The value of a formal job and the consequences of job loss in presence of informality

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Abstract

Literature about labor informality says little about the career consequences of choosing a formal or informal job. This is relevant since firms in different sectors, besides the institutional settings like the minimum wage, differ in the accumulation of human capital, job destruction rates, and arrival rates of potential offers. To understand these differences in the value of formal and informal jobs, I propose a novel model of a frictional labor market with two sectors with different institutional settings, where firms inside each sector differ in their productivity and exogenous destruction rate. At the same time, workers search for jobs off- and on-the-job and accumulate human capital. This generates a job ladder where workers can improve their situation, moving to a more productive or safer firm, or to a formal firm if they are in an informal job with similar or worse characteristics. I estimate the model using Chile's survey and administrative data from 2010-2019. The model allows us to understand the heterogeneity of the extra value given by a formal job compared to an informal one and the consequences of job loss in the presence of labor informality. The main result is that the value of formalizing jobs is higher for those working in firms at the beginning of the job ladder and have lower levels of human capital. Finally, I estimate how these values react to changes in the minimum wage, providing insight into how this policy affects the job ladder component in economies with informal labor.

Keywords: Labor informality, job ladder, minimum wage, cost of job loss.

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1 Introduction

Labor informality presents a pressing concern within developing economies, with far-reaching consequences for social welfare. In these contexts, labor regulations do not extend to informal workers, exempting them from minimum wage requirements and regulated working hours. Furthermore, the informal sector generally evades taxation, which can strain government finances. Informal workers and firms also tend to sidestep contributions to the social security system, placