Evaluating Pension Reform and Labor-Market Policy Changes in Chile through a Structural Search Model[1]

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Abstract

This paper estimates and calibrates a structural search model with formal and informal sectors and life-cycle elements to analyze counterfactual social-security reforms relevant for Chile using data from the harmonized Longitudinal Social Protection Survey (LSPS) and other official sources. The paper considers a drop in contribution rates and an increase in the non-contributory pension payments after retirement. A drop in the contribution rates implies increase in the average duration of unemployment, rejecting both types of job offers more often. Also, an increase in the non-contributory pension reduces the average duration of unemployment by increasing the acceptance of informal job offers.

Keywords: search models, life-cycle, simulation-based estimation, social-security reform.

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Evaluating Pension Reform and Labor-Market Policy Changes in Chile through a Structural Search Model

This paper constructs and estimates a search model with life-cycle features using data from Chile, including variables from that country in the harmonized Longitudinal Social Protection Survey (LSPS). The paper uses a mixed methodology to assign numerical values to the parameters, estimating some of them using a simulation-based econometric method and calibrating the rest. In this regard, for a parameter such as the probability of a worker losing her job the estimated value is closer to the highest values obtained in the literature.

The paper then uses the estimated version of the model to perform two quantitative policy exercises to analyze the possible consequences within the model and the transmission mechanism. The first exercise consists in assuming a drop in the contribution rate for formal workers (from the current value of 10 per cent down to 7 per cent). The major effect in the model is an increase in the average duration of unemployment in the order of 23 per cent, simultaneously with a drop in the acceptance rate of formal jobs when unemployed. The main mechanism for this result is the increase in the formal reservation wage. The second exercise is a 10 per cent increase in the non-contributory pensions. The major result is a 24 per cent drop in the unemployment duration simultaneously with an increase in the acceptance rate of informal jobs. The latter shows a disincentive to work formally given the higher future non-contributory pensions.

Motivation and main contributions of the paper.

The interaction between employment decisions, savings and contributions to social security (including working as a formal worker or as an informal one) is probably one of the key concerns in the design of pension systems and labor market regulations in Emerging Market countries, including LAC countries. Reforms in any policy from either of those two institutions may have complex effects on decisions to be formally employed, which also has important effects on social

security contributions (and even on the sustainability of the social security system). The general picture on variables such as retirement savings and degrees of informality are far from being optimistic in those countries. Thus, a more in-depth analysis of the consequences of recent reforms in those two policy dimensions is needed to improve in their design.

The case of Chile is of particular importance in the Latin American region. That country constitutes one of the first cases of a pension system with private funds in which formal workers can contribute for their retirement years. In 1981 the military government implemented a new defined-contribution system with a key role for private pension funds. Although for at least two decades (especially during the 1990's) the Chilean system has been proposed as a model to re-design their respective social-security systems for other LAC countries.

Yet, in the decade of 2010's, particularly since 2016, [4] increasing discontent grew in the Chilean population against the status-quo of that pension system. These movements of protests should clearly promote a more conscious debate on possible reforms on that system. Clearly, proposals for future reforms cannot be properly addressed using "reduced-form-based" techniques since clearly the data is obviously not available.

Instead, to analyze those possible future policy changes, structural models in Labor Economics have been increasingly used to quantify possible effects of examples of such policy reforms. In particular, there has been progress in search models since the beginning of the XXI century both on theoretical as well as on empirical estimation methods to increase its relevance for policy analysis in Emerging Market and developing countries. The inclusion of informal labor markets and of life-cycle decisions is an example of the first set of recent contributions. The development of different econometric methods, such as those based on moments from data, using

[4] Mostly referred to the "*No + AFP*" movement initiated in August of that year.

recently available databases with micro-data, are all examples of the progresses made by the labor search literature on the empirical side. After estimation, those quantified model are used to obtain the effects of specific policy reforms through simulation methods. In this way, those models allow for a more clear way to understand possible mechanisms behind policy changes, complementing then what may be found later on through RCT's methods.

As stated in the first two paragraphs, this paper develops a search model with life-cycle elements to quantitatively analyze the consequences of examples of those policy reforms that underlying the recent discussion in Chile, using the Chilean data from the Longitudinal Social Protection Survey (LSPS) harmonized database. The model assumes the full life of a worker, who in her first two third of her life is active in the job market, and the last third of her life becomes retired. For the period of active work, the model captures the presence of two types of labor markets, one that can be called *formal* and the other *informal*, since the first year of working age until retirement.

In particular, as standard in the search literature, an active worker may be either employed or unemployed. When searching for a new job, the unemployed worker may find one of two types of job offer, a formal one and an informal one. [5] A formal job offer is reduced to the realization of a random wage offer, which is subject to a contribution rate. Such fraction is almost fully destined to feed a fund that will generate income flows to the worker after retirement. The return on those funds is assumed to be fully known already when contributing. Clearly, this assumption constitutes a simplification destined to make the computation side of the model feasible. (More on this issue is discussed below).

[5] The model in this paper ignores the demand side issues of labor markets. For a random-matching based model of labor market equilibrium with formal and informal side see Bosch and Esteban-Pretel (2012 and 2015).

On the other hand, an informal job offer reduces to a wage that is not subject to the contribution rate. Yet, the latter implies no contribution to the funds after retirement, having the agent full information about this feature. For both types of jobs, an employed worker always faces an exogenous probability of losing her job. In case of being fired, the worker receives an unemployment compensation while searching for new job opportunities, as standard in the search literature.

Meanwhile, the worker always has available a (liquid) savings technology in every period. For savings to become relevant agents are assumed to be risk-averse. Risk aversion is not only important for consumption smoothing while actively working. It is a more relevant assumption to reinforce the importance of accumulating funds to generate income flows after retirement.

The model assumes also a non-contributed component of the social security system for the workers after retirement, reflecting in part the solidarity pillar implemented in Chile. This component is one of the key policy variables that have been placed at the center of recent policy discussions about the possible necessity of increasing its scope. Changes in its value may generate effects on the decisions to accept informal job offers (that do not generate income flows from saved funds coming from contributions) vis-à-vis formal job offers.

The paper proceeds to quantify the parameters of the model. For this purpose this paper combines a simulated-method-of-moment approach with the more traditional calibration technique. In particular, this paper uses three moments from the database: average unemployment duration, the coefficient of variation in consumption for active workers and that of consumption for retired agents to estimate values of two parameters: the probability of losing a job for an employed worker and that of finding a new job opportunity (of any kind) for an unemployed one. In this regard, one result regarding parameter estimation is that the probability of being fired is

slightly above (but within range) the values in the search literature. The rest of the parameters are calibrated, most of which use official information from the Chilean pension regulator, while a few parameters are calibrated using an ad-hoc as benchmark given limitation of data.

