Home Production Function

Using the second regression equation, I can estimate the parameters of the home production function, a_3 and b_3. The definition of spending on the home production input will be very important in this regression. Due to the issues related to the construction of this spending series, I show the results for each of the three spending series defined in the data section: spending on consumer durables only, spending on housing only, and spending on both consumer durables and housing. The regression results are show in Table 27 and the associated structural parameters in Table 28.

This regression includes a deviation from the home production literature–an extra term in the regression which controls for the substitutability between formality and informality to impact the results. Because of this extra term, there are two coefficients in the regression model which allow

Table 28: Home Production Function Parameter Estimates

	Estimate (SE)		
	consumer durables + housing	consumer durables	housing
a_3	0.892	0.070	0.963
	(0.106)	(0.044)	(0.102)
b_3	−0.507	0.035	−1.442
	(0.487)	(0.182)	(1.571)

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

us to identify the substitution between durables and home hours in home production. The prior home production literature has identified this parameter using the variation from the after-tax wage. Because this work focuses on the impact of informality, I report the results for these parameters that come from calculations from the coefficient on the term which includes formality and informality.

The choice of parameter values used depends upon how I think about the home production sector in Chile. In particular, I must take a stance on whether housing should be considered in a measure of home production. In the baseline estimates, I choose a definition of durable spending that includes only consumer durables based upon anecdotal evidence on the Chilean economy.

As expected when housing is excluded from the measure of durable spending, the weight of durable spending in the home production function is much lower than when housing is included. Additionally, the inclusion of housing makes housing less substitutable as these estimates move between -1.442 to 0.035. However, the parameter which governs the substitution between the two inputs, b_3, is not precisely measured and has large standard errors.

8.2.2 Estimation of the Substitutability between Home and Market Consumption

Given the estimates for the parameters of the home production function, a_3 and b_3, the final regression can be used to estimate the share and substitutability of market and home consumption in total consumption. Just as with the estimation of the home production function, I show results for each of the three definitions of durable spending in Tables 29 and 30.

It is important to note here that there are two main differences in these regression depending on the way durable spending is defined in the data. First, as the dependent variable in this case is the ratio of market consumption to durable spending, this dependent variable is directly impacted by

Table 29: Home Production Function Regression Results

	Coefficient (SE)		
	consumer durables + housing	consumer durables	housing
$\ln\left[1+\frac{1-a_3}{a_3}\left(\frac{h_h}{d}\right)^{b_3}\right]$	0.494^{**}	-0.143	0.548^{***}
	(0.211)	(0.140)	(0.211)
constant	-0.390	3.308^{***}	-0.394
	(0.466)	(0.549)	(0.506)
N	4,997	3.959	4,997

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

$^{*}p \leq 0.1$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$

Table 30: Total Consumption Parameter Estimates

	Estimate (SE)		
	consumer durables + housing	consumer durables	housing
a_1	0.374	0.538	0.367
	(0.117)	(0.039)	(0.138)
b_1	-0.205	0.039	-0.364
	(0.103)	(0.005)	(0.232)

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

Table 31: Categories of Durable Costs

	Refrigerators	Washing Machine	Stove	Microwave
Low	\$500	\$200	\$350	\$75
Medium	\$800	\$450	\$600	\$100
High	\$1500	\$700	\$1000	\$250

Table 32: Comparison of Parameters with Different Costs of Durables

	Market vs. Home		Home Production Function	
Low	$a_1 = \underset{(0.091)}{0.338}$	$b_1 = \underset{(0.089)}{-0.183}$	$a_3 = \underset{(0.006)}{0.004}$	$b_3 = \underset{(0.257)}{-0.079}$
Medium	$a_1 = \underset{(0.039)}{0.538}$	$b_1 = \underset{(0.005)}{0.039}$	$a_3 = \underset{(0.044)}{0.070}$	$b_3 = \underset{(0.182)}{0.035}$
High	$a_1 = \underset{(0.029)}{0.709}$	$b_1 = \underset{(0.002)}{0.033}$	$a_3 = \underset{(0.086)}{0.304}$	$b_3 = \underset{(0.156)}{0.037}$

the choice of defining this variable. Therefore, the regression coefficients differ across the regressions. Second, the relationship between the regression coefficients and the structural parameters depends upon the values a_3 and $b_3$which were estimated in the home production function. As these values differ in the various definitions, this calculation also differs in the three examples.

8.2.3 Impact of Assumptions on the Value of Consumer Durables

In this section I compare the results of the estimation under different assumptions regarding the cost of the durables considered. Table 31 shows the costs of various durable items in each of the categories. The baseline costs considered in the other parts of the estimation discussion are taken to be the medium level of durable costs. Table 32 then shows how the estimation results differ depending on these definitions.

As expected as the costs of durables right, the durable spending and, thus, its importance in the home production function increases. Additionally, as the cost of durables increases, the weight of market consumption in total consumption increases. The weight parameters ($a_1$and a_3) are measured precisely, with small standard errors. However, the parameters which govern the elasticity of substitution, especially in the estimation of the home production function, have higher standard errors. These high standard errors are likely driven by the fact that the cost of durable consumption is not directly included in the data set but rather constructed based on these assumptions.

Table 33: Home Production Function Regression Results without Informality

	Coefficient (SE)		
	consumer durables + housing	consumer durables	housing
$\ln\left[\frac{(1-\tau_h)w\varepsilon}{(1+\tau_c)}\right]$	-0.698^{***}	-0.992^{***}	-0.646^{***}
	(0.061)	(0.036)	(0.080)
constant	-0.802^{*}	3.351^{***}	-0.949^{*}
	(0.438)	(0.254)	(0.571)
N	6,765	5,268	6,765

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

$^{*}p \leq 0.1$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$

8.3 Impact of Ignoring Informality

Due to the way in which I have written the problem, there is an difference in the substitutability between home production and formality and home production and informality. The inclusion of the extra term to control for this additional substitution impacts the results. The tables below show the results of the estimation is the impact of informality is ignored.

In particular, in this section I run the following regression:

$$\ln\left[\frac{h_h}{d}\right] = \beta_2 + \beta_3 \ln\left[\frac{(1-\tau_h)\,w\varepsilon}{(1+\tau_c)}\right] + \varepsilon_2 \tag{22}$$

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

The difference between this and the estimation above is that this regression excludes the control for the substitutability between formality and informality. Therefore, in this estimation the choice of home production hours is only based upon the relative price, the after-tax wage.

Tables 33 to 36 show the results of the estimation of regressions related to home production for each of the three definitions of durable spending: only consumer durables, only housing, both consumer durables and housing. The estimation of the home production function is shown first. Then, the estimation of the CES aggregation of market consumption and home consumption is shown.

These parameters show that when informality is included the production function puts less weight on durable spending and more on home production hours. This may be as we are ignoring

Table 34: Home Production Function Parameter Estimates without Informality

	Estimate (SE)		
	consumer durables + housing	consumer durables	housing
a_3	0.555	0.013	0.632
	(0.180)	(0.002)	(0.248)
b_3	−0.433	−0.008	−0.548
	(0.126)	(0.037)	(0.192)

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

that the workers have the ability to move between sectors of the market (formality and informality) rather than exiting the market into home production. These results also show that in the two cases which include housing, the two inputs are slightly more substitutable. However, the substitution parameters still show high standard errors and are not precisely measured.

Excluding the presence of informality also impacts the estimation of the total consumption function. The results of these regressions are shown in tables 35 and 36 below.

The estimation results show that excluding informality in this regression leads to smaller dispersion across the definitions of durable spending. All three definitions lead to estimates of the weight of market consumption in total consumption to be around 0.3 and the substitution parameter is clustered around 0. These factors where present in the estimation which includes informality, but there is more dispersion in the results.

8.4 Comparison to Previous Studies of the United States

The same estimation procedure was performed on United States data in order to provide a test for the method. The results are shown in the table. More discussion of the methodology and the data used in this process is found in the appendix. In order to perform the estimation, I use the American Time Use Survey for the year 2015 and the Consumer Expenditure Survey for 2004, 2006, and 2009.

The goal of this exercise is to compare the results of the methodology above to the results of the home production literature in the United States.[8] Overall, the results of the exercise conform

[8]Specifically, the results are compared to Benhabib, Rogerson, and Wright (1991), McGrattan, Rogerson, and Wright (1994), Fang and Zhu (2012), and Aguiar, Hurst, and Kararbarbounis (2013)

Table 35: Home Production Function Regression Results

	Coefficient (SE)		
	consumer durables + housing	consumer durables	housing
$\ln\left[1+\frac{1-a_3}{a_3}\left(\frac{h_h}{d}\right)^{b_3}\right]$	0.764^{***}	0.530^{***}	0.817^{***}
	(0.286)	(0.157)	(0.232)
constant	-0.640	0.918^{*}	-0.668
	(0.492)	(0.534)	(0.447)
N			

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

$^{*}p \leq 0.1$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$

Table 36: Total Consumption Parameter Estimates

	Estimate (SE)		
	consumer durables + housing	consumer durables	housing
a_1	0.311	0.250	0.316
	(0.071)	(0.026)	(0.073)
b_1	-0.077	-0.003	-0.069
	(0.100)	(0.001)	(0.094)

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

Table 37: Comparison Between Chile and the United States

Function	Estimate (SE)			
	Chile		United States	
$\left\{a_1 c_m^{b_1} + (1-a_1) c_h^{b_1}\right\}^{1/b_1}$	$a_1 =$ 0.538 (0.039)	$b_1 =$ 0.039 (0.005)	$a_1 =$ 0.424 (0.035)	$b_1 =$ 0.435 (0.003)
$\left\{a_2 h_f^{b_2} + (1-a_2) h_i^{b_2}\right\}^{1/b_2}$	$a_2 =$ 0.447 (0.039)	$b_2 =$ 0.869 (0.030)	$a_2 =1$	$b_2 =1$
$\left\{a_3 d^{b_3} + (1-a_3) h_h^{b_3}\right\}^{1/b_3}$	$a_3 =$ 0.070 (0.044)	$b_3 =$ 0.035 (0.182)	$a_3 =$ 0.186 (0.004)	$b_3 =$ 0.160 (0.006)

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

Source (US): American Time Use Survey (2015), Consumer Expenditure Survey (2004, 2006, 2009)

with the results of the literature. In particular, empirical studies of home production in the United States finds and elasticity of substitution between market and home goods between 1.75 and 2.3.[9] This work finds this elasticity in the United States to be 1.77. Additionally, the literature finds a the elasticity of substitution between durables and home hours in home production between 1.16 and 1.20. The value founds in this work is 1.19- solidly in the range of previous results.

Part IV

Model Fit

9 Aggregates

The model does reasonably well in matching the time series for the capital to output ratios as well as the aggregate hours worked. Recall that only the value in 1980 is targeted. Figures 6a and 6b show the time series of these variables. Given that I do not target time varying trends in any way other than including population growth, I believe the model does a fairly good job of replicating the dynamic features of the data. In particular, the model replicates the facts that aggregate hours

[9] This elasticity of substitution is defined as $\varepsilon = \frac{1}{1-b_1}$

worked are declining throughout the transition and that the capital to output ratio remains fairly constant. However, there are things the model does not replicate or that we do not see in the data. First, in the data, we see the capital to output ratio drop until the mid 1990s and then begin to increase. However, in the model we see a drop initially, but then the ratio rebounds to around its original level. It remains near this level for the remainder of the time series. Second, in the data we see a steady decline in aggregate hours throughout the time period. In the model, however, hours drop initially but rebound to a constant level in the 1990s. These differences most likely occur as I do not model explicitly other reforms and changes that occurred in Chile during this time period. Despite these differences, though, I am confident that the model can accurately replicate the features of the aggregate data throughout the time series.

10 Distribution

Data constraints limit my ability to fully study the distributional impact of the reform on savings and labor supply. Specifically, I lack sufficient micro-level data for the years prior to 2004. However, I can use the data from the year 2004 to study some of the distributional effects. In addition to the difficulties caused by missing data, changes between the data used for 1980 and the data used after the reform limit how I can split the data by productivity type. In the model, and the EOD survey, I separate my productivity types into three groups: manual laborers, employees, and managers. In the post-reform survey, the EPS survey, occupation is not separated between manual laborers and employees. Therefore, in the post reform tests, I compare two groups: manual laborers combined with employees and managers by themselves. Distributional impacts on savings are discussed in this section.

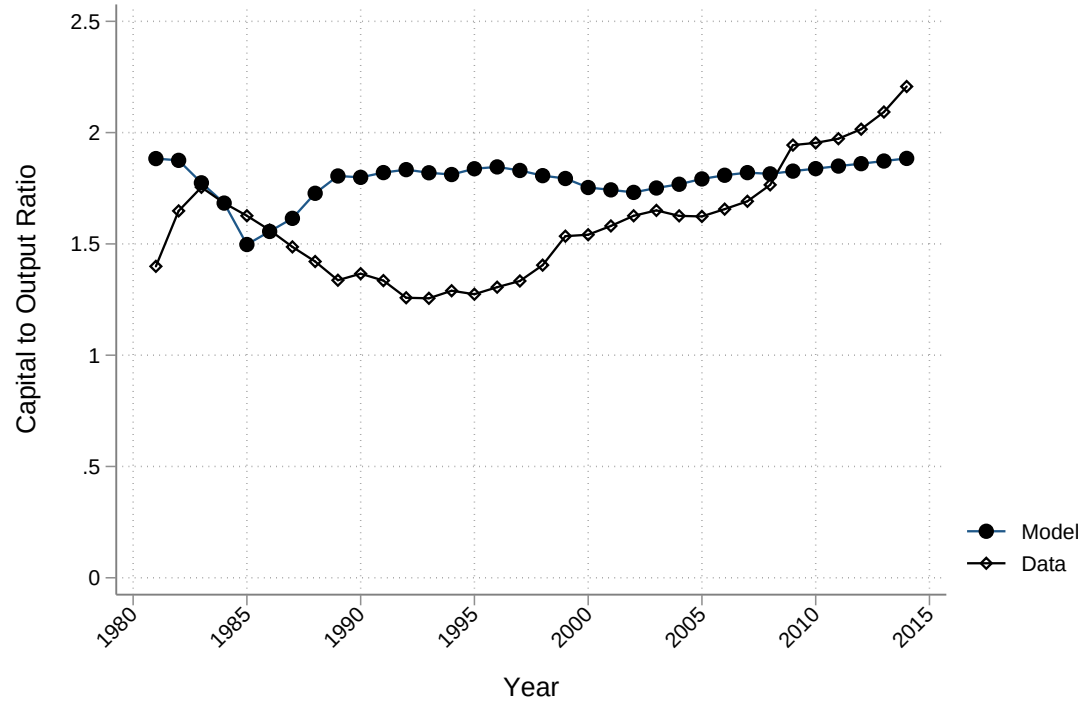
10.1 Savings

I define savings as the sum of savings in many different areas: savings for housing, savings in a voluntary pension accounts (including a second account run through a AFP fund), savings in a bank account, holding a term deposit, investments in mutual funds, ownership in bonds or stocks, holding loans to 3rd parties, and all other savings. In the text, I present the ratio of the average savings for managers to the average savings for manual laborers+employees. For 2004, this ratio was 3.2. In my model, this ratio was 4.3.

In addition to studying the distribution across types, I can also look at the distribution of savings over age. The comparison between the savings in the model and the data are shown in Figure 7. The data points shown are the average among different binned ages: under 30, 30 to 35, 35 to 40, 40 to 45, 45 to 50, 50 to 55, 55 to 60, 60 to 70 and over 70. Both the data points and the model

Figure 6: Model Fit Time Series

(a) Capital to Output Ratio



(b) Aggregate Hours Worked

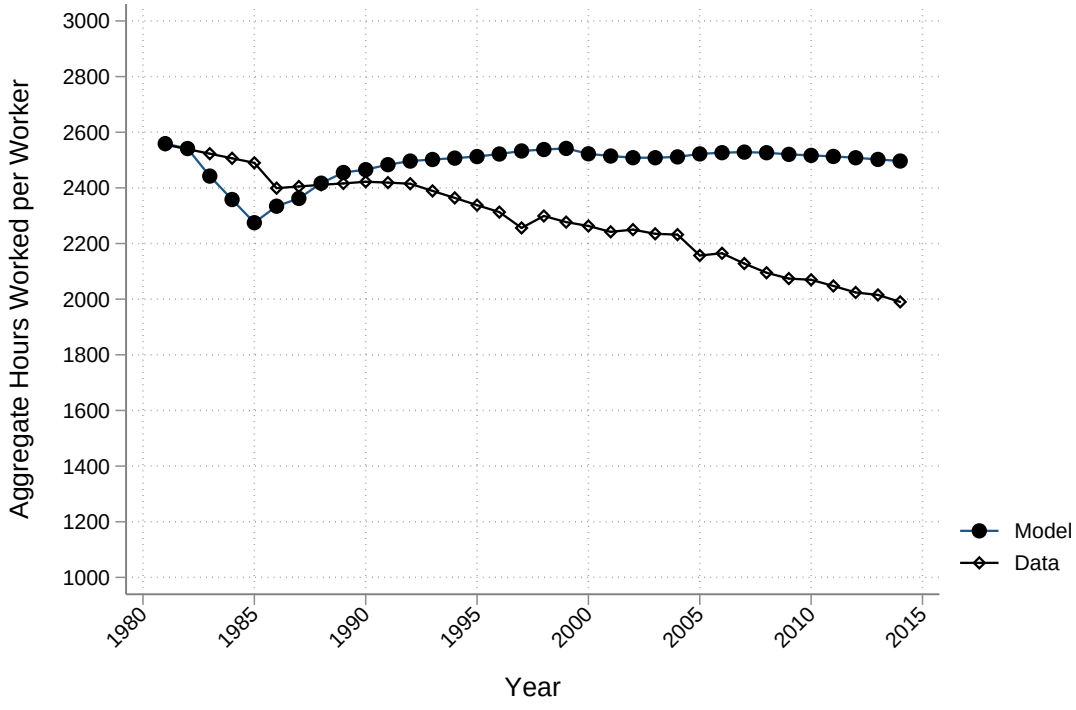
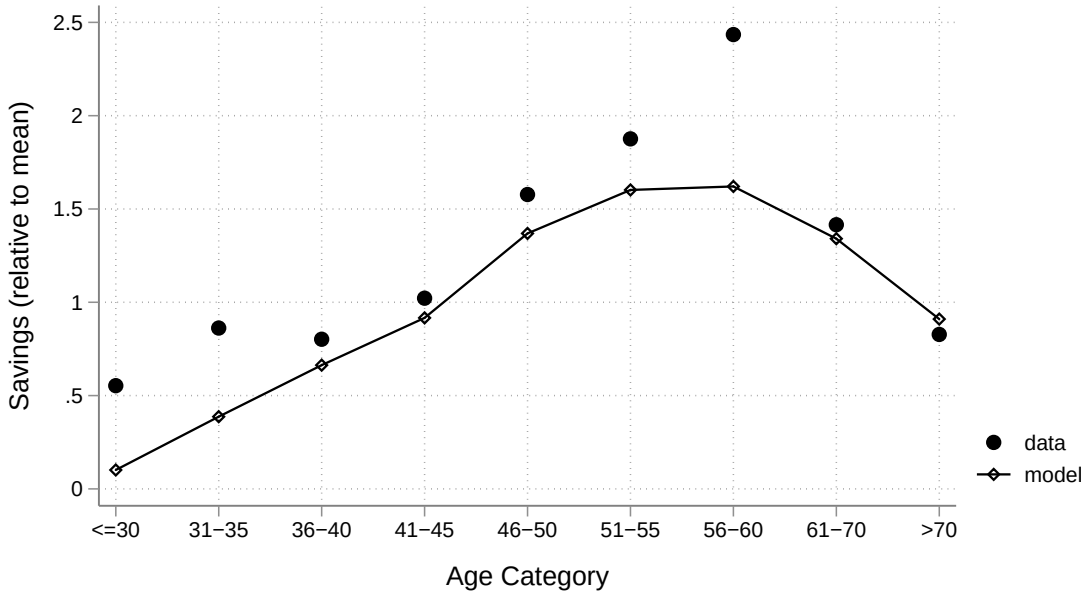


Figure 7: Savings by Age



NOTE: Data shows the average savings for each age category relative to the mean over all ages.
Model shows how savings evolve throughout the lifetime, relative to the average savings over the lifetime
Both data and model are shown using aggregate savings across employment types for 2004

are shown relative to the average saving across all age groups. The figure show that the model does a good job of replicating the pattern over saving over the life-cycle. One feature that the model cannot reproduce is that household have some savings early in life. This, as discussed in the paper, is likely due to the assumption that household enter the labor force at age 25 with 0 assets. Additionally, the model under-predicts assets of households nearing retirement (between the ages of 56 and 60).

10.2 Labor Supply

The ability to compare the labor supply implications of the model with the data are limited due to the method used to estimate the formality, informality, and home production parameters. Specifically, I use the micro data to estimate the substitution and shares of hours in each sector. Therefore, the ratio of hours in each sector in my model are, somewhat by construction, the same as those in the data. In particular the average ratio of formal hours to informal hours for a household is 3.2 in the data and 3.1 in the model. This ratio indicates that between 20 and 30 percent of hours worked are in the informal sector.

However, this same ratio across productivity types cannot be matched by my model. In my estimation, I assume there are single values for the parameters which govern substitution between

home production and the market sector as well as the substitution between formality and informality. Therefore, my model matches the aggregate ratios of hours worked in various sectors. It cannot, however, match the fact that the lower productivity workers, manual laborers and employees, work a higher fraction of hours in the informal sector than the managers.

Part V

Sensitivity

11 Small Open Economy Model

11.1 Theoretical Changes

Adapting the model to be a small open economy rather than a closed economy consists of only small changes. In particular, now the prices r and w are fixed.

Additionally, now the resource constraint for the economy features a term net exports

$$f\left(K_m, H_f + H_i\right) = Y = C_m + D + X_m + G + NX \tag{23}$$

In addition the resource constraint, the government budget constraint also changes to reflect the inclusion of exports and imports.

$$B_{t+1} + NX_t + \tau_{ct}\left(C_{mt} + D_t\right) + \tau_{pt}\Pi_t + \tau_{dt}\Delta_t + \sum_{j,\varepsilon} \mu_t^{j,\varepsilon}\left[\left(\tau_{ht} + \tau_{sst}\right) w_t \varepsilon h_{ft} - \psi_j^R\left(\bar{y}_t\right) - \psi^c\right] = (1 + i_t)B_t + G_t \tag{24}$$

11.2 Computational Differences

Changes in the computation of the small open economy rather than the baseline model are focused on the solution of the balanced growth path. If these changes are made to the BGP solution, the computation of the transition follows the steps in Section 2.2 prior. Computationally, allowing for a small open economy eliminates the loop in which the fixed point on prices is found. Rather than making a guess for prices, the prices are fixed. In particular, I set the world interest rate to 4%, $i = 0.04$. Then, a fixed point is only found on the transfer that is used to balance the government budget constraint.

As with government spending and debt in the closed economy case, I assume that net exports

are a fraction of GNP. In other words, I use a parameter ϕ_{NX} as a parameter in the government budget constraint

$$NX = \phi_{NX} GNP = \phi_{NX} Y \tag{25}$$

Then, the condition for clearing the government budget constraint–$\mathbb{R}_2(x)$ in the original computational algorithm–becomes[10]:

$$\mathbb{R}_2(x) = T + G - \tau_h H_f - \tau_p \Pi - \tau_d \Delta - B^{'} + (1+i) B - \tau_c C_m - NX \tag{26}$$

12 Additional Change in 2008

In 2008, the Chilean government implemented additional change which augmented the minimum pension workers were eligible for if they did not accumulate sufficient savings. This section describes how including this additional reform in the model impacts the parameters and the results. In particular, I discuss the details of the 2008 reform, the impact that the inclusion of this reform has on the model and parameters, the impact on the computation, and finally how the inclusion of the reform changes the transitional results.

12.1 2008 Changes to the Minimum Pension

In 2008, the Chilean government made additional changes to both the minimum pension guarantee (MPG) and the welfare pension (PASIS). Under this secondary reform, the MPG and PASIS were replaced with a new program which consists of two items: a new means-tested welfare program and a change to the method of augmenting low contributory pensions. The means tested program, Pensión Básica Solidaría (PBS), is nearly 50% greater than the PASIS program and covers the 60% poorest households. The second part of the program, Aporte Previsional Solidario (APS), is calculated as a fraction of the PBS which is added to the pension an agent can fund with his own savings. PBS and APS programs were enacted gradually between 2008 and 2012.

[10]Note that although I use the notation $r_2(x)$ this is the only residual equation used in computation of the balanced growth path of the small open economy. The subscript of 2 is meant only to create a connection to the residual equation of the baseline computation.

Table 38: Transition Schedule for Solidarity Pension (agreed December 2008)

Year	PBS (CLP$ monthly)	APS (% of PBS)	Percentiles of HH Income Included
2008	60,000	85.7%	Bottom 40%
2009	75,000	62.5%	Bottom 45%
2010	75,000	50.0%	Bottom 50%
2011	$75{,}000\times(1-\pi)$	$37.5\%\times(1-\pi)$	Bottom 55%
2012 and beyond	$75{,}000\times(1-\pi)$	$29.4\%\times(1-\pi)$	Bottom 60%

SOURCE: text of the law approved by the Chilean Congress on January 16, 2008; Valdés-Prieto (2009)
NOTE: π represents the inflation for the period from July 2010 to June 2012. Figures are indexed by prices as of July 2012

12.2 Impact on the Model and Parameters

The inclusion of the 2008 Reform has minimal impact on the model– it will only cause a change the I model the retirement transfer. Specifically, including this reform will add a case to the function used for the retirement transfer. Case 4 will apply to those workers who entered the workforce after the privatization of the pension system in 1981 as long as the year is after 2008. Cases 1, 2, and 3 are the same as in the baseline parametrization.

$$\psi_t^R = \begin{cases} \zeta^{\varepsilon}\overline{y}_t & \text{Before the reform} \\ \frac{1}{J-R}\left[0.8\overline{y}_t\left(\frac{t^*-t_0}{35}\right)\nu_G\nu_A(1.04)^{R-t^*}\right] & \text{Cohorts who entered the workforce prior to the reform and switched} \\ \max\left\{0,\underline{c}-\left(\frac{R-1}{J-R}\right)*(0.1\overline{y}_t)\right\} & \text{Cohorts who entered the workforce after to the reform and year is prior to 2008} \\ \widetilde{c} & \text{Cohorts who entered the workforce after to the reform and year after 2008} \end{cases} \tag{27}$$

Case 4: Agents who entered the workforce after the reform, $t \geq 2008$

The formula for the government provided retirement transfer after 2008 is given by the following formula:

$$\widetilde{c}$$

After the 2008 reform, the structure of the minimum pension provided by the government

changed. Rather than providing a top up to the pensions of any worker who did not save sufficiently, the government provided an additional income for workers who were among the poorest in the population. This benefit was defined as a percentage of the new welfare pension level which was also enacted in 2008. The transition for this additional income, $\widetilde{c}$, is shown in the table below:

As the table shows, the new minimum pensions were phased in over the years between 2008 and 2012. In 2008, the bottom 40% of earners received a benefit equivalent to 85.7% of the welfare pension. This amount was added to the pension that a worker could fund with his own savings. This benefit decreased to only 29.4% of the welfare pension by 2012, but the bottom 60% of household received the additional income.

12.3 Impact on the Computation and Welfare Calculation

In order to solve for the result of this secondary reform, I assume that the 2008 changes to the minimum pension were not expected as of the change in 2008. Therefore, I solve the model for the baseline case of the 1981 reform. Then, I use the result for the distributions of individual states as the starting point for a second transition beginning with the 2008 secondary reform. These two transition paths are combined for results.

For the welfare calculation, this means that the welfare of current and future generations in 2008 have augmented lifetime consumption and leisure. For future cohorts this augmented lifetime consumption and leisure is entirely from the transition path in which the 2008 changes have been implemented. For current generations these augmented values are a combination of results from the transition path only including 1981 changes and the transition path that adds in the 2008 changes.

12.4 Impact on Transitional Results

Inclusion of the secondary reform in 2008 has only minimal impact on the transitional results of the model. Table 39 and Figure 8 show the behavior of the aggregates throughout the transition and the welfare impact of the reform with and without the reform, respectively.

Consider, first, the aggregates throughout the transition path. The results show that the 2008 change has minimal impact on aggregates. The first years of the transition are identical to the aggregates in the baseline as the reform has not yet occurred and is unexpected. Because the reform is unexpected, household do not make different decisions prior to the reform. The result show that long-run aggregates are only slightly different when the 2008 changes are included. This is also shown when we look at the welfare impact.

The results for the welfare impact by cohort differs minimally from the baseline case. Figure 8 shows this. The darker lines show the baseline case. The finer lines show the case in which the secondary reform is implemented. Welfare increases slightly (about 2 percent of lifetime market

Table 39: Aggregates, Prices, and Government Budget through the Transition

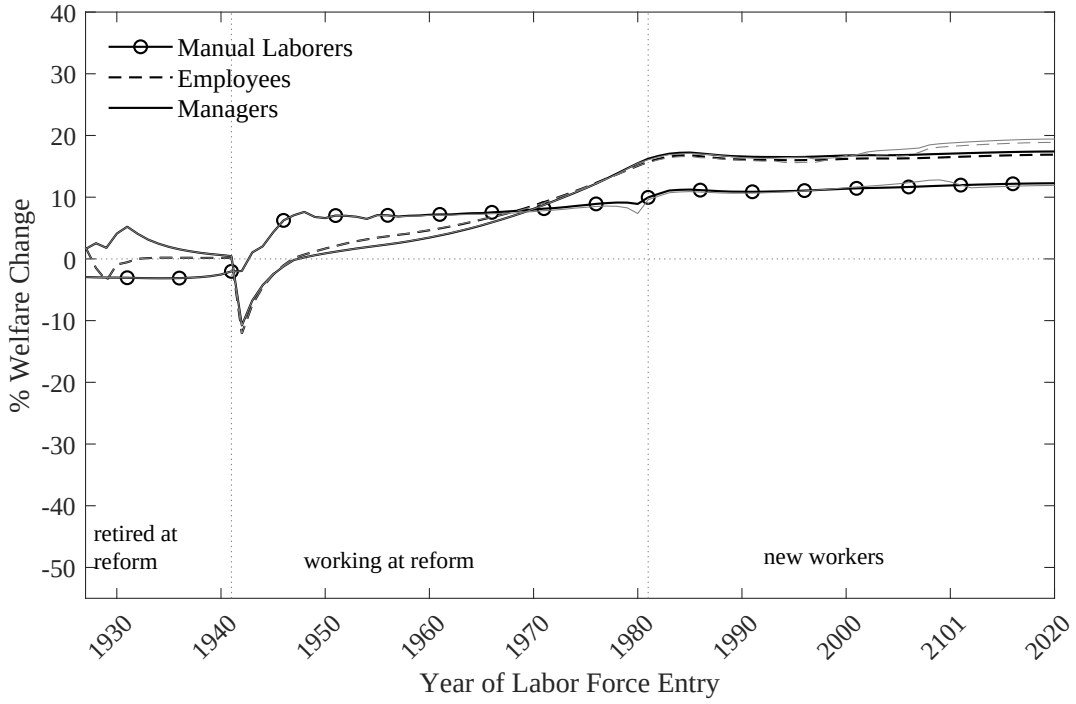
Transition from PAYG to Current Chilean Policy Including 2008 Reform

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	0.929	0.985	1.010	0.993	0.994	0.992
Capital Stock	1.000	0.961	1.003	1.064	1.073	1.070	1.121
Hours	1.000	0.930	0.934	0.901	0.880	0.867	0.857
Formal Hours	1.000	0.769	0.789	0.786	0.769	0.758	0.747
Informal Hours	1.000	5.489	5.632	5.606	5.487	5.411	5.333
Home Hours	1.000	0.958	0.917	0.823	0.797	0.783	0.782
Consumption	1.000	1.164	1.196	1.140	1.118	1.104	1.104
Market Consumption	1.000	1.255	1.320	1.280	1.260	1.247	1.247
Durable Spending	1.000	1.254	1.317	1.278	1.257	1.244	1.244
Home Consumption	1.000	0.973	0.937	0.846	0.821	0.807	0.805
Investment	1.000	1.192	1.373	1.087	1.003	0.981	1.022
Interest Rate	1.000	0.996	0.985	0.977	0.975	0.971	0.968
Wage	1.000	1.006	1.041	1.068	1.074	1.085	1.102
Per-capita Transfer	1.000	0.407	0.455	0.740	0.763	0.766	0.769
Consumption Tax	0.075	0.090	0.057	0.036	0.036	0.035	0.035
Labor Tax	0.378	0.211	0.213	0.220	0.222	0.222	0.222
Corporate Tax	0.082	0.077	0.074	0.084	0.086	0.087	0.085
Retirement Transfer	0.077	0.095	0.096	0.017	0.004	0.004	0.004
PAYG Pension	0.077	0.034	0.000	0.000	0.000	0.000	0.000
Recognition Bond	—	0.060	0.096	0.012	0.000	0.000	0.000
MPG	—	0.000	0.000	0.005	0.004	0.004	0.004
Per-capita transfer	0.364	0.154	0.168	0.267	0.280	0.281	0.282
Debt	0.252	0.361	0.056	0.035	0.035	0.035	0.035
Government Spending	0.043	0.041	0.024	0.019	0.019	0.019	0.019

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

Figure 8: Welfare Impact by Cohort Including the 2008 Reform



consumption) for each of the types. These increases long run welfare gains are mainly driven by larger future transfers in the case of the secondary reform.

I do not believe this result indicates that these secondary changes did not have an impact. Rather, I believe that the results indicates that the important margins for understanding this reform are not included in this model. Specifically, I believe that this reform was targeted mainly at workers who were not eligible for the minimum pension guarantee prior to the reform. The baseline model does not include a notion of eligibility. Therefore, people who move between non-eligibility and eligibility are not measured in this experiment. I consider this reform more carefully in other work (McKiernan (2020)).

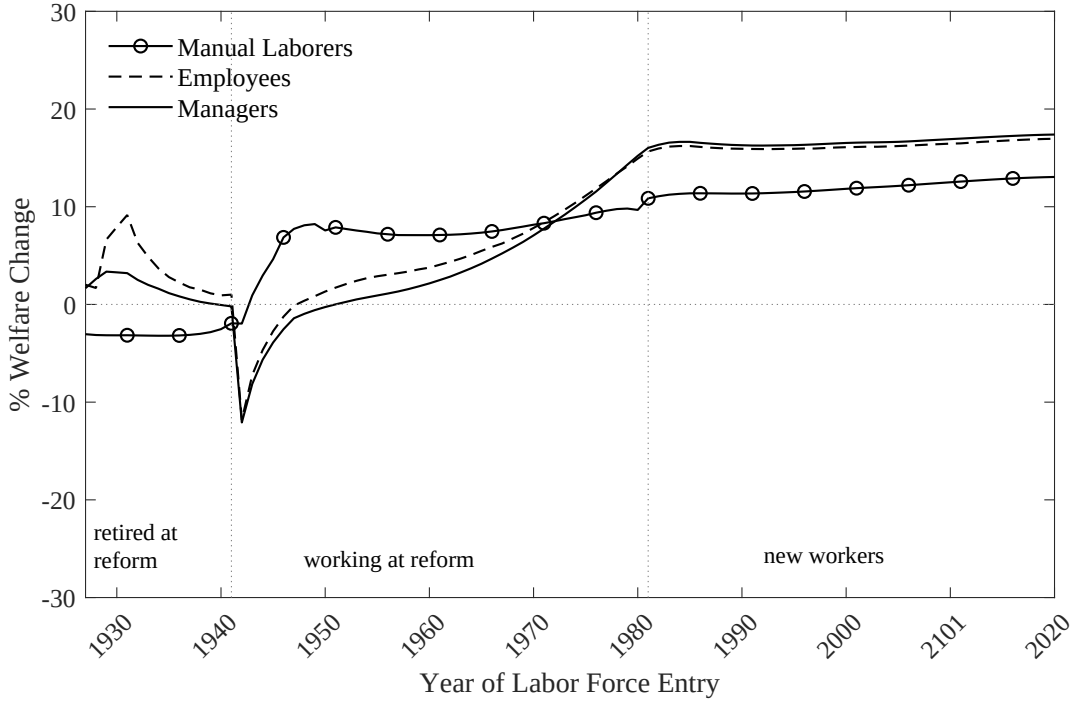
13 Changes in Fiscal Series

This section shows the transitional results under various assumptions regarding the changes in the fiscal variables. Figures 9, 10, and 11 show the welfare impact under three scenarios. First, I show the results if all fiscal variables had stayed constant at its 1980 value under both the simulations with and without the reform. Second, I show the results under the scenario that the fiscal series stay constant in the scenario in which PAYG continues but only the debt series remains constant in

the simulation in which the reform occurs. All other series in the reform simulation evolve as they did in the data. Finally, I show the results in a scenario in which fiscal series remain constant when the reform does not occur but evolve according to the data when the reform occurs. This depicts the assumption that the government used fiscal changes to help support the transition but that they would not have changed these series if the reform had not occurred. Each of these cases isolates the impact of a different element of the fiscal series.

First, consider the case in which fiscal series are constant under both simulations. The welfare result shows that much of the transitional losses for manual laborers disappears. This results leads to to believe that the assumptions regarding how fiscal series would have evolved had the reform not occurred are important for the welfare impact on those generations of manual laborers who were retired at the time of reform.

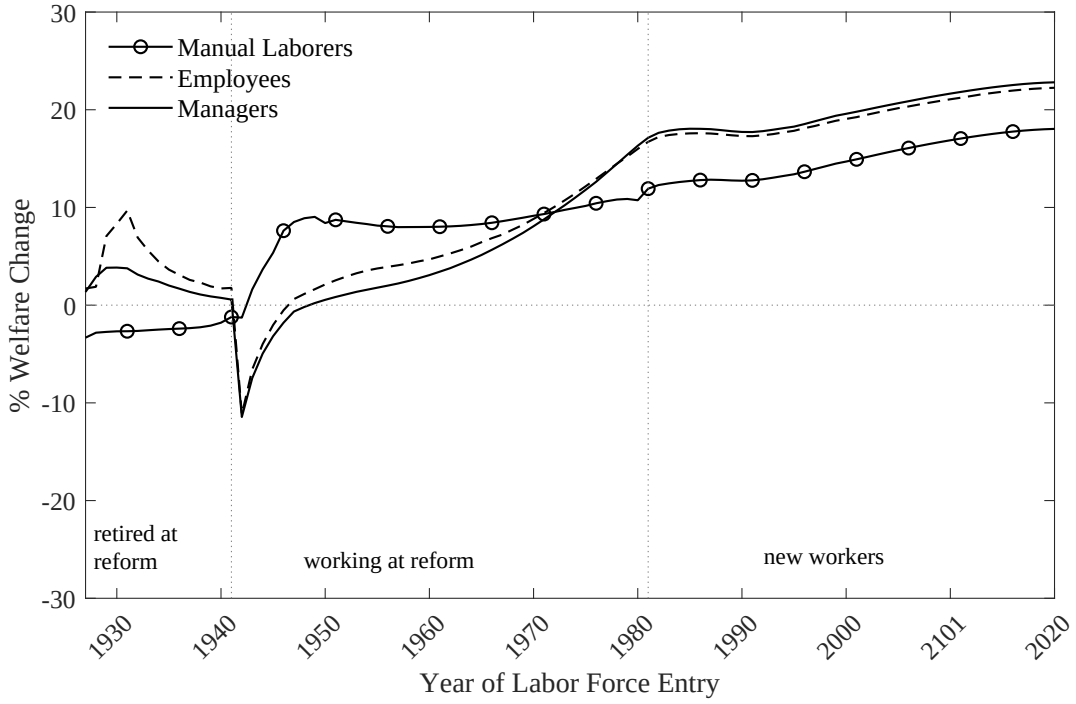
Figure 9: Welfare Impact by Cohort: All Constant



Now, consider a case in which all series are constant when PAYG continues, but only debt is constant in the case of the reform. Previous work on Social Security privatization has shown that debt can be used to transfer welfare gains from future generations to current ones. This case can interpreted as isolating how much of gains were due to debt accumulation. Results show that transitional results are very similar to the case prior. However, long-run welfare gains are larger. These larger long-run welfare gains are because the government paid debt down quickly and to a very low level. Holding debt constant keeps debt higher in these future periods and leads to higher

gains.

Figure 10: Welfare Impact by Cohort: Only Debt Constant



In the final simulation all series are held constant in the case of PAYG continuing but the series evolve according to data in the reform. This is the baseline case but series are constant when the reform does not occur.

The main take-away from these experiments is that the largest driver of welfare changes due to other fiscal variables is whether the government would have used debt to help sustain PAYG had the reform not occurred. These three cases exhibit very similar welfare impacts and all three consider a situation in which the series are constant in the no reform simulation. Therefore, these experiment make me conclude that transitional results are impacted by the choices involving what the reform is compared to. However, as seen in the case of only debt being constant in the reform, long-run gains can be influenced by the debt choices–as has been shown in other literature.