With the quantitative model at hand the following step is to use it to simulate a pair of counterfactual but potentially relevant policy changes, given the recent debate in Chile mentioned above. In particular, this paper considers two exercises of policy reform. One consists of increasing the contribution rate on formal jobs from the current value, 10per cent down to 7per cent. Such drop is seen as a possible reaction facing the growing discontent against the current pension system. The second exercise implies a 10per cent raise in the non-contributory pension payments to retired workers. This exercise is viewed as a specific response to recent demands from different stakeholders (including the OECD) to increase the scope of the solidarity pillar of the system.

The main results of these exercises can be summarized as follows. The drop in the contribution rate *increases* the average duration of unemployment (relative to the benchmark case) by about 23 per cent. That effect is simultaneous to a *decrease* in the fraction of both formal job offers (by about 4per cent) and informal job offers (by about 32per cent). What lies behind these responses is a clear raise in the reservation wage for both types of offers. This increase reflects the prevalence of some sort of "wealth" effect coming from the decrease in the income flow after retirement given the drop in the contribution rate over the more standard "substitution" effect that would induce agents to accept a lower reservation wage when the contribution rate decreases. Indeed, as a check method for this mechanism, the paper also performs the same exercise in an ad-hoc modified version of the model dropping all retirement years. In the latter the fraction of formal job offers accepted actually raises by 25per cent (although informal job offers are also less frequently accepted here). Thus, these results also stress the importance of planning horizon and

information about the profitability of contributions to funds in evaluating the possible impacts on formality-informality decisions when changing the contribution rates.

The main result relative to the 10per cent-increase in the non-contributory pension is the decrease in unemployment duration by about 24per cent. This effect reflects the raise in the fraction of informal job offers (by about 3.6per cent) although formal job offers almost does not change. The last effect is a bit subtle. Undoubtedly, the level of informality rises with the increase in the non-contributory pension. But that raise does not occur at the expense of rejecting formal offers much more often. That raise occurs instead due to an increase in the propensity to accept informal offers. Then, the main mechanism at work is similar to that in the first exercise.

This paper contributes to two brands of literature. The first is that on job-search models with life-cycle elements. Examples of this literature are Low et al (2010), Piguillem et al (2012), Michelacci and Ruffo (2015) and especially Cirelli et al (2017). In those papers wages are assumed to follow a deterministic path or otherwise directly being a constant. This paper keeps the random nature of wage offers more traditional in search models, among other reasons, to analyze more in depth the role of changes in reservation wages in the mechanisms behind policy reforms. To our knowledge, that mechanism has not been exploited in those models. Of course, given the assumption of risk-averse workers, computing the reservation wage is far from being trivial given its dependence on asset holdings[6] and the life-cycle assumption. This is also one of the assumptions imposing constraints on the possibility of estimating parameters using simulation-based methods given the well-known curse-of-dimensionality problems.

The paper also provides a contribution to the search literature that considers informal labor markets. The latter include the work by Bosch and Esteban-Pretel (2012, 2015), Meghir et al

[6] This problem goes back to the well-known analysis by Danforth (1979) and subsequent work.

(2015) and Flórez (2017). The papers by Bosch and Esteban-Pretel and Meghir et al (2015) include the demand side of labor markets through a matching model, although they all abstract from savings and retirement considerations that are central in this paper. Flórez (2017) does consider savings in a search model with an informal sector, although it ignores retirement and life-cycle elements. In this regard, this paper is a good complements of those four articles providing a focus on the interaction between formal versus informal labor-markets and retirement savings, an issue not addressed before in that literature.

The rest of the paper is as follows. Section 2 presents the search model. Section 3 presents the data sources and the estimation-calibration methods. Section 4 presents the result of the estimation and calibration of parameters. Section 5 presents the results of the policy exercises. Finally, section 6 concludes.

A life-cycle, labor search model with informal and formal labor markets and noisy expectations on retirement-savings returns.

This section introduces the search model. The first subsection presents the set-up, while the following subsection presents some features that arise from the solution of this model.

The set-up

This subsection presents the major assumptions of the model. Consider a stationary environment with (possibly) infinite horizon and discrete periods. In the latter the model considers an agent[7] whose age is counted in semesters (half years). Let $t = 0, 1, \ldots T$ denote the time-periods (semesters) in which that agent may work, depending on the job opportunities encountered. Let $t = T+1,\ldots,T+\mathcal{T}$ be the semesters of retirement for the agent until her death at age $T+\mathcal{T}$. This model assumes that all these terminal dates are known with certainty at the very beginning of her life. This assumption

[7] Just as a convention we use the term "she" to refer to the agent in the subsequent paragraphs.

allows higher feasibility for the estimation procedure, although we consider plausible a version where we replace the knowledge of the death date with a probability of death.

The agent's preferences can then be represented by an expected utility function depending on each period consumption, c_t. The Bernoulli (per-semester) utility function with respect to consumption is $u(c_t) = \frac{(c_t)^{1-\sigma}}{1-\sigma}$. The model assumes a discount factor per month equal to a constant β, which lies in the open segment (0,1).

For all periods $t = 0, 1, \ldots T$ the agent can be either unemployed or else employed in a job. The assumption is that there are two types of employed agents, who, when unemployed, may find one of two possible types of job opportunities with certain probabilities. The two types of potential jobs are a *formal* employment and an *informal* employment. Characteristics of each type of jobs are presented below. For unemployed agents search frictions, imply that obtaining a new job opportunity of either type occurs with a probability α, while with the remaining probability the agent remains unemployed. When receiving an offer the probability that the latter is a formal type is equal to p, while with the remaining probability the offer received is of an informal type. The formal job is characterized by a certain gross wage w^f, subject to tax rate equal to τ. The amount paid by the worker is her contribution to a pension fund, as it is the case in countries like Chile. For then other worker type the informal job is characterized by a tax-free wage w^I.

Unlike other structural models that include the labor demand side (whose information is not available in the (harmonized) LSPS database), and where the formality decision comes from an implicit bargaining process with employers,[8] here wage realizations are assumed as exogenous with finite support. Let $\{w^I_{(1)}, w^I_{(2)}, \ldots, w^I_{(K)}\}$ be the support of w^I and let $\{w^F_{(1)}, w^F_{(2)}, \ldots, w^F_{(L)}\}$ be

[8] See Bosch and Esteban-Pretel (2012, 2015) as examples of these types of matching models with endogenous informality decisions through bargaining.

the one for the gross formal wage w^f. The probability of each possible wage realization is denoted as π_w. Each type of employed agent keeps her job the following period with respective probabilities δ^f and δ^I, and lost with the respective remaining probabilities. When loosing the job the agent remains at least the period when fired as unemployed.