14 Alternate Home Production Parameters

Much previous work has studied the impact of home production. Many of these studies have also estimated the parameters that govern the household choices of market work and home production. The parameters I estimate are slightly different from those found in previous work. In particular, I

Table 40: Aggregates, Prices, and Government Budget through the Transition

Continue PAYG Program: All Fiscal Series Constant

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	0.923	0.910	0.858	0.832	0.815	0.812
Capital Stock	1.000	1.049	1.045	1.008	0.984	0.975	0.977
Hours	1.000	0.963	0.949	0.914	0.898	0.887	0.881
Formal Hours	1.000	0.940	0.920	0.867	0.839	0.820	0.811
Informal Hours	1.000	0.960	0.957	0.907	0.880	0.860	0.851
Home Hours	1.000	1.011	1.011	1.017	1.026	1.031	1.034
Consumption	1.000	1.003	1.020	1.029	1.040	1.047	1.050
Market Consumption	1.000	1.000	1.024	1.034	1.046	1.054	1.057
Durable Spending	1.000	1.000	1.024	1.034	1.046	1.054	1.057
Home Consumption	1.000	1.011	1.012	1.018	1.028	1.033	1.036
Investment	1.000	1.398	1.126	1.021	0.912	0.871	0.858
Interest Rate	1.000	1.007	1.004	1.004	1.003	1.003	1.000
Wage	1.000	0.983	0.987	0.989	0.990	0.993	1.000
Per-capita Transfer	1.000	0.809	0.713	0.553	0.479	0.423	0.411
Consumption Tax	0.075	0.072	0.047	0.034	0.035	0.036	0.037
Labor Tax	0.378	0.373	0.355	0.350	0.348	0.347	0.346
Corporate Tax	0.082	0.068	0.077	0.077	0.080	0.081	0.081
Retirement Transfer	0.077	0.099	0.123	0.167	0.193	0.212	0.218
PAYG Pension	0.077	0.099	0.123	0.167	0.193	0.212	0.218
Recognition Bond	—	—	—	—	—	—	—
MPG	—	—	—	—	—	—	—
Per-capita transfer	0.364	0.319	0.285	0.235	0.210	0.189	0.184
Debt	0.252	0.252	0.252	0.252	0.252	0.252	0.252
Government Spending	0.043	0.043	0.043	0.043	0.043	0.043	0.043

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

Table 41: Aggregates, Prices, and Government Budget through the Transition

Transition from PAYG to Current Chilean Policy: All Fiscal Series Constant

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	0.947	0.950	0.965	0.956	0.950	0.950
Capital Stock	1.000	0.984	1.058	1.070	1.028	1.044	1.085
Hours	1.000	0.937	0.918	0.885	0.871	0.858	0.850
Formal Hours	1.000	0.781	0.767	0.761	0.751	0.739	0.730
Informal Hours	1.000	5.571	5.474	5.432	5.362	5.275	5.206
Home Hours	1.000	0.952	0.927	0.833	0.815	0.806	0.807
Consumption	1.000	1.145	1.153	1.076	1.055	1.047	1.049
Market Consumption	1.000	1.231	1.253	1.183	1.161	1.153	1.156
Durable Spending	1.000	1.229	1.251	1.181	1.159	1.151	1.154
Home Consumption	1.000	0.966	0.944	0.851	0.833	0.825	0.825
Investment	1.000	1.257	1.275	1.053	0.960	0.958	0.977
Interest Rate	1.000	0.994	0.987	0.980	0.979	0.975	0.971
Wage	1.000	1.010	1.030	1.047	1.050	1.056	1.064
Per-capita Transfer	1.000	0.531	0.478	0.695	0.722	0.716	0.716
Consumption Tax	0.075	0.086	0.056	0.034	0.034	0.034	0.034
Labor Tax	0.378	0.212	0.210	0.217	0.219	0.219	0.217
Corporate Tax	0.082	0.076	0.075	0.085	0.088	0.088	0.089
Retirement Transfer	0.077	0.093	0.106	0.022	0.010	0.011	0.011
PAYG Pension	0.077	0.033	0.000	0.000	0.000	0.000	0.000
Recognition Bond	—	0.060	0.106	0.015	0.000	0.000	0.000
MPG	—	0.000	0.000	0.007	0.010	0.011	0.011
Per-capita transfer	0.364	0.204	0.183	0.262	0.275	0.275	0.275
Debt	0.252	0.252	0.252	0.252	0.252	0.252	0.252
Government Spending	0.043	0.043	0.043	0.043	0.043	0.043	0.043

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

Table 42: Aggregates, Prices, and Government Budget through the Transition

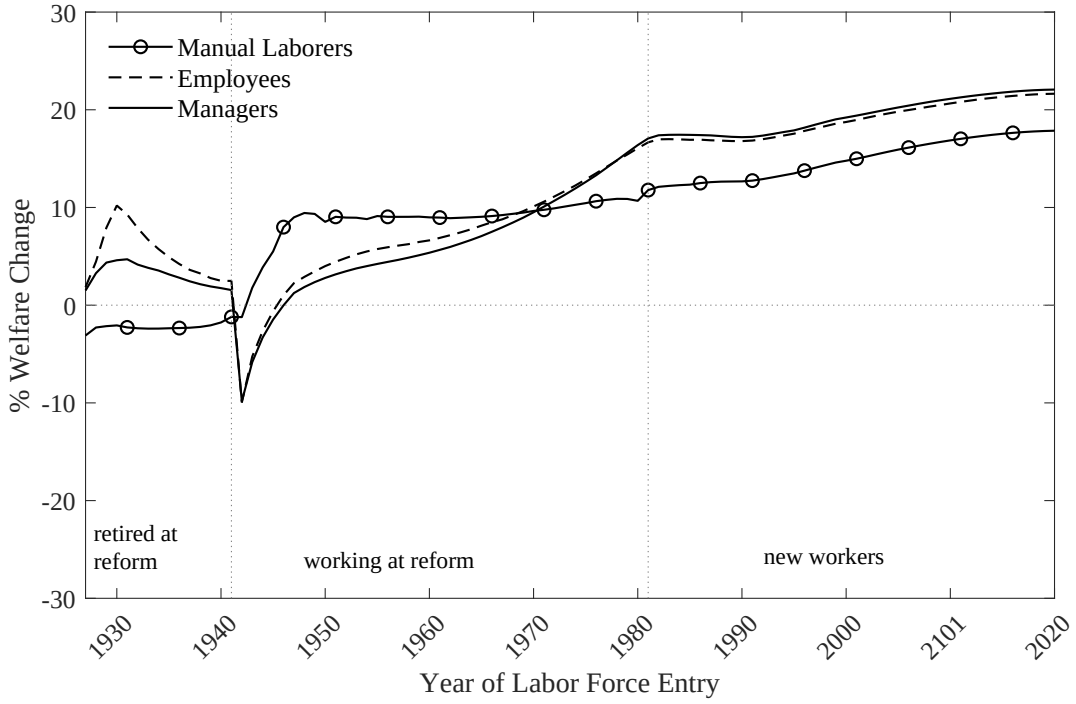
Transition from PAYG to Current Chilean Policy: Only Debt Constant

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	0.947	0.956	0.969	0.957	0.950	0.950
Capital Stock	1.000	0.971	0.996	1.048	1.025	1.043	1.083
Hours	1.000	0.937	0.921	0.886	0.870	0.858	0.850
Formal Hours	1.000	0.780	0.772	0.764	0.752	0.740	0.730
Informal Hours	1.000	5.568	5.506	5.452	5.367	5.278	5.210
Home Hours	1.000	0.951	0.923	0.829	0.812	0.804	0.804
Consumption	1.000	1.157	1.318	1.274	1.118	1.110	1.112
Market Consumption	1.000	1.248	1.318	1.274	1.254	1.246	1.249
Durable Spending	1.000	1.246	1.316	1.272	1.251	1.243	1.246
Home Consumption	1.000	0.967	0.943	0.852	0.835	0.827	0.827
Investment	1.000	1.203	1.194	1.059	0.960	0.956	0.975
Interest Rate	1.000	0.994	0.987	0.980	0.978	0.975	0.971
Wage	1.000	1.010	1.030	1.047	1.050	1.056	1.064
Per-capita Transfer	1.000	0.489	0.437	0.638	0.664	0.658	0.658
Consumption Tax	0.075	0.090	0.060	0.038	0.038	0.038	0.038
Labor Tax	0.378	0.177	0.175	0.181	0.181	0.181	0.180
Corporate Tax	0.082	0.075	0.078	0.082	0.084	0.085	0.085
Retirement Transfer	0.077	0.093	0.102	0.022	0.011	0.012	0.012
PAYG Pension	0.077	0.033	0.000	0.000	0.000	0.000	0.000
Recognition Bond	—	0.060	0.102	0.014	0.000	0.000	0.000
MPG	—	0.000	0.000	0.008	0.011	0.012	0.012
Per-capita transfer	0.364	0.157	0.141	0.217	0.229	0.229	0.229
Debt	0.252	0.252	0.252	0.252	0.252	0.252	0.252
Government Spending	0.043	0.041	0.024	0.019	0.019	0.019	0.019

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

Figure 11: Welfare Impact by Cohort: Series Constant in PAYG



estimate home production and market consumption to be less substitutable than in the literature. I also find total consumption weighted more towards home production. Additionally, I find the home production function to be more weighted towards durables and the two inputs (durable spending and hours) to be more substitutable. In order to check how these different parameter values may impact my results, I perform the same experiment with the parameter values estimated in McGrattan, Rogerson, and Wright (1997). Because they study an economy without informality. I hold the parameters governing the formality and informality decision to be the same as in the baseline. The parameters are shown in Table 43. Tables 44 and 45 show the calibrated parameters and the fit of this calibration in this experiment.

Results are similar with other values for the home production parameters. Tables 46 and 47 show the aggregates throughout the transition. Figure 12 shows the welfare impact of the reform in the case of these alternative parameters. The welfare impact shows that while quantitative results may differ between this counterfactual and the baseline, but the patterns are very similar. The key difference is that differences in welfare gains between the productivity types are magnified. The long run welfare gains of manual laborers decrease slightly but remain around 10 percent of lifetime consumption. Welfare gain for employees and managers, on the other hand, are larger under these new parameters values. Gains for these groups increase to around 20 percent. Finally, gains and losses throughout the transition path are also magnified.

Table 43: Alternative Parameter Values from McGrattan, Rogerson, and Wright (1997)

Function	Estimate (SE)		Elasticity of Substitution*
$\left\{a_1 c_m^{b_1} + (1-a_1) c_h^{b_1}\right\}^{1/b_1}$	$a_1 = 0.414$	$b_1 = 0.429$	$\eta_1 = 1.751$
$\left\{a_2 h_f^{b_2} + (1-a_2) h_i^{b_2}\right\}^{1/b_2}$	$a_2 = \underset{(0.055)}{0.432}$	$b_2 = \underset{(0.059)}{0.844}$	$\eta_2 = 6.410$
$\left\{a_3 d^{b_3} + (1-a_3) h_h^{b_3}\right\}^{1/b_3}$	$a_3 = 0.220$	$b_3 = 0.189$	$\eta_3 = 1.233$

*The elasticity of substitution shown is that which is implied by the estimation of the b parameters using the equation $\eta_i = \frac{1}{1-b_i}, i = 1,2,3$

Table 44: Calibrated Parameters

Parameter	Baseline	MRW (1997)
β	0.901	0.900
γ	0.484	0.498
$\{\varepsilon_1, \varepsilon_2, \varepsilon_3\}$	$\{0.5, 1.45, 4.5\}$	$\{0.6, 1.4, 3.5\}$

Table 45: Targeted Moments

Moments	Data	MRW (1997)
Capital to output ratio	1.667	1.666
Aggregate hours worked	0.495	0.494
Fraction of GNP spent on social programs	0.144	0.145
Fraction of labor income earned by manual laborers	0.210	0.203
Fraction of labor income earned by employees	0.520	0.523
Fraction of labor income earned by managers	0.270	0.273