In every period, the agent (either before or after retirement) has available a savings technology, which can be empirically interpreted as a bank account or cash. Such savings technology yields a constant (real) gross per-period return equal to *R*.[9] For future reference, we denote as a_t the level of savings that the agent decides in date *t* - 1 for the next date *t*. On the other hand, when an agent is formally employed, all her contributions are recognized as a pension payment after retirement. The yield on these contributions is known at the time of the contribution.[10]

Finally, after retirement, a social security branch different from pension funds pays an amount additional to the contribution-yield transfers, which is viewed as a non-contributory branch of the retirement payments. These non-contributory pension payments are assumed to be lump-sum. Although the presence of such pensions in the model reflects the implementation of this type of non-contributory pillars of pension reforms in most LAC countries, the assumption of being lump sum forces us to assume that agents are not aware that such non-contributory payments may have the goal of allowing a minimum consumption after retirement, a policy applied not only in Chile but also in other LAC countries.

Bellman equations for each age range[11]

[9] This is clearly a convenient assumption for computation-estimation purposes.

[10] This assumption is clearly made for computational and estimation purposes. The life-cycle intrinsic feature of this model makes policy functions non-stationary in a recursive sense. This introduces several computing complexities that threaten the feasibility of using any type of structural estimation methods. This is the main reason for excluding possibly more realistic assumptions regarding knowledge on the yield on retirement fund contributions.

[11] Some calculations are available upon request.

Under the assumptions presented in the first part of section 2 it is possible to write the Bellman equations for the agent when retired and before retirement.

- *Retired agents*

Suppose that retired agents know that contributions yield a stream of transfers T_t in date *t*, with *t* larger than T. Thus, the on-line appendix (section 6) shows that the Bellman equation for retired people is simply:

$$V_t(Ra_t, \mathbf{T}_t, \mathbf{T}_{t+1}, \dots) = \max_{a_{t+1}} \left\{ \frac{\left(Ra_t + \left(T_t + T_t^{NC}\right) - a_{t+1}\right)^{1-\sigma}}{1-\sigma} + \right.$$

$$\left. \beta \Phi_t(R, \beta, \mathcal{T}) \frac{\left(R^{\mathcal{T}-t} a_{t+1} + \sum_{s=t}^{12\mathcal{T}} R^{12\mathcal{T}-s}\left(T_s + T_s^{NC}\right)\right)^{1-\sigma}}{1-\sigma} \right\} \quad (3a)$$

where:

$$\Phi_{\mathcal{T}}(R, \beta, \mathcal{T}) = \frac{1+\beta(\beta R)^{\frac{1-\sigma}{\sigma}}}{\left[R + (\beta R)^{\frac{1}{\sigma}}\right]^{1-\sigma}}, \; \Phi_t(R, \beta, \mathcal{T}) = \frac{1+\left(\beta R^{(\mathcal{T}-t)(1-\sigma)}\right)^{\frac{1}{\sigma}} \Phi_{t+1}(R, \beta, \mathcal{T})}{\left[R^{\mathcal{T}-t} + (\beta R^{\mathcal{T}-t-1})^{\frac{1}{\sigma}} \Phi_{t+1}(R, \beta, \mathcal{T})\right]}. \quad (3b)$$

Here the variable T_s refers to the income received from pension funds, while T_s^{NC} refers to the non-contributory side of social-security payments. The value function corresponding to the very first period of retirement is equal to:

$$V_T\left(Ra_T, \sum_{s=0}^{\mathcal{T}} R^{\mathcal{T}-s} T_s\right) = \frac{\left[Ra_T + \sum_{s=0}^{\mathcal{T}} R^{\mathcal{T}-s}\left(T_s + T_s^{NC}\right)\right]^{1-\sigma}}{1-\sigma} \Phi_T(R, \beta, \mathcal{T}) \quad (4)$$

The just-retired agent knows the total yield $\sum_{s=0}^{\mathcal{T}} R^{\mathcal{T}-s} T_s \equiv Y$ with certainty at the retirement date *T*. How this same agent considers this variable before retirement is presented next, together with the Bellman equations for her when active in the labor market. The last expression taken ex – post constitutes the whole amount of funds from which contributed pension payments are taken after retirement. The model assumes that, at least for countries where the majority of formal workers

contribute to a funded system then the amount of such payment is just the pro-rata fraction of all those accumulated funds:

$$T_t = \frac{Y}{\mathcal{T}-T},\ t = T+1, \dots, \mathcal{T} \qquad (4b)$$

For countries with pay-as-you-go systems such as Uruguay, the amount of contributed-pension payments is tied to a reference value with additional amounts usually tied to the number of periods with positive contributions to the system. This is clarified below after presenting the problems of active workers.

- *The agent's problem(s) before the retirement*

We first start presenting the pre-retirement perception of post-retirement yields of the |contributed side of pension payments. In the case of a country with fully-funded system, , the non-retired agent perceives *Y* as follows:

$$Y = \sum_{s=0}^{T} \rho^s \theta_s \tau_s w_s^f 1_s \qquad (5)$$

where 1_s is an indicator function taking on the value of 1 in every period *s* when the agent is formally working at the formal wage w_s^f. In equation (5), the total amount of funds coming from contributions consists in the capitalized value of all contributions (each of which consists in the product of the formal wage w_s^f multiplied by the net-capitalization factor θ_s.

This information allows writing a Bellman equation for active workers, one for each employment status, given an education level denoted as *h*. If in a given date *t*, the agent is unemployed then:

$$V_t^U(Ra_t, Y_t) = \max_{a_{t+1}} \Big\{ \frac{(Ra_t + b - a_{t+1})^{1-\sigma}}{1-\sigma} + \alpha\beta \Big\{ p \Big[\sum_{w_{t+1}^f} max\big\{ V_{t+1}^f\big(Ra_{t+1} + (1 - \tau_{t+1}) w_{t+1}^f; Y_{t+1}\big); V_{t+1}^U(Ra_{t+1}, Y_t)\big\} \pi_{w_{t+1}^f} \Big] + (1-p) \Big[\sum_{w_{t+1}^I} max\{ V_{t+1}^I(Ra_{t+1} + w_{t+1}^I; Y_t); V_{t+1}^U(Ra_{t+1}, Y_t)\} \pi_{w_{t+1}^I} \Big] \Big\} + \beta(1-\alpha) V_{t+1}^U(Ra_{t+1}, Y_t) \Big\} \qquad (6)$$