Figure 12: Welfare Impact by Cohort: MRW Parameters

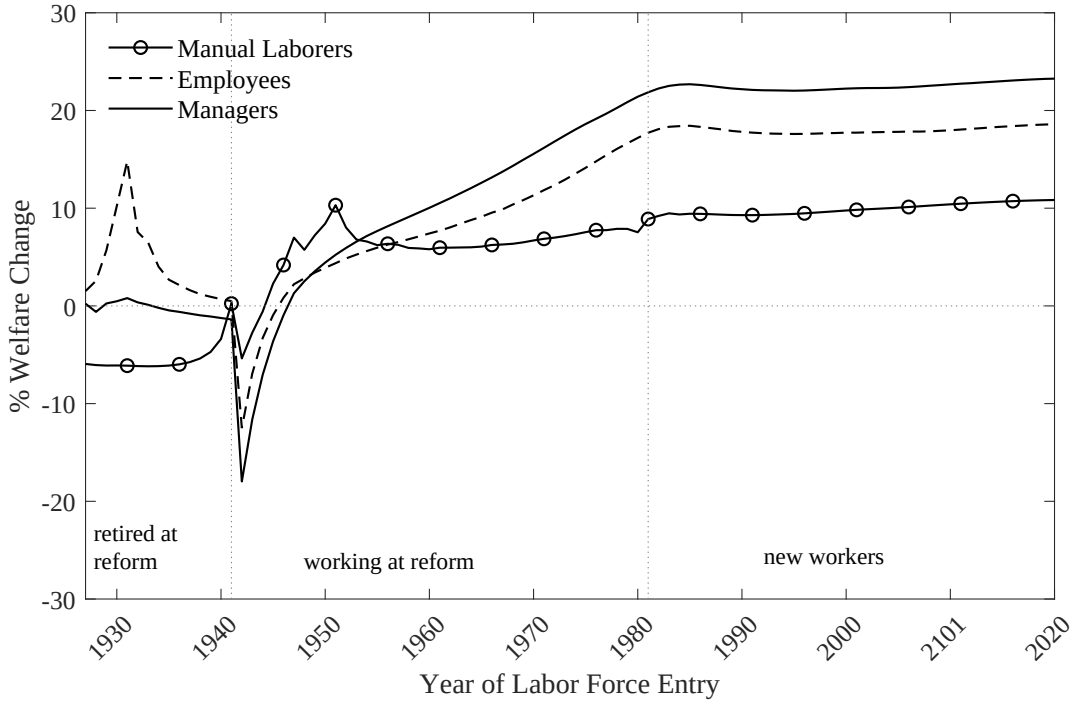


Table 46: Aggregates, Prices, and Government Budget through the Transition

Continue PAYG Program: Alternate Parameters

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	0.943	1.006	0.934	0.906	0.888	0.883
Capital Stock	1.000	0.841	0.790	0.853	0.851	0.838	0.841
Hours	1.000	0.968	0.998	0.955	0.938	0.926	0.920
Formal Hours	1.000	0.949	1.013	0.942	0.911	0.890	0.880
Informal Hours	1.000	0.970	1.048	0.988	0.958	0.937	0.927
Home Hours	1.000	1.006	0.966	0.978	0.989	0.994	0.997
Consumption	1.000	1.019	1.042	1.089	1.104	1.112	1.116
Market Consumption	1.000	1.024	1.073	1.135	1.152	1.161	1.165
Durable Spending	1.000	1.026	1.049	1.094	1.093	1.118	1.121
Home Consumption	1.000	1.010	0.981	0.998	1.010	1.015	1.018
Investment	1.000	0.877	0.925	0.898	0.789	0.747	0.744
Interest Rate	1.000	1.003	1.002	1.003	1.003	1.002	1.000
Wage	1.000	0.988	0.991	0.994	0.995	0.998	1.005
Per-capita Transfer	1.000	0.778	0.885	0.649	0.581	0.521	0.502
Consumption Tax	0.079	0.076	0.047	0.036	0.037	0.038	0.039
Labor Tax	0.407	0.402	0.393	0.385	0.384	0.383	0.383
Corporate Tax	0.084	0.089	0.090	0.087	0.090	0.091	0.090
Retirement Transfer	0.084	0.108	0.128	0.191	0.216	0.237	0.244
PAYG Pension	0.084	0.108	0.128	0.191	0.216	0.237	0.244
Recognition Bond	—	—	—	—	—	—	—
MPG	—	—	—	—	—	—	—
Per-capita transfer	0.399	0.317	0.350	0.277	0.255	0.234	0.227
Debt	0.252	0.361	0.056	0.035	0.035	0.035	0.035
Government Spending	0.043	0.041	0.024	0.019	0.019	0.019	0.019

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

Table 47: Aggregates, Prices, and Government Budget through the Transition

Transition from PAYG to Current Chilean Policy: Alternate Parameters

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	0.988	1.055	1.082	1.071	1.063	1.061
Capital Stock	1.000	1.084	1.240	1.266	1.207	1.228	1.0271
Hours	1.000	0.950	0.954	0.916	0.899	0.884	0.877
Formal Hours	1.000	0.823	0.851	0.849	0.837	0.822	0.813
Informal Hours	1.000	6.176	6.388	6.371	6.277	6.167	6.097
Home Hours	1.000	0.883	0.827	0.722	0.699	0.690	0.690
Consumption	1.000	1.213	1.258	1.179	1.145	1.133	1.136
Market Consumption	1.000	1.355	1.445	1.378	1.339	1.326	1.331
Durable Spending	1.000	1.211	1.251	1.165	1.132	1.121	1.124
Home Consumption	1.000	0.933	0.890	0.786	0.762	0.752	0.753
Investment	1.000	1.522	1.522	1.238	1.132	1.123	1.146
Interest Rate	1.000	1.001	0.988	0.977	0.976	0.972	0.969
Wage	1.000	1.009	1.030	1.044	1.046	1.051	1.057
Per-capita Transfer	1.000	0.447	0.543	0.784	-813	0.803	0.800
Consumption Tax	0.079	0.094	0.060	0.037	0.036	0.036	0.036
Labor Tax	0.407	0.227	0.220	0.223	0.224	0.223	0.222
Corporate Tax	0.084	0.069	0.075	0.087	0.090	0.091	0.091
Retirement Transfer	0.084	0.098	0.104	0.021	0.009	0.009	0.009
PAYG Pension	0.084	0.036	0.000	0.000	0.000	0.000	0.000
Recognition Bond	—	0.063	0.104	0.015	0.000	0.000	0.000
MPG	—	0.000	0.000	0.006	0.009	0.009	0.009
Per-capita transfer	0.399	0.171	0.205	0.289	0.302	0.301	0.301
Debt	0.252	0.361	0.056	0.035	0.035	0.035	0.035
Government Spending	0.043	0.041	0.024	0.019	0.019	0.019	0.019

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

Table 48: Contribution Rates by Type of Employment

Effective Date and Type of Worker	% paid by –		
	Employee	Employer	Total
Old System			
Before 1981,			
Servicio de Seguro Social (SSS)	7.25	15.95	23.2
Caja de Empleados Particulares (EMPART)	16.67	10.83	27.5
After 1981,			
SSS	18.9	0.0	18.9
EMPART	19.9	0.0	19.9
New System			
	10.0	0.0	10.0

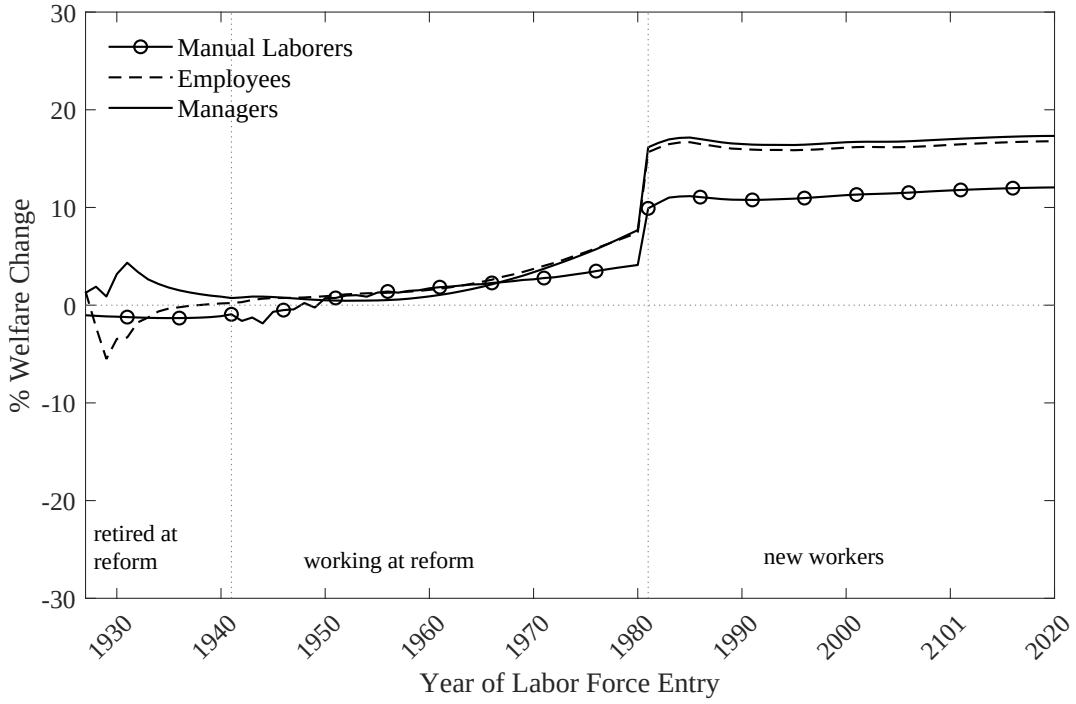
15 No One Switches

The baseline model assumes that everyone who had entered the workforce prior to the reform immediately switched to the new program. This section presents the results in an economy in which the no one who was enrolled in the pay-as-you-go system switched to the individual account system. While this is an extreme case, especially since over 90 percent of workers chose to switch, this case will give an understanding of the bounds on the welfare impact of the reform. Table 49 shows the aggregates throughout the transition. Figure 13 shows the welfare impact from the reform in the case where no one switches.

The long-run impact of the reform is very similar in both the case in which no one switches and the baseline. This is intuitive future generations face the same policies whether no one switches or everyone switches. While it is possible that the difference in the transition could impact the long-run welfare gains, this is not the case here. The welfare impact on transitional generations, however, is very different. In the case in which no one switches, there are very large welfare losses for manual laborers. When no one switches, the government is unable to decrease its pension liability through the recognition bond. Therefore, they must decrease transfers drastically in order to fund the pensions. Since the transfers are a large portion of the income for manual laborers, these household experience large losses.

There is a sharp increase in welfare for new generations. This sharp increase is due to the

Figure 13: Welfare Impact by Cohort: No One Switches



discrete change in policy between older generations and future ones.

16 Labor Force Growth

The baseline model uses population growth to show the demographic change in the economy. There is a concern that the relevant comparison, however, is not population growth but rather labor force growth. This section presents the results of the model in which labor force growth is used rather than population growth. Figure 14 shows how these two time series vary. First of all, labor force growth is more volatile than population growth. Second, labor force growth is almost always larger than population growth (with the exception of the year 2000). However, while these growth rates are different, the magnitude of these differences is not large. Mostly, there is less than 1 percentage point difference between the two growth rates.

Tables 50 and 51 show the evolution of aggregates throughout the demographic transition in the presence of labor force growth. Figure 15 shows the transitional welfare impact of the reform.

Table 49: Aggregates, Prices, and Government Budget through the Transition

Transition from PAYG to Current Chilean Policy: No One Switches

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	0.943	0.985	0.977	0.963	0.954	0.952
Capital Stock	1.000	0.774	0.664	1.036	1.095	1.116	1.153
Hours	1.000	0.944	0.943	0.894	0.874	0.861	0.854
Formal Hours	1.000	0.851	0.814	0.771	0.757	0.744	0.735
Informal Hours	1.000	3.381	5.010	5.501	5.404	5.308	5.246
Home Hours	1.000	0.978	0938	0.839	0.811	0.804	0.804
Consumption	1.000	1.112	1.165	1.124	1.102	1.094	1.096
Market Consumption	1.000	1.172	1.265	1.250	1.230	1.223	1.225
Durable Spending	1.000	1.171	1.263	1.247	1.228	1.220	1.223
Home Consumption	1.000	0.986	0.955	0.860	0.833	0.826	0.826
Investment	1.000	0.694	0.835	1.238	1.030	1.021	1.032
Interest Rate	1.000	0.996	0.985	0.978	0.977	0.974	0.971
Wage	1.000	1.006	1.025	1.036	1.037	1.041	1.046
Per-capita Transfer	1.000	0.308	0.332	0.487	0.582	0.574	0.573
Consumption Tax	0.075	0.083	0.054	0.036	0.036	0.036	0.036
Labor Tax	0.378	0.169	0.160	0.158	0.158	0.158	0.157
Corporate Tax	0.082	0.095	0.095	0.082	0.088	0.089	0.089
Retirement Transfer	0.077	0.099	0.126	0.044	0.010	0.011	0.011
PAYG Pension	0.077	0.099	0.126	0.000	0.000	0.000	0.000
Recognition Bond	—	0.000	0.000	0.000	0.000	0.000	0.000
MPG	—	0.000	0.000	0.044	0.010	0.011	0.011
Per-capita transfer	0.364	0.114	0.122	0.181	0.220	0.219	0.219
Debt	0.252	0.361	0.056	0.035	0.035	0.035	0.035
Government Spending	0.043	0.041	0.024	0.019	0.019	0.019	0.019

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

Figure 14: Population Growth vs. Labor Force Growth

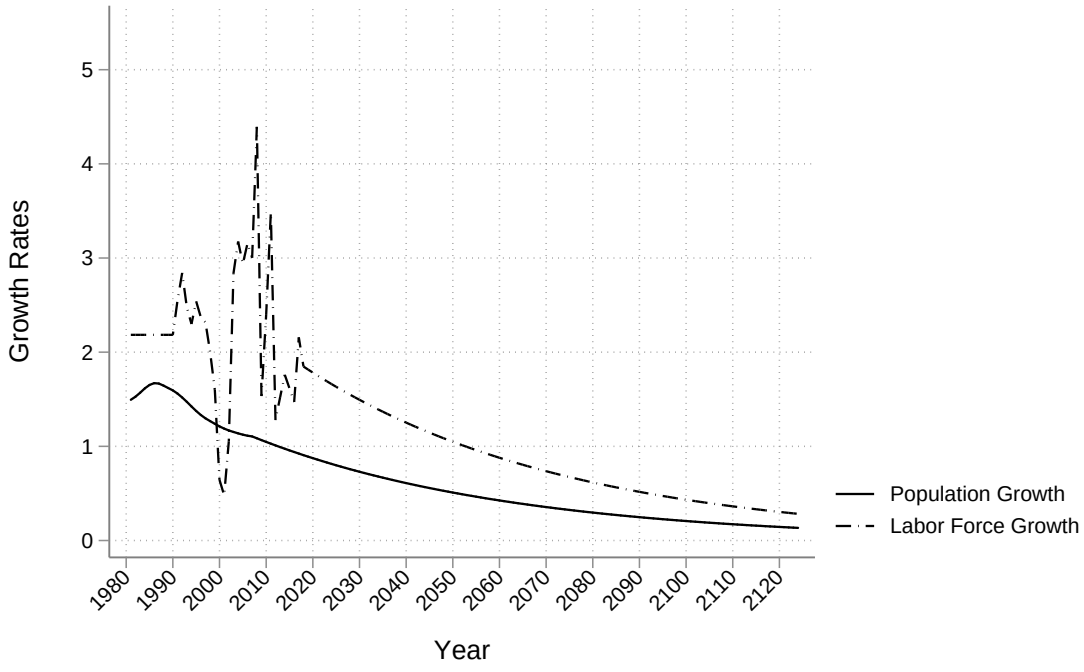


Figure 15: Welfare Impact by Cohort: Labor Force Growth

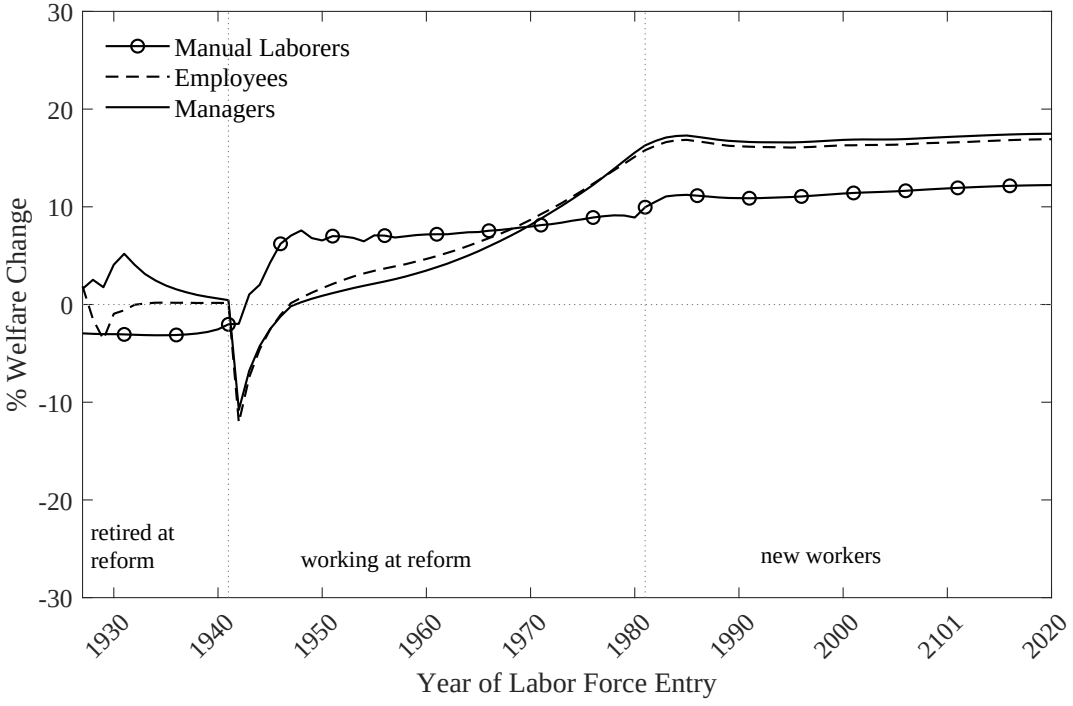


Table 50: Aggregates, Prices, and Government Budget through the Transition

Continue PAYG Program: Labor Force Growth

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	0.925	0.979	0.956	0.915	0.878	0.864
Capital Stock	1.000	0.922	0.900	0.879	0.871	0.854	0.854
Hours	1.000	0.956	0.982	0.965	0.940	0.916	0.905
Formal Hours	1.000	0.933	0.980	0.955	0.913	0.873	0.854
Informal Hours	1.000	0.952	1.002	0.982	0.942	0.904	0.885
Home Hours	1.000	1.007	0.986	0.987	0.999	1.009	1.014
Consumption	1.000	1.010	1.026	1.046	1.061	1.075	1.081
Market Consumption	1.000	1.011	1.043	1.072	1.088	1.103	1.110
Durable Spending	1.000	1.011	1.043	1.072	1.088	1.103	1.109
Home Consumption	1.000	1.008	0.989	0.992	1.005	1.015	1.020
Investment	1.000	1.122	1.090	1.015	0.900	0.813	0.785
Interest Rate	1.000	1.003	0.999	0.998	0.998	0.997	0.995
Wage	1.000	0.985	0.988	0.991	0.992	0.995	1.002
Per-capita Transfer	1.000	0.757	0.914	0.816	0.709	0.599	0.553
Consumption Tax	0.075	0.073	0.045	0.032	0.033	0.035	0.036
Labor Tax	0.378	0.371	0.369	0.364	0.361	0.359	0.358
Corporate Tax	0.082	0.078	0.084	0.085	0.087	0.089	0.089
Retirement Transfer	0.077	0.098	0.105	0.133	0.163	0.196	0.210
PAYG Pension	0.077	0.098	0.105	0.133	0.163	0.196	0.210
Recognition Bond	—	—	—	—	—	—	—
MPG	—	—	—	—	—	—	—
Per-capita transfer	0.364	0.285	0.340	0.311	0.282	0.248	0.233
Debt	0.252	0.361	0.056	0.035	0.035	0.035	0.035
Government Spending	0.043	0.041	0.024	0.019	0.019	0.019	0.019

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

Table 51: Aggregates, Prices, and Government Budget through the Transition

Transition from PAYG to Current Chilean Policy: Labor Force Growth

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	0.933	0.982	1.015	1.001	0.978	0.967
Capital Stock	1.000	0.962	1.039	1.058	1.045	1.092	1.164
Hours	1.000	0.932	0.938	0.922	0.903	0.878	0.865
Formal Hours	1.000	0.772	0.793	0.804	0.788	0.762	0.746
Informal Hours	1.000	5.511	5.662	5.735	5.623	5.441	5.322
Home Hours	1.000	0.957	0.921	0.840	0.822	0.810	0.810
Consumption	1.000	1.163	1.186	1.132	1.113	1.101	1.106
Market Consumption	1.000	1.254	1.304	1.261	1.241	1.230	1.236
Durable Spending	1.000	1.252	1.301	1.259	1.239	1.228	1.234
Home Consumption	1.000	0.972	0.941	0.861	0.844	0.832	0.832
Investment	1.000	1.230	1.365	1.196	1.099	1.093	1.112
Interest Rate	1.000	0.997	0.987	0.980	0.978	0.974	0.971
Wage	1.000	1.006	1.026	1.037	1.039	1.043	1.048
Per-capita Transfer	1.000	0.398	0.523	0.758	0.775	0.751	0.738
Consumption Tax	0.075	0.089	0.056	0.035	0.035	0.035	0.036
Labor Tax	0.378	0.211	0.212	0.216	0.218	0.217	0.216
Corporate Tax	0.082	0.076	0.075	0.084	0.087	0.087	0.087
Retirement Transfer	0.077	0.093	0.093	0.017	0.008	0.010	0.011
PAYG Pension	0.077	0.034	0.000	0.000	0.000	0.000	0.000
Recognition Bond	—	0.059	0.093	0.012	0.000	0.000	0.000
MPG	—	0.000	0.000	0.006	0.008	0.010	0.011
Per-capita transfer	0.364	0.150	0.194	0.272	0.282	0.280	0.278
Debt	0.252	0.361	0.056	0.035	0.035	0.035	0.035
Government Spending	0.043	0.041	0.024	0.019	0.019	0.019	0.019

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

17 Pension Eligibility Based Upon Years of Contributions

In this section, I present the results of a balanced growth path exercise which allows pension eligibility to depend upon years of contributions. Chilean regulations allow workers to be eligible to receive a pension once he has contributed to the system for 20 years. In the baseline exercise, I abstract from this detail. In order to do, I augment the state variable $\bar{y}_t$ from one which keeps track of only average taxable income to one which keeps track of years of contributions early in the life cycle and average taxable earnings once a worker has achieved the necessary years of contributions needed to eligibility.

17.1 Impact on the Model

The main change this makes to the model involves the individual state variable, $\bar{y}_t$. This single state variable will be augmented to be a combination of two variables: years of contributions to the public pension system, p_t, and average taxable earnings, $\bar{y}_t$. This second part is the same variable used in the baseline model. This directly impacts the way in which the state evolves. Now, this value evolves based upon the following:

$$\bar{y}_{t+1} = \begin{cases} p_t & ,\text{if } j \leq R, p_t < \overline{p}, h_{ft} < \underline{h} \\ p_t + 1 & ,\text{if } j \leq R, p_t < \overline{p}, h_{ft} \geq \underline{h} \\ \overline{p} & ,\text{if } j \leq R-5, p_t \geq \overline{p} \\ \frac{(j-1)\bar{y}_t + w_t \varepsilon h_{ft}}{j} & \text{if } R-5 \leq j \leq R, p_t \geq \overline{p} \\ \bar{y}_t & ,\text{if } j > R, , p_t \geq \overline{p} \end{cases} \tag{28}$$

Assuming that the household is early in his or her life-cycle, the household begins the period with some amount of years of contributions, p_t. If he works a sufficient amount of time in the formal sector $\left(h_{ft} \geq \underline{h}\right)$, he is given credit for that as an additional year of contributions and the years of contributions evolves to $p_t + 1$. Once the worker accumulates years of contributions above the eligibility or $p_t \geq \overline{p}$, the state variable remains constant until the last 5 years prior to retirement. Once a worker is within 5 years of retirement, the calculation changes to be the average taxable earnings.[11] This value then evolves the same as in the baseline model. Additionally, as in the baseline, average taxable earnings are constant after retirement.

[11] This calculation mirrors that in reality the calculation of the pension in Chile are based upon the earnings of a worker in the 5 years prior to retirement

Table 52: Comparison of Long-Run Welfare Gains

		Baseline	Pension Eligibility
Total		14.7	27.6
Manual Laborers		12.3	24.3
	Workers	*13.9*	*24.5*
	Retirees	*-3.8*	*-0.1*
Employees		16.9	30.6
	Workers	*17.0*	*31.0*
	Retirees	*-0.2*	*-0.2*
Managers		17.6	31.4
	Workers	*17.7*	*32.5*
	Retirees	*-0.1*	*-0.9*

17.2 Parameters

There are two important parameters that must be set in order to keep consider this case: the eligibility threshold, $\overline{p}$, and the threshold for the amount of time a worker must spend in the formal sector to be considered contributing, $\underline{h}$.

In this experiment I set the eligibility threshold at which the state variable changes to be equal to 20 years of contributions, $\overline{p} = 20$. This value is chosen to match that the Chilean system required 80 quarters of contributions in order to be eligible for a pension.

Chilean law does not clearly state a number of hours that a worker must spend in the formal sector to be considered contributing to the system. In this work, I assume that $\underline{h} = 0.2$ This indicates that all households who have at least 20 hours per week in the formal sector are considered to be contributing. Therefore, as long as someone in the household works part-time in the formal sector, the household is on the way to being eligible for a pension based upon formal sector income.

17.3 Impact on Results of the Balanced Growth Path

I compare the long-run impact of the Chilean reform through a comparison of two balanced growth paths: one using the details of the pre-1981 pay-as-you-go system and one using the details of the reformed system. It is important to note that this exercise does not consider transitional dynamics. Rather, I focus on what would be the impact of the reform in the long-run.

Table 52 shows the long-run welfare gains for the baseline economy as well as the economy

which includes pension eligibility based upon years of contributions. Long-run welfare gains are larger in the experiment in which pensions depend upon years of contributions. These larger gains are due to additional capital deepening and higher wages after the reform occurs Table 53 shows the long run changes in the aggregates.

The aggregates demonstrate that in the economy in which workers are eligible for a pension based upon years of contributions and the size of this pension is calculated based upon the 5 prior years of earnings, capital stock and output are higher after the reform than in the baseline economy. This additional capital deepening leads to larger wages than in the baseline economy. These larger wages push welfare gains higher; this argument is also supported by the fact that lifetime welfare gains are mainly due to welfare gains during working years while welfare gains during retirement are very small or even negative. The higher wages contribute to higher labor tax revenue for the government and higher transfers in the pension eligibility experiment than in the baseline economy.

An interesting feature of this experiment is that when welfare gains are split by working years and retirement years, welfare gains during retirement are decreasing in productivity type with the highest productivity workers experiencing the largest losses. This is the opposite of the baseline case. In the pension eligibility experiment, households receive larger pensions as their average taxable earnings are high when only the five years prior to retirement are used in the calculation. Therefore, retirees–high income retirees in particular–lose more when the reform occurs. However, the higher wages allow savings to be higher in the pension eligibility reform than in the baseline reform. This higher wage is not increased enough to overcome the large pensions higher productivity workers were receiving prior to reform.

17.4 Issues with the Transition Path

This specification of the state vector is able to combine multiple features of the Chilean system-namely eligibility requirements based upon years of contributions and calculation of the pension based upon the five years prior to retirement. However, this is not chosen as the baseline due to issues calculating the value of the recognition bond for some transitional generations in the model.

An important feature of the Chilean reform is the design of the transitional policy that applies to those generations of workers who were already in the labor force at the time of the reform. As discussed in the text, the transitional policy provided workers with a recognition bond to represent prior contributions to the pay-as-you-go program. Importantly, this bond is calculated based upon the taxable earnings of the worker. This causes issues with using the above methodology throughout the transition path. With the augmented state variable above, those workers within 5 years of retirement are the only workers for whom I keep track of average taxable earnings rather

Table 53: Long-Run Aggregates, Prices, and Government Budget

Pension Based Upon Years of Contributions

	Pension Eligibility Experiment			Baseline		
	1980	Continue INP	Reform	1980	Continue INP	Reform
Output	1.000	0.846	1.017	1.000	0.846	0.953
Capital Stock	1.000	0.953	1.535	1.000	0.836	1.151
Hours	1.000	0.903	0.871	1.000	0.894	0.854
Formal Hours	1.000	0.838	0.736	1.000	0.836	0.735
Informal Hours	1.000	0.841	5.268	1.000	0.867	5.248
Home Hours	1.000	1.064	0.855	1.000	1.019	0.804
Consumption	1.000	1.158	1.225	1.000	1.087	1.097
Market Consumption	1.000	1.185	1.333	1.000	1.116	1.227
Durable Spending	1.000	1.184	1.330	1.000	1.116	1.224
Home Consumption	1.000	1.072	0.879	1.000	1.026	0.826
Investment	1.000	0.953	1.535	1.000	0.735	1.031
Interest Rate	1.000	0.997	0.961	1.000	0.995	0.971
Wage	1.000	1.010	1.158	1.000	1.002	1.047
Per-capita Transfer	1.000	0.580	0.762	1.000	0.498	0.737
Consumption Tax	0.104	0.055	0.051	0.075	0.037	0.036
Labor Tax	0.605	0.599	0.339	0.378	0.357	0.216
Corporate Tax	0.084	0.079	0.065	0.082	0.091	0.089
Retirement Transfer	0.098	0.331	0.000	0.077	0.229	0.011
PAYG Pension	0.098	0.331	—	0.077	0.229	0.000
Recognition Bond	—	—	—	—	—	0.000
MPG	—	—	0.000	—	—	0.011
Per-capita transfer	0.659	0.452	0.494	0.364	0.214	0.282
Debt	0.252	0.035	0.035	0.252	0.035	0.035
Government Spending	0.043	0.019	0.019	0.043	0.019	0.019

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

than years of contributions.[12] Without this calculation, it is difficult to calculate the bond that a worker is eligible for. As the transitional policy is a key focus on this analysis, I choose not to model pension eligibility based upon years of contributions.