In equation (7) the variable V_{t+1}^{f}denotes the value of becoming formally employed in the next period, while V_{t+1}^{I} denotes the value of becoming informally employed. The term Y_t denotes the total perceived value at time of retirement of the yield on contributions (according to equation (5)), up to period *t*. The law of motion is

$$Y_{t+1} = Y_t + 1_t^f \theta_t \tau_t w_t^f \tag{7}$$

For the formally employed at period *t* the Bellman equation is simpler:

$$V_t^f\left(Ra_t + (1-\tau_t)w_t^f; Y_t\right) = \max_{a_{t+1}}\left\{\frac{\left(Ra_t+(1-\tau_t)w_t^f-a_{t+1}\right)^{1-\sigma}}{1-\sigma} + \left[\beta\delta V_{t+1}^f\left(Ra_{t+1} + (1-\tau_{t+1})w_t^f; Y_{t+1}\right) + \beta(1-\delta)V_{t+1}^U(Ra_{t+1}, Y_t)\right]\right\} \tag{8}$$

while for the informally employed the Bellman equation is similar

$$V_t^I(Ra_t + w_t^I; Y_t) = \max_{a_{t+1}}\left\{\frac{\left(Ra_t+w_t^I-a_{t+1}\right)^{1-\sigma}}{1-\sigma} + [\beta\delta V_{t+1}^I(Ra_{t+1} + w_t^I; Y_{t+1}) + \beta(1-\delta)V_{t+1}^U(Ra_{t+1}, Y_t)]\right\} \tag{9}$$

The terminal condition for any of these value functions at the month previous to retirement (period *T* - 1) is common to all of them. Let y_{T-1}^e be the (net-of-tax) income in that period. Then the corresponding Bellman's equation for any employment state *e* is

$$V_{T-1}^e(Ra_{T-1} + y_{T-1}^e; Y_{T-1}) = \max_{a_T}\left\{\frac{\left(Ra_{T-1}+y_{T-1}^e-a_T\right)^{1-\sigma}}{1-\sigma} + \beta\Phi_T(R,\beta,\mathcal{T})\frac{\left[Ra_T+\sum_{s=0}^{T}\rho^s\theta_s\tau_s w_s^f 1_s+\sum_{s=0}^{12\mathcal{T}}R^{\mathcal{T}-s}T_s^{NC}\right]^{1-\sigma}}{1-\sigma}\right\} \tag{10}$$

The last expressions assume that the agent correctly perceives that the amount of payments after retirement is proportional to the total capitalized value of contributions while working (in the

formal labor market). Again, the paper makes this assumption to facilitate computation feasibility, which is a key requirement for estimation purposes. As it will be stated in the last section, possible future research may generalize this simple assumption.

Data and estimation / calibration.

Data

This paper uses the harmonized database from the Longitudinal Social-Protection Survey (LSPS). Such database is based on national surveys from five countries: Chile (for which there are two years included here, 2006 and 2009), Colombia (year 2012), Paraguay (2015), El Salvador (2013) and Uruguay (2013). Each observation corresponds to an interviewed person from a household in a given country for the year in which the survey was performed. For some of the variables there is retrospective information, while for the Chilean case the presence of two waves allows for a more complete longitudinal dimension in the variables included.

The harmonized database includes information on social security characteristics such as whether the interviewed person receives a contributed pension or a non-contributory pension, or is retired, and if so, the amount of income received from retirement pensions. Another variable informs whether the interviewed person, given that she or he is an active worker, contributes to the formal retirement pension system. This information is key to trace a link between the forma-informal dimension in the model and its empirical counterpart. Below is an explanation for how this link is done in this current version of the paper.

The database includes also labor-market variables (current and past employment status, unemployment duration in the last twelve months), income-related variables, education variables and demographic information, including age and sex. Income information does not come at the individual-level precision. Rather, for each observation then income level reported is the mean-

value of the income corresponding to the quintile at which the observation belongs. That is, the income reported for an interviewed person *i* that belongs, say, to the second quintile, is the mean-income of the second quintile. The same happens to the information on expenditure, with the difference that the database provides five different categories of those expenditures. Given that the model only considers a unique consumption good, the paper aggregates the five expenditures component by adding them up. Proceeding in this way, the resulting "aggregate" expenditure has a more disperse and wider support than each of the five expenditure components. Thus, this version uses this information on expenditures for the estimation-calibration stage of some of the parameters, to be described in the subsection below.

Across all countries included in the Survey, the paper only uses the Chilean data. There are two main reasons for this choice. The first is that it constitutes the Latin American country with the most mature privately-funded pension system in the sub-continent. Although subject to several recent criticisms from different political actors, the Chilean system still now is highly valued by specialists. The model in this paper is more suitable for a "fully-funded system", at least concerning the contributions from formal jobs, rather than more mixed contributory-pension systems.

The second reason is that there is accurate secondary information such as tax rates and other variables for Chile, while for other countries in the Survey the availability of the same variables is more doubtful. Such information directly comes from public sources,[12] and it is information necessary to complete the calibration of parameters in the model.

Quantitative methodology.

[12] See, e.g., https://www.spensiones.cl/portal/orientacion/580/w3-propertyvalue-6138.html.

This subsection describes the methodology followed in this paper, both for estimating – calibrating the model parameters and for policy exercises. It first starts with a brief review on the literature and then it specifies a rationale for the method chosen in this paper.

A large fraction of the empirical literature on search models uses ML-based methods.[13]That literature exploits both the risk-neutrality assumption of the standard model and longitudinal data on unemployment duration to construct likelihood functions that can be used for estimation. Yet, with risk-averse workers, this task becomes much more cumbersome, mainly because of the unavailability of exact closed-form solutions for the likelihood function in such cases. Papers like Lentz (2009) use a numerical approach to compute policy functions embedding the latter into more analytical likelihood functions.[14] Availability of higher frequency data may limit the application of ML methods in highly non-linear search models. The latter is particularly applicable to this paper, given the use of a Survey with low-frequency data.