18 Impact of Informality and Home Production

This section presents the tables showing how the aggregates evolve throughout the transition paths associated with the counterfactual economies: one in which the only only is formality, one which has options of formality and home production, and one which has options of formality and informality. Theses results are shown in Tables 54 - 59. These tables of aggregates accompany the discussion of the impact of informality and home production on welfare that is presented in the main text.

Part VI

More Data on Informality

19 Informality by Age

An important consideration that is missing in my framework is how incentives for formality and informality may differ by age. This section presents two main data facts: how annual formal and informal hours vary by the age of the household head and how the age distribution of workers looks depending on whether the workers works entirely in the formal sector, entirely in the informal sector or splits time between the two. An important feature that drives data is that everything is based upon the level of aggregation being the household. Therefore, when I present formal hours at age 30, for example, it is the formal hours of a household which has a household head of age 30.

Figure 16 shows average aggregate formal and informal hours by age category. The take-away from this graph is that it does not seem that there is meaningful substitution between the sectors as the household head ages. There seems to be some increase in informal hours and some decrease in formal hours at older ages, but it is not a large change. This increase in formal hours and decrease in formal hours may be a result of older households have a younger worker in the household that may be more likely to work in the informal sector.

[12] I could augment this to keep track of average taxable earnings once a worker reaches 20 years of contributions. However, this would still leave at least 20 cohorts for whom I do not have this calculation.

Table 54: Aggregates, Prices, and Government Budget through the Transition

Continue PAYG Program: Formality Only

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	0.967	0.962	0.876	0.853	0.836	0.837
Capital Stock	1.000	0.914	0.886	1.159	1.280	1.256	1.267
Hours	1.000	0.955	0.949	0.875	0.844	0.825	0.818
Formal Hours	1.000	0.955	0.949	0.875	0.844	0.825	0.818
Informal Hours	1.000	—	—	—	—	—	—
Home Hours	1.000	—	—	—	—	—	—
Consumption	1.000	1.066	1.105	1.219	1.287	1.296	1.305
Market Consumption	1.000	1.066	1.105	1.219	1.287	1.296	1.305
Durable Spending	1.000	—	—	—	—	—	—
Home Consumption	1.000	—	—	—	—	—	—
Investment	1.000	1.060	1.032	1.404	1.156	1.129	1.146
Interest Rate	1.000	0.999	0.998	1.006	1.002	1.002	0.997
Wage	1.000	1.021	1.038	1.046	1.047	1.051	1.055
Per-capita Transfer	1.000	0.816	0.893	0.598	0.552	0.487	0.478
Consumption Tax	0.073	0.071	0.047	0.038	0.041	0.042	0.043
Labor Tax	0.373	0.378	0.386	0.382	0.378	0.379	0.376
Corporate Tax	0.076	0.080	0.079	0.055	0.063	0.063	0.064
Retirement Transfer	0.080	0.100	0.130	0.196	0.214	0.236	0.240
PAYG Pension	0.080	0.100	0.130	0.196	0.214	0.236	0.240
Recognition Bond	—	—	—	—	—	—	—
MPG	—	—	—	—	—	—	—
Per-capita transfer	0.351	0.293	0.325	0.239	0.227	0.205	0.200
Debt	0.252	0.361	0.056	0.035	0.035	0.035	0.035
Government Spending	0.043	0.041	0.024	0.019	0.019	0.019	0.019

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

Table 55: Aggregates, Prices, and Government Budget through the Transition

Transition from PAYG to Current Chilean Policy: Formality Only

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	1.0088	1.008	0.977	0.954	0.941	0.940
Capital Stock	1.000	1.030	1.269	1.519	1.517	1.529	1.564
Hours	1.000	0.983	0.955	0.908	0.883	0.865	0.856
Formal Hours	1.000	0.983	0.955	0.908	0.883	0.865	0.856
Informal Hours	1.000	—	—	—	—	—	—
Home Hours	1.000	—	—	—	—	—	—
Consumption	1.000	1.277	1.324	1.253	1.233	1.226	1.232
Market Consumption	1.000	1.277	1.324	1.253	1.233	1.226	1.232
Durable Spending	1.000	—	—	—	—	—	—
Home Consumption	1.000	—	—	—	—	—	—
Investment	1.000	1.431	1.674	1.600	1.423	1.384	1.402
Interest Rate	1.000	0.993	0.980	0.973	0.972	0.970	0.967
Wage	1.000	1.022	1.038	1.048	1.049	1.053	1.056
Per-capita Transfer	1.000	0.517	0.566	0.735	0.750	0.735	0.730
Consumption Tax	0.073	0.082	0.054	0.035	0.035	0.036	0.036
Labor Tax	0.373	0.253	0.250	0.249	0.249	0.248	0.247
Corporate Tax	0.076	0.073	0.068	0.070	0.074	0.076	0.076
Retirement Transfer	0.080	0.093	0.112	0.038	0.029	0.031	0.032
PAYG Pension	0.080	0.032	0.000	0.000	0.000	0.000	0.000
Recognition Bond	—	0.060	0.112	0.017	0.000	0.000	0.000
MPG	—	0.000	0.000	0.020	0.029	0.031	0.032
Per-capita transfer	0.351	0.179	0.197	0.264	0.276	0.274	0.273
Debt	0.252	0.361	0.056	0.035	0.035	0.035	0.035
Government Spending	0.043	0.041	0.024	0.019	0.019	0.019	0.019

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

Table 56: Aggregates, Prices, and Government Budget through the Transition

Continue PAYG Program: Formal + Home Production

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	0.923	0.918	0.865	0.839	0.823	0.819
Capital Stock	1.000	0.867	0.901	0.890	0.871	0.857	0.858
Hours	1.000	0.970	0.967	0.940	0.928	0.920	0.915
Formal Hours	1.000	0.938	0.936	0.877	0.849	0.831	0.821
Informal Hours	1.000	—	—	—	—	—	—
Home Hours	1.000	1.017	1.014	1.032	1.042	1.049	1.053
Consumption	1.000	0.998	1.036	1.077	1.091	1.101	1.105
Market Consumption	1.000	0.991	1.044	1.095	1.110	1.121	1.125
Durable Spending	1.000	0.991	1.044	1.095	1.110	1.121	1.125
Home Consumption	1.000	1.015	1.016	1.036	1.047	1.054	1.058
Investment	1.000	0.991	1.048	0.898	0.806	0.764	0.749
Interest Rate	1.000	1.002	1.002	1.001	1.000	1.000	0.998
Wage	1.000	0.962	0.964	0.967	0.968	0.971	0.978
Per-capita Transfer	1.000	0.711	0.669	0.512	0.446	0.401	0.384
Consumption Tax	0.121	0.115	0.077	0.058	0.060	0.062	0.063
Labor Tax	0.706	0.695	0.689	0.683	0.681	0.681	0.682
Corporate Tax	0.071	0.084	0.081	0.084	0.087	0.088	0.088
Retirement Transfer	0.151	0.196	0.245	0.339	0.387	0.422	0.437
PAYG Pension	0.151	0.196	0.245	0.339	0.387	0.422	0.437
Recognition Bond	—	—	—	—	—	—	—
MPG	—	—	—	—	—	—	—
Per-capita transfer	0.763	0.579	0.553	0.451	0.405	0.371	0.358
Debt	0.252	0.361	0.056	0.035	0.035	0.035	0.035
Government Spending	0.043	0.041	0.024	0.019	0.019	0.019	0.019

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

Table 57: Aggregates, Prices, and Government Budget through the Transition

Transition from PAYG to Current Chilean Policy: Formality + Home Production

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	0.982	1.049	1.084	1.067	1.059	1.060
Capital Stock	1.000	1.000	1.121	1.607	1.668	1.725	1.769
Hours	1.000	0.969	0.967	0.919	0.895	0.881	0.877
Formal Hours	1.000	0.979	1.000	0.977	0.953	0.935	0.926
Informal Hours	1.000	—	—	—	—	—	—
Home Hours	1.000	0.955	0.918	0.834	0.811	0.803	0.806
Consumption	1.000	1.171	1.212	1.119	1.087	1.078	1.081
Market Consumption	1.000	1.257	1.331	1.234	1.198	1.189	1.192
Durable Spending	1.000	1.256	1.329	1.232	1.196	1.186	1.189
Home Consumption	1.000	0.971	0.939	0.855	0.831	0.823	0.826
Investment	1.000	1.233	1.649	1.759	1.599	1.572	1.579
Interest Rate	1.000	1.001	0.981	0.962	0.959	0.956	0.953
Wage	1.000	0.970	1.009	1.032	1.036	1.042	1.050
Per-capita Transfer	1.000	0.482	0.489	0.694	0.724	0.717	0.715
Consumption Tax	0.121	0.139	0.087	0.052	0.051	0.051	0.051
Labor Tax	0.706	0.468	0.462	0.449	0.447	0.445	0.443
Corporate Tax	0.071	0.077	0.070	0.074	0.079	0.080	0.080
Retirement Transfer	0.151	0.180	0.200	0.035	0.007	0.008	0.008
PAYG Pension	0.151	0.067	0.000	0.000	0.000	0.000	0.000
Recognition Bond	—	0.113	0.200	0.030	0.000	0.000	0.000
MPG	—	0.000	0.000	0.005	0.007	0.008	0.008
Per-capita transfer	0.763	0.374	0.357	0.488	0.517	0.516	0.515
Debt	0.252	0.361	0.056	0.035	0.035	0.035	0.035
Government Spending	0.043	0.041	0.024	0.019	0.019	0.019	0.019

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

Table 58: Aggregates, Prices, and Government Budget through the Transition

Continue PAYG Program: Formality + Informality

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	0.928	0.973	0.815	0.802	0.787	0.791
Capital Stock	1.000	0.929	0.964	1.563	1.724	1.638	1.689
Hours	1.000	0.926	0.973	0.827	0.803	0.787	0.781
Formal Hours	1.000	0.926	0.973	0.826	0.801	0.786	0.780
Informal Hours	1.000	0.940	0.985	0.873	0.804	0.789	0.783
Home Hours	1.000	—	—	—	—	—	—
Consumption	1.000	1.039	1.094	1.213	1.277	1.276	1.287
Market Consumption	1.000	1.039	1.094	1.213	1.277	1.276	1.287
Durable Spending	1.000	—	—	—	—	—	—
Home Consumption	1.000	—	—	—	—	—	—
Investment	1.000	1.065	1.323	1.958	1.522	1.477	1.575
Interest Rate	1.000	1.004	1.002	1.010	1.006	1.006	1.001
Wage	1.000	1.005	1.022	1.029	1.031	1.034	1.038
Per-capita Transfer	1.000	0.772	0.906	0.424	0.477	0.406	0.417
Consumption Tax	0.072	0.072	0.045	0.040	0.043	0.044	0.044
Labor Tax	0.360	0.360	0.366	0.333	0.332	0.332	0.330
Corporate Tax	0.077	0.079	0.071	0.032	0.046	0.047	0.045
Retirement Transfer	0.074	0.096	0.115	0.188	0.174	0.202	0.194
PAYG Pension	0.074	0.096	0.115	0.188	0.174	0.202	0.194
Recognition Bond	—	—	—	—	—	—	—
MPG	—	—	—	—	—	—	—
Per-capita transfer	0.340	0.272	0.315	0.175	0.202	0.175	0.180
Debt	0.252	0.361	0.056	0.035	0.035	0.035	0.035
Government Spending	0.043	0.041	0.024	0.019	0.019	0.019	0.019

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

Table 59: Aggregates, Prices, and Government Budget through the Transition

Transition from PAYG to Current Chilean Policy: Formality + Informality

	1980	1981-2000	2001-2020	2021-2050	2051-2080	2081-2115	Steady State*
Output	1.000	0.896	0.961	0.964	0.947	0.937	0.935
Capital Stock	1.000	0.978	0.797	0.714	0.693	0.705	0.734
Hours	1.000	0.885	0.921	0.908	0.889	0.873	0.864
Formal Hours	1.000	0.743	0.772	0.762	0.746	0.732	0.724
Informal Hours	1.000	5.258	5.483	5.408	5.296	5.200	5.145
Home Hours	1.000	—	—	—	—	—	—
Consumption	1.000	1.243	1.265	1.183	1.160	1.152	1.152
Market Consumption	1.000	1.243	1.265	1.183	1.160	1.152	1.152
Durable Spending	1.000	—	—	—	—	—	—
Home Consumption	1.000	—	—	—	—	—	—
Investment	1.000	1.127	0.799	0.698	0.657	0.644	0.667
Interest Rate	1.000	0.997	0.984	0.978	0.976	0.974	0.971
Wage	1.000	1.006	1.022	1.032	1.033	1.036	1.040
Per-capita Transfer	1.000	0.200	0.275	0.570	0.667	0.665	0.657
Consumption Tax	0.072	0.089	0.054	0.033	0.033	0.033	0.033
Labor Tax	0.360	0.201	0.201	0.206	0.207	0.207	0.206
Corporate Tax	0.077	0.079	0.096	0.102	0.104	0.105	0.105
Retirement Transfer	0.074	0.094	0.097	0.037	0.032	0.034	0.035
PAYG Pension	0.074	0.034	0.000	0.000	0.000	0.000	0.000
Recognition Bond	—	0.059	0.097	0.014	0.000	0.000	0.000
MPG	—	0.000	0.000	0.023	0.032	0.034	0.035
Per-capita transfer	0.340	0.066	0.097	0.201	0.239	0.242	0.239
Debt	0.252	0.361	0.056	0.035	0.035	0.035	0.035
Government Spending	0.043	0.041	0.024	0.019	0.019	0.019	0.019