In contrast, other recent empirical literature with search models focuses on simulation-based methods.[15] Several recent papers estimating structural search models,[16] including some assuming risk-averse workers such as Lise (2013), Haan and Prowse (2017), use different variants of those methods whose common origin goes back to the *simulated methods of moments* (SMM) proposed by Mc Fadden (1989) and Pakes and Pollard (1989). The typical SMM method starts from the computation of moments pointing towards identifying corresponding parameters of the model. Then the method uses an algorithm to minimize a weighted distance between the sample

[13] For a survey on that methodology see, e.g., Eckstein and van den Berg (2007).
[14] Launov and Walde (2013) proceeds in a similar way but using a model with risk neutral workers estimated for the German case.
[15] For an early survey on simulation-based estimation methods see Stern (1997). For a more recent survey see Aguirregabiria and Mira (2010).
[16] For example, Yamaguchi (2010), Meghir et al (2015),

moments of the selected variables and the moments implied by the model for given values of the parameters.[17]

This paper uses a mix of SMM-based estimation and calibration procedures to quantify the parameters. The type of data available prevents the use of ML-based methods. On the other hand, the task of estimating parameters on a life-cycle, highly non-linear model also imposes constraints on the exact number of parameters to be estimated through SMM, forcing to calibrate the rest of the parameters. The reason for this limitation is that those two features of the model here introduce serious computation-feasibility concerns, which at the same time implies a compromise on the feasibility of estimating all parameters through SMM. It is then useful also to review the computation issues of this type of models.

Computation in this context is important for two reasons. First, as mentioned above, feasibility of computation is a key property for the estimation of at least some parameters of the model itself. Second, one of the main purposes of working of structural search models is to perform counterfactual policy-change exercises. The literature on empirically-oriented labor search model emphasizes this role as the main value-added of those models relative to more reduced-form approaches. Those two reasons are enough to ensure that computation is feasible for the model at hand.

A well-known literature on numerical dynamic programming applied to discrete choice models[18] describes important computational issues generated by search models as in this paper. The strategy here is to use the computation side of this methodology for the estimation of

[17] Recently, Eisenhauer et al (2015) compare both ML and SMM type of estimation methods in occupational choice models thorough Monte Carlo simulations. Although SMM performed reasonably well in several dimensions, that paper shows that ML methods tend to more generally present the same or better properties.

[18] For surveys on numerical dynamic programming and computational issues see, e.g., Rust (1997) and Judd (1998). Some papers propose several algorithms to overcome such problem. See, e.g., Keane and Wolpin (1994)

parameters using a technique that is included in the family of the well-known simulated methods of moments, or minimum-distance estimators in some other cases.

The computation dimension of the methodology entails obtaining the optimal policy-functions (where the optimality is at the individual level) computed over a finite grid of points corresponding to the state variables: wages (or, else, the unemployment-benefit parameter) and assets. Given the life-cycle nature of the model here, there is a large degree of heterogeneity coming from the age profile. This may introduce a typical curse-of-dimensionality problem that appears in these dynamic models.[19]

In the case of this paper, though, such particular problem is controlled in a simple way. The first point to stress is that the support of wages is very coarse. In particular, given how income information comes from the LSPS, the support for wages has only five elements. Each of them is linked to a particular quintile of the income distribution within the Survey. On the other hand, the asset grid is also coarse enough to avoid this dimensionality problem.

Regarding a more specific discussion on estimation of parameters, it is important to recall some of the papers doing quantitative work with labor-search models with risk-averse workers and savings, regarding identification of parameters.[20] A well-known contribution is Lentz (2009). That paper estimates a search model with risk-averse workers, based on Lentz and Tranaes (2005), applied to Dutch weekly data. Lentz (2009) uses Dutch data on unemployment spells to eventually estimate a hazard rate for active workers. In the case of this paper, the Survey provides information about months being unemployed during a whole year for each worker.

[19] Again, the references introduced in footnote 11 provide excellent detailed discussion on the types of these dimensionality problems in numerical dynamic programming.
[20] A more complete survey on identification in models of labor markets see French and Taber (2011).

Another important parameter to identify is the probability of being fired after the job, δ. The LSPS database provides some information on whether the last year the interviewed person was employed while in the current year was unemployed. Yet, there is no information about whether a worker lost his or her job between semesters within a given year. Then, the identification of that probability from this variable may also be unprecise.

For the identification and estimation of those two parameters, then, this paper uses an alternative approach, based on the information about income and expenditures, together with the duration of unemployment.[21] The paper computes the coefficient of variation of consumption (expenditures) for active workers and for retired people, according to the information in the Survey. The paper uses those two coefficients together with the average duration of unemployment to identify and estimate the probability of finding a new job for an unemployed worker and the probability of being fired from a job. The estimation is based on a variant of the well-known simulated method of moments. The paper uses an overidentified version of the method, a frequent practice in the literature.

At first glance it may seem odd the use of the coefficient of variations on consumption to identify and estimate parameters related to job creation or job destruction. Yet, there is a rationale behind this use. Suppose two different values for this coefficient. Given a value for the variance of wages, and given the borrowing constraint assumed in the model, what lies behind the agent facing higher coefficient of variation of consumption is that she must be more liquidity constrained relative to the agent with lower consumption variation. This implies that the former accumulated

[21] Regarding the wage probability distributions, several papers in the search literature such as, e.g., Lise (2012) and Low et al (2010) estimate a wage equation by running auxiliary regressions using panel data with monthly or weekly frequency. Lentz (2009) however explains that such strategy may explain too little of the wage variation. Given the type of wage (income) data in the LSPS, the probabilities of realizations are directly calibrated from the relative frequency for each of the five realizations in the Survey.

a lower amount of assets and then her reservation wage is lower than for the latter. *Ceteris paribus* the rest of the conditions in the model then the agent more liquidity constrained should generate a shorter duration of unemployment than the other agent. But if this duration does not get shorter in the data, then the only way to make all these features consistent is that the probability of finding a new job for an unemployed should be larger and the firing probability should be lower. This is so since the reservation wage in the model is increasing in the first parameter and decreasing in the second (the value of accepting a job is lower the larger is the chance of losing it in the following period). These variations in those two parameters would make consistent a given unemployment duration and two possible values of the variations in consumption.

The policy parameters are identified and calibrated directly from the public web-pages with official information on contribution rates, unemployment benefits and contributed and non-contributed pension payments (for retired people). Another parameter is the fraction of total tax payments devoted to the contributed pension system. Also, the parameter measuring the return on contributions to future pensions is also identified from public information about the return on Chilean pension funds.

On the other hand, this paper does not intend to identify and calibrate (or estimate) preference parameters (risk aversion and discount factor). The reason is that the Survey does not provide information on asset accumulation, together with the fact that the expenditures information is already used to identify and estimate the two labor-market related parameters referred in the paragraphs above. Thus, the values for those two preference-related parameters are set to standard values in the related literature (both from labor search and from Macro papers).

Results I: structural estimation and calibration.

This section reports results concerning the estimation-calibration of parameters. Table 1 below first shows the three moments that are used to estimate the probability of finding a new job for the unemployed and the probability of being fired for the employed.

TABLE 1 HERE

As stated above, the moments include the average duration of unemployment, as reported in the number of months remaining as unemployed in the last twelve months, the coefficient of variation of the aggregated consumption of the active workers and that of the retired. As stated in the last section, for other parameters we use information from official Chilean sources.

Table 2 below then presents the values of the parameters estimated and calibrated.

TABLE 2 HERE

The estimated value of the firing probability is 0.068. This estimation outcome seems the consequence of the fact that the consumption of retired agents is non-stochastic. However, this value is within the order of magnitudes relative to other estimates in the literature.[22] In fact, it is often slightly above those other estimates with few exceptions. Clearly, a straight interpretation of these differences in estimated values is that at least for the Chilean case (and presumably for other LAC countries) jobs in the "averaged" labor market (between formal and informal) may be slightly less secure than their counterparts in more developed countries, as ex-ante expected.

On the other hand, the probability of finding a new job opportunity (of any kind) is estimated in 0.535. Comparing this with other estimates in the literature, this value is also within the bounds offered by that work.[23] Admittedly, the estimated value of this parameter is influenced

[22] For example, Paserman (2008) gets a range of estimates for a similar parameter between 0.0087 and 0.011. Yamaguchi (2010) obtains a separation probability of 0.04 for workers with college education and 0.077 for workers with only high-school education. Low et al (2010) calibrates those two probabilities in 0.028 and 0.049 respectively.

[23] For example, comparing this value with the estimates in Paserman (2008) the latter predicts a range of offer probabilities from the estimated parameters in that paper, where the upper bound for that range is 0.562 for workers receiving high-wage offers in the first week of unemployed, a similar value to that estimated in this paper. On the

by the assumed values for the probability of the offer being formal, *p*. This paper assumes a benchmark value of 0.5. Although this looks too simple, it assumes a value that facilitates the simulation-based method used in this paper. On the other hand, it does not look implausible given the unemployment duration reported in the Survey for the Chilean case and also replicated in Table 1 in this paper. Finally, at the bottom of Table 2 appears the standard error of the joint estimation of those two parameters, equal to 0.0893.

The following eight rows of table 2 report the calibrated values of three parameters related to formal workers: the tax rate on formal wages, the fraction of tax payments included for future retirement payments, and the (implicit or explicit) return on pension funds. As stated above, the web-page from the *Superintendecia de Pensiones*[24] provides information on several of those parameters such as the rate applied from labor income as the contribution to the pension fund. The return on funds comes also directly from the report of the above-mentioned website. The value of the fraction of total tax payments going to retirement funds is set to 90per cent to take into account for fees and other deductions.

The value of the real interest rate on savings is calibrated from the average real interest rate on deposits reported from the official Chilean statistics. Ideally, the relevant calibration should include possibly other returns from other investment options, depending on the qualitative information found in LSPS on the types of investment that the interviewed person reports to have. Yet, given that such information is only qualitative, it is not possible to compute weighted averages of rates of return from the LSPS database.

other hand, the value used in Low et al (2010) is slightly higher than in this paper (0.76 for low-education workers, 0.82 for high-education workers).

[24] See https://www.spensiones.cl/portal/orientacion/580/w3-propertyvalue-6138.html

The next row reports the calibrated value of the unemployment benefit, equal to 0.70. This value corresponds to the normalized value of unemployment benefit that is currently in force in Chile, according to the official information from the social security Chilean web site. In fact, as usual in any unemployment benefit system, the payments corresponding to such benefits are decreasing in the duration of unemployment, a feature that is not present in the paper. There is a possibility of assuming an unemployment benefit within a model that may depend on the explicit duration of unemployment. However, the drawback of this assumption lies on the feasibility of computation of the model. Such assumption would clearly make the former much more costly, making the dimensionality problems harder.[25]

Finally, the last two rows present the values of the main two preference parameters. As stated in the section above, this paper uses values for those parameters directly taken from those found in the international literature.

Table 3 presents few quantitative features of the calibrated-estimated benchmark model.

TABLE 3 HERE

The first three rows of this table report statistical moments on the three variables used to estimate the probabilities of job separation and new job offer. The main purpose of these reported statistics is to provide a rough comparison with the empirical moments used in the estimation of the two parameters mentioned above.

Regarding the comparison between the observed unemployment duration and that predicted by the model, the difference does not look large. Indeed, the unemployment duration from the model overestimates that from the data in less than 18per cent. On the other hand, the model also predicts a coefficient of variation for active workers's consumption by 60per cent. This

[25] Again, we want to explicitly show our availability to discuss this issue.

seems a weakness of the estimation method. Yet, part of this problem is attributed to the fact that the intertemporal consumption choice by retired people are assumed to be non-stochastic. Indeed, the last row of table 3 shows that the model predicts a coefficient of variation in consumption for retired people lower than observed, although the difference is not large (7per cent less). Yet, it is expected that the deterministic nature of the retired people's choice problem may introduce some possible distortions in the estimation procedure. Again, the justification of using such assumption in the model comes from the trade-off between estimation precision and dimensionality problems commented above.

The last two rows show the values of two relative frequencies generated by the quantitative model. In such benchmark case, the fourth row indicates that about 81per cent of the formal job offers are accepted (and so 19per cent of those offers are rejected). Similarly, the fifth row indicates that only 35per cent of the informal job offers are accepted, while the remaining 65per cent of those informal offers are rejected. The paper does not intend to compare those two frequency values with features from the Survey. Instead, they will be used as the benchmark values for comparison when performing the counterfactual policy exercises in the next section.

Results II: policy-evaluation exercises

As stated in the introduction, structural models are useful to analyze counterfactual policy exercises. This paper considers two alternative counterfactual policy reforms for the case of Chile that are of some relevance in the recent policy discussion.

The first exercise assumes a permanent decrease in the tax rate on formal-wages, from 10per cent to 7per cent. Although this specific policy change is not explicitly present in the policy debate, this decrease can be seen as a possible reaction by government authorities facing the

increasing demands against the functioning of the Chilean pension system that have been observed at least since the second half of the 2010's.

The second policy exercise is a 10per cent-increase in non-contributory pensions, a frequently discussed type of policy with redistributive goals. This change can also be seen as a possible reaction towards several suggestions in favor of such change.[26] In both cases, the focus is set on labor markets and formality-informality choice variables. Table 4 below shows the results of each of the policy exercises.

TABLE 4 HERE

Panel A of table 4 shows the results regarding the drop in the contribution rate from 10per cent to 7per cent. The first row shows an increase in the average duration of unemployment. This increase is proportionally quite big (about 23per cent from the benchmark case). The mirror image of this increase in the unemployment duration appears in the following two rows: for both types of job offers received by unemployed workers, the frequency of acceptance drops. In the case of formal jobs, the drop in the acceptance rate is about 4per cent, while for the informal jobs the drop is much larger, about 32per cent.