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

* The steady state value is the average of these values for the last 9 years of the transition 2116-2124

Figure 16: Annual Formal and Informal Hours by Age Category

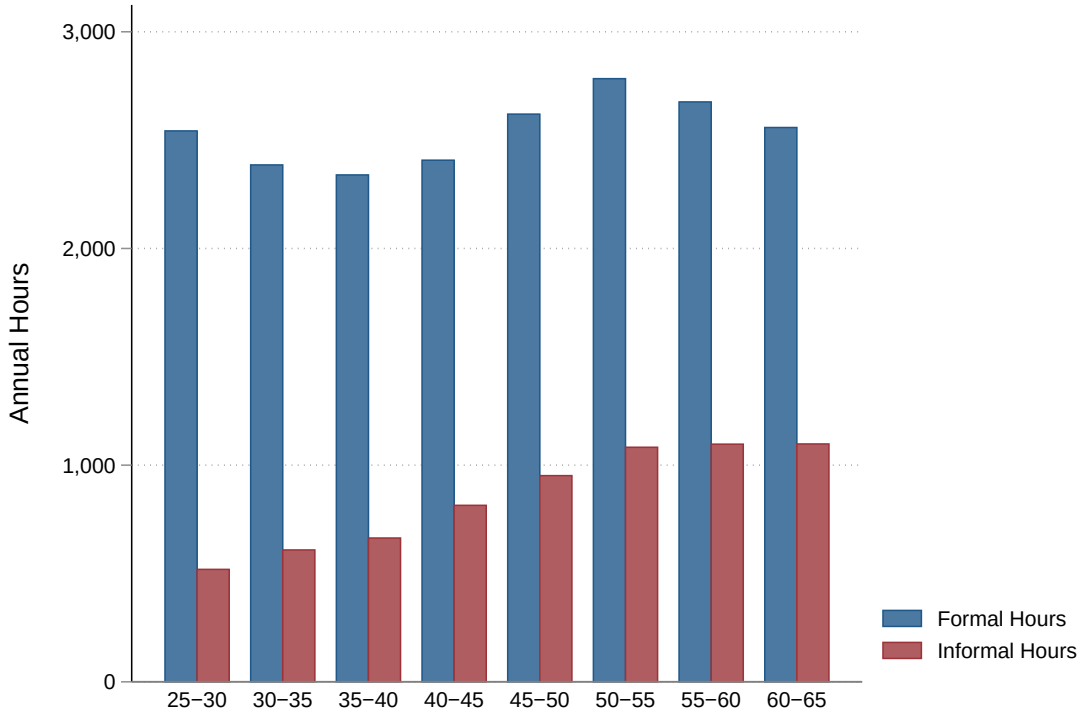
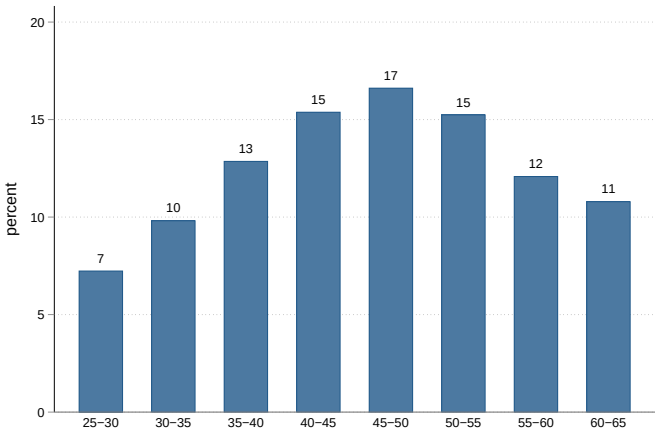


Figure 17 shows hows the age distribution of households differs based on whether the household only supplies hours to the formal sector (Figure 17a), only supplies hours to the informal sector (Figure 17b), or supplies positive hours to both sectors (Figure 17c). This shows a few main features. First, households that supply labor only to the formal sector are more likely to be young than those that supply labor to only the informal sector or to both sectors. Second, older households make up a larger fraction of households who work in only the informal sector that only in the formal sector. Finally, households that split time between sectors are most likely to be in the years nearing retirement than those household who work in only one sector or the other.

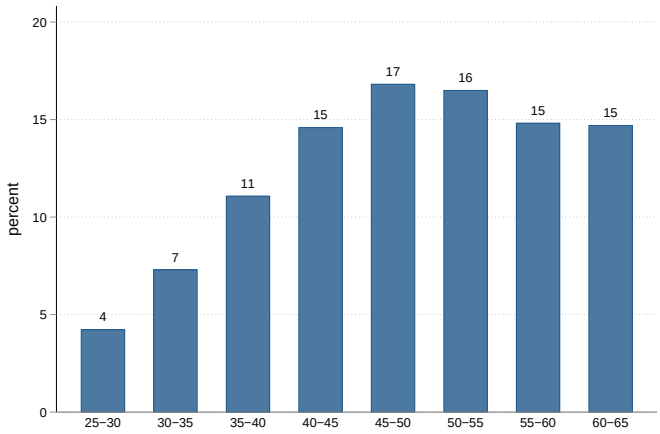
There is much evidence that younger workers are more likely to work informally. I do not find this feature obvious in my data. This is not contradictory to the literature because I am always focused on the household rather than the individual. Older workers are likely working more in the formally, sector but they are also likely to have younger workers living in their household who may work informally. This may skew the patterns documented in the literature.

Figure 17: Age Distribution of Workers

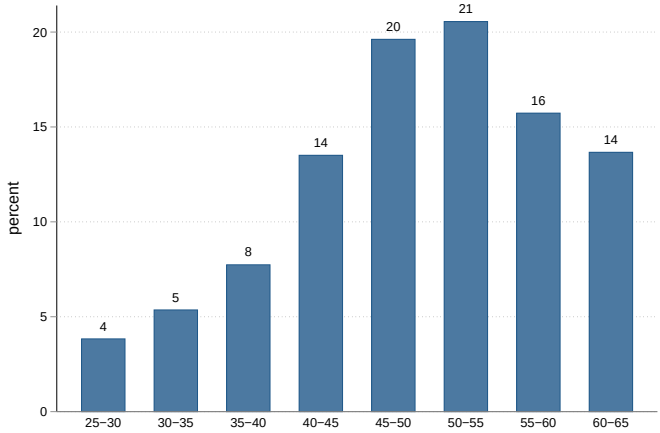
(a) Formal Only



(b) Informal Only



(c) Split Time



20 Informality by Sector and Occupation

20.1 Data Source and Sample

The data source for data used on informality in Chile is Encuesta de Protección Social (EPS). The years 2004, 2006 are used for analysis. Years prior to 2004 are not used in the study of the prevalence of informality due to the lack on data on the presence of contracts and whether an agent contributes to a pension system.

The original sample from EPS 2004 and 2006 have 29,896 observations and 27,514 observations, respectively. Note that the unit of observation in this analysis of formality versus informality is a single job or employment/unemployment spell. Therefore, a single individual may show up in the sample more than once if that individual held more than one job during the reference year. This is reasonable since the study aims to count the percentage of jobs in a year that are formal or informal. Multiple jobs from a single person can still contribute to this percentage.

Only employment spells in which the contract status and/or contribution status are included in the final sample. Additionally, for the analysis of the fraction of formality by industry and occupation, the final sample includes only employment spells in which the industry or occupation is reported. In 2004, the sample for formality by industry includes 29,571 observations (98.91% of the original sample) while the sample for formality by occupation includes 29,415 observations (98.81% of the original sample). The sample sample in 2006 include 27,261 (99.08% of the original sample) and 27,124 (98.58% of the original sample) observations, respectively.

20.2 Tables

The tables that follow show break downs of formality by industry and occupation. Both definitions of formality, the presence of a contract and whether the worker makes contributions, are represented in the data tables that follow. Additionally, comparisons between 2004 and 2006 are shown for each of the groupings.

These tables show some interesting results regarding informality across definition, time, industries. I see a few main facts to highlight. First, while there is variation across industry, I do not believe there is a strong reason to believe that the data shows informality as an industry specific phenomenon. Tables 60 and 61 show the percentage of formal workers across industries for both definitions of informality. Second, informality can differ a lot across occupation. Tables 62 and 63 show this by occupation as well. When we look at occupation, there is a significant difference between the two definitions of informality. However, there is not as much variation across occupations as there is across industries.

The remaining results show how the percentage of formal and informal workers have changed

across time. Tables 64 to 67 show this. The fraction of workers in each industry and occupation has not changed much between the years 2004 and 2006.

Table 60: Presence of a Signed Contract by Industry

	Yes, has a signed contract	No, has a contract but not signed	No contract
agriculture, hunting, forestry, fishing	66.23	1.47	32.3
mining and quarrying	92.14	0.00	7.86
industry, manufacturing	80.95	1.37	17.68
electricity, water, gas	91.95	0.00	8.05
construction	77.93	1.46	20.61
commerce, restaurants, hotels	71.90	0.92	27.18
transport, storage, communication	74.00	1.24	24.75
financial services	77.89	1.43	20.68
social services	65.95	1.44	32.60
other	74.08	0.00	25.92

Source : Encuesta de Protección Social (2004)

Table 61: Contributions Made by Industry

	Yes, AFP	Yes, INP	Yes, Other	No
agriculture, hunting, forestry, fishing	55.74	2.21	0.25	41.81
mining and quarrying	84.62	2.01	0.00	12.36
industry, manufacturing	67.25	1.38	0.27	31.10
electricity, water, gas	89.93	2.52	0.00	7.55
construction	64.86	1.69	0.48	32.98
commerce, restaurants, hotels	51.45	1.23	0.42	46.90
transport, storage, communication	61.56	1.44	0.88	36.12
financial services	69.15	0.76	0.30	29.79
social services	56.94	3.58	1.13	38.36
other	73.87	0.57	0.50	25.06

Source : Encuesta de Protección Social (2004)

Table 62: Presence of a Signed Contract by Occupation

	Yes, has a signed contract	No, has a contract but not signed	No contract
management staff	89.21	1.19	9.61
scientific/intellectual professionals	85.18	1.16	13.66
mid-level technician/ professionals	82.80	0.74	16.46
office employees	79.72	1.47	18.81
service workers and merchants	67.29	1.14	31.47
agriculture and fishing workers	72.54	0.84	26.61
operators, mechanics, and other trades	77.83	1.66	20.52
machine operators and assemblers	81.88	0.65	17.47
unclassified workers	58.75	1.52	39.73

Source : Encuesta de Protección Social (2004)

Table 63: Contributions Made by Occupation

	Yes, AFP	Yes, INP	Yes, Other	No
management staff	40.41	3.64	1.01	54.94
scientific/intellectual professionals	75.10	2.27	0.91	21.72
mid-level technician/ professionals	74.34	0.95	1.15	23.56
office employees	77.10	0.68	0.35	21.87
service workers and merchants	53.04	1.82	0.87	44.27
agriculture and fishing workers	49.01	2.64	0.26	48.09
operators, mechanics, and other trades	57.93	1.39	0.15	40.53
machine operators and assemblers	71.68	1.70	0.17	26.45
unclassified workers	52.35	3.17	0.45	44.03

Source : Encuesta de Protección Social (2004)

Table 64: Presence of a Signed Contract by Industry and Year

	2004	2006
agriculture, hunting, forestry, fishing	66.23	70.44
mining and quarrying	92.14	97.43
industry, manufacturing	80.95	84.34
electricity, water, gas	91.95	85.92
construction	77.93	80.09
commerce, restaurants, hotels	71.90	75.89
transport, storage, communication	74.00	75.25
financial services	77.89	84.58
social services	65.95	66.23
other	74.08	76.33

Source : Encuesta de Protección Social (2004, 2006)

Table 65: Contributions Made by Industry and Year

	2004	2006
agriculture, hunting, forestry, fishing	58.20	61.58
mining and quarrying	86.63	95.90
industry, manufacturing	68.87	75.93
electricity, water, gas	92.45	86.90
construction	67.03	69.85
commerce, restaurants, hotels	53.10	62.45
transport, storage, communication	63.88	68.71
financial services	70.21	78.03
social services	61.65	58.59
other	74.94	71.28

Source : Encuesta de Protección Social (2004, 2006)

Table 66: Presence of a Signed Contract by Occupation and Year

	2004	2006
management staff	89.21	93.87
scientific/intellectual professionals	85.18	78.42
mid-level technician/ professionals	82.80	79.27
office employees	79.72	85.14
service workers and merchants	67.29	73.61
agriculture and fishing workers	72.54	78.50
operators, mechanics, and other trades	77.83	79.73
machine operators and assemblers	81.88	81.29
unclassified workers	58.75	62.05

Source : Encuesta de Protección Social (2004, 2006)

Table 67: Contributions Made by Occupation and Year

	2004	2006
management staff	55.06	74.13
scientific/intellectual professionals	78.28	71.23
mid-level technician/ professionals	76.44	69.29
office employees	78.13	82.41
service workers and merchants	55.73	59.63
agriculture and fishing workers	51.91	57.23
operators, mechanics, and other trades	59.47	65.92
machine operators and assemblers	73.55	72.91
unclassified workers	55.97	60.06

Source : Encuesta de Protección Social (2004, 2006)

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