Those three results show the major effect of that policy change: an increase in the reservation wage when such contribution rate drops. Indeed, a drop in the contribution rate decreases the income flow after retirement, increasing the value of being unemployed, making workers more demanding when receiving job offers. The latter can be seen as a type of *wealth* effect. This counterbalances a more traditional effect present in the traditional search literature, namely, a *substitution* effect. In the latter a first order effect of such decrease in a "tax rate" applied

[26] For example, the recent OECD report on Chile (2018) suggests the increase of the "solidarity pillar" as a strategy to improve inclusiveness for the old in the Social Security system.

to wages also decreases the reservation wage (given the positive correlation that those two variables have in the standard model).

In fact, the last two rows of panel A of table 4 reflect that effect. Those two rows compute the results of a similar exercise on the fraction of formal and informal jobs accepted but modified in an ad-hoc way. This variation consists in dropping all semesters of retirement, keeping only the periods while actively working (or otherwise being unemployed). In this case clearly the parameter τ corresponds to a proper labor income tax rate, not to a contribution to funds available later on in life. Then, a drop in that parameter implies an increase in the propensity of accepting a new formal job (although it still implies a drop in the propensity to accept an informal job), not only due to the standard mechanism present in traditional search models with risk-neutral workers, but also reinforced by the effect on asset holdings.

Instead, in the full model with retirement, those direct effects are more than counterbalanced by the effects on transfers received after retirement. Indeed, the drop in the contribution rate not only implies a drop in the cost of accepting a new job, but also a decrease in income after retirement. Given the estimated and calibrated values of the parameters, this model shows that the second effect ends up being stronger than the first one.

Yet, the difference between the two above-mentioned cases suggests that such a change depends crucially on the true planning horizon of workers.[27] Those results indeed suggest that the possible effects of changes in contribution rates are very different (essentially, the opposite) for workers with long-run horizons than for those with short-run horizons. Although the paper does not deal directly with behavioral issues like myopia, this rough exercise presents a first step towards understanding the role of planning horizon when evaluating potential policy reforms in

[27] This effect is also related to empirical literature linking financial literacy (as in Meier and Sprenger (2013)) and information (as in Fuentes et al (2017)) to voluntary savings for retirement.

social-security contributions. Besides, to our knowledge at least, such result is novel in the search literature with life-cycle considerations.

The other relevant comment is related to the relationship between the propensity to accept formal jobs and that to accept informal jobs. In the case of the full model, the drop in the contribution rate undoubtedly makes the unemployed worker even more reluctant to accept informal jobs than formal ones. This result is in line with the intuition that a drop in such rate makes labor formality less costly for workers. An even sharper result is obtained in the ad-hoc modified model, where the same drop generates a decrease in the number of informal jobs offered to unemployed workers. At least in relative terms, then, such a drop in contribution rates at least may generate correct incentives on the labor-supply side to decrease informality in labor markets, although making unemployment a phenomenon with higher duration.

The second panel of table 4 evaluates the effects of the increase in the non-contributory pension after retirement. The effect on unemployment duration is a drop in the latter by about 24per cent relative to the benchmark value. This drop in fact reflects an increase in informality jobs, measured by the increase in the fraction of new informal jobs by about 3per cent. On the other hand, the propensity to accept formal jobs drops very little (less than 1per cent). The last result is a bit surprising. Indeed, one would expect a more significant drop in the propensity to accept formal offers when increasing the solidarity pillar. Thus, what is at work here is a mechanism similar to that at stake in the contribution-rate fall exercise, that is, a wealth effect counterbalancing a substitution effect. Yet, from both the labor-market informality and the fiscal policies discussion, these results seem undesirable. Indeed, and from a more macro perspective, these results suggest that making non-contributory pension transfers more “generous” may imply lower incentives to contribute to the formal branch of the social security system and so it may

ceteris paribus worsen the fiscal position of the government providing those transfers. Although this exercise does not consider more careful designs of policy-reforms, this result puts a word of caution regarding the conditions under which extending the "solidarity pillar" does not introduce possible fiscal threats.

Conclusions.

This paper has presented a labor-search model with life-cycle elements, with the major goal of quantifying it properly for counterfactual policy reform evaluations. From the paper there are two major lessons to stress in future work. The first lesson is of methodological order. Introducing life-cycle elements into search models always represents a challenge for estimation through SMM methods. The main challenge comes from the well-known curse-of-dimensionality issues, which in such model seems even worse than in other search models, since the life-cycle elements introduce an additional dimension of heterogeneity. Undoubtedly this should constitute a focal point for future research to develop methods that allow improving the precision, extending the scope of the estimation (i.e., extending the number of parameters to be properly estimated) and also the possibility of estimating parameters with richer assumptions (e.g., dropping the assumption of deterministic lives after retirement, as assumed in this paper).

The second lesson is related to policy discussions and the use of those models to address them. The asymmetric results on formal job acceptance and the drop in contribution rates between the model with agents fully taking into account the retirement years and that where agents ignore them represent a first step towards a more systematic line of research regarding planning horizons and the effects of policy social-security reforms in labor-market outcomes and even in welfare. Although the literature on myopia and social security is well-known, very little has been developed

when introducing search costs in labor markets. This is also particularly relevant when dealing with labor informality issues as well.

Other venues for future research include for example the introduction of the labor-demand side. In this regard, it is clear that the random-matching models with bargaining (such as those by Bosch and Esteban-Pretel, mentioned in the introduction) must be the starting point to introduce life-cycle issues. Yet, to our knowledge such extension has not been tried yet, possibly due to computational complexities, among others. It seems an important modeling challenge to be carefully thought of to better understand the interaction between both social-security and labor market policies and outcomes.

Other extensions include adapting search models with explicit intra-household analysis. Indeed, Adda et al (2017) and Haan and Prowse (2017) constitute recent contributions of models analyzing marriage, fertility and labor-search considerations that is explicitly estimated through simulation-based methods. No attempt to extend such analysis to Emerging Market countries is known at this time. Such extensions may imply richer and more subtle effects that a model without such considerations may generate.

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Appendix: estimation and computation of the model.

This appendix provides a rough description of the method used to compute and estimate the probabilities of being fired when employed and that of finding a new job offer when unemployed. As present in other papers such as Low et al (2010), a major complication is the combination of an employment choice and savings choice. Yet in this paper such complication is worsened by the endogeneity of reservation wages. As explained in the main text, computing feasibility given such complexities forced us to limit the estimation based on simulation methods to two parameters only.

The algorithm is based on six codes[28], each of which is allocated in a separate file. The first file is called "SLC". This file contains the active part of the life cycle. Agents take labor and saving decisions. Agents accumulate savings and make employment decisions according to equations (6), (8) and (9) in the main text. The second file is called "retNS". This file contains the consumption and saving decisions of the retired agents. As explained above, retired agents receive two types of transfers: contributive, associated with compulsory savings, and non-contributive transfers from the government. These decisions are made according to equations (3a) and (3b) in the main text. The third file is called "CF". This is a compilation file. The file "CFNS" (NS means non-segmented labor market) puts together active and non-active decisions and compute the level of assets for the period previous to retirement (the last active period). This is done in equation (10). The file "EST" computes the "matched" parameters (δ, α) according to the observed values for the coefficient of variation of consumption and average duration of unemployment. Finally, the file "markovchain" simulates a finite state space Markov process.

[28] All codes are written in MATLAB© language.

The procedure runs as follows. The first step is to run the EST file providing as an input the vector of the three moments used for estimation, using the syntactic expression ESTNS(0.15, 0.43, 1.5). As explained in the main text, the first input is the coefficient of variation of consumption for the active life and retired life respectively. The last number is the average duration of unemployment. Also as explained in the main text, the process for wages is in fact assumed to be iid (all rows of the transition matrix are equal). The values for the wages (formal and informal sector) are taken from the data as well as the probability associated with each possible value.

The EST file provides as output a first iteration for the estimated parameters, using the simulated method of moments, named as "alphastarNS" and "lambdastarNS" in the code. Repeat the procedure several times and compute the average across simulations. That is, the name "alphastarNSj" is the output of the j-th execution of the code "ESTNS". The reported valued must be an average of across the *J* simulations. These averages are the estimated calling (alphastarNS_Avg) and lay-off probability (lambdastarNS_Avg).

Finally, the algorithm uses these average values "alphastarNS_Avg" and "lambdastarNS_Avg" to run the file "CFNS". This provides a series of consumption, assets, and labor-decision statistics listed as an output of the code. The next step repeats the procedure several times and average the values across simulations for each time (i.e. $\text{CANS}_{i,t}$ is the consumption (C) of the agent during her active (A) life in a non-segmented (NS) labor market, in period "t", simulation "i". $(\sum_i \text{CANS}_{i,t})/\text{I}$ must be the reported value, where "I" is the number of simulations.)

The delivery of this paper includes then the files "CFNS", "retNS", "CFNS", "ESTNS" and "markovchain".

Table 1: moments for estimation	
This table presents moments from labor-market variables included in the LSPS. The average duration of unemployment is computed directly from the reported variable on unemployment duration during the last 12 months. Variarion coefficients are computed from the aggregated expenditure variable, taking the mean and the standard deviation through the corresponding ages.	
Moment	Value
Average Duration of Unemployment in Semesters	1,5
Variation coeff of consumption, active workers	0,15
Variation coeff of consumption, retired	0,43
Source: own calculation from harmonized LSPS database	

Table 2. Quantification of parameters

This table presents the estimated / calibrated values of parameters. Estimation come from matching moments that appear in table 2. Calibrated values for wages are obtained directly from the LSPS data on income. The return on pension funds are obtained from public information of return on pension funds in Chile. The tax rate on wages is obtained from OECD. Interest rate informnation is obtained from official statistics. The unemployment compensation is obtained from the Chilean social-security authority web-site.

Parameter	Description	Value	Method
δ	Layoff probability	0,068	Estimated through SMM (*)
α	Probability of receiving a new offer	0,535	Estimated through SMM (*)
p	Probability of a formal offer (conditional on a new offer)	0,5	Assumed
π_w	Probability vector of each wage in the support	[0.14 0.21 0.20 0.24 0.21]	Calibrated from LSPS
θ	Fraction of compulsory savings paid as transfers when retired	0,9	Calibrated from public source
ρ	Maximum return on pension funds	0,045	Calibrated from public source
τ	Tax on wages	0,1	Calibrated from public source
R-1	Net interest rate	0,03	Calibrated from data on interest rate
b	Unemployment compensation (same for both)	0,7	Calibrated from public source
β	Subjective discount factor	0,95	Reproduced from literature
σ	Relative risk aversion	3,0	Reproduced from literature

(*) For this joint estimation the standard error is 0.0893

Sources: own estimation and calibration based on harmonized LSPS data, *Superintentendencia de Pensiones* (Chile) and banking system information

Table 3: Properties of the benchmark model		
This table reports the quantitative results in the benchmark models for five endogenous variables: average duration of unemployment, coefficient of variation of consumption for active workers and that coefficient for retired. Moments are taken across the semesters of active life of workers.Column 2 reports the results for data while column 3 does so for the model predictions. Averages and standard deviations are taken within the agent's first fifty years of life.		
Variable	Data	Model
Average duration of uneployment (in semesters)	1,5	1,76
Coefficient of variation of consumption - active	0,15	0,24
Coefficient of variation of consumption - retired	0,43	0,4
Frequency of accepted formal job offers	-	0,81
Frequency of accepted informal job offers	-	0,35
Source: own computations based on model		

Table 4: Results of counterfactual policy exercises

Panel 4.A: Drop in contribution rate from 10% to 7%

This panel reports the results of a drop in the contribution rate from 10% to 7% on three major variables: unemployment duration, the fraction of formal offers accepted when unemployed, and the fraction of informal offers accepted when unemployed. For the last two variables, there are two types of values reported. The first two correspond to the effects of the above-mentioned rate in the full model, i.e., when agents take into account their effects when retired. The other two values correspond to the effects when agents ignore the effects after retirement.

Variable	Benchmark	After drop in τ
Average unemployment duration (semesters)	1,769	2,186
Fraction of formal offers accepted (full model)	0,813	0,783
Fraction of informal offers accepted (full model)	0,356	0,243
Fraction of informal offers accepted (no retirement)	0,633	0,795
Fraction of informal offers accepted (no retirement)	0,456	0,278

Panel 4.B: Increase in non-contributory pensions in 10%

This panel reports the results of an increase in the non-contributory pensions by 10% on three major variables: unemployment duration, the fraction of formal offers accepted when unemployed, and the fraction of informal offers accepted when unemployed.

Variable	Benchmark	After increase in T^{NC}
Average unemployment duration (semesters)	1,769	1,351
Fraction of formal offers accepted (full model)	0,813	0,811
Fraction of informal offers accepted (full model)	0,356	0,369

Source: own computations based on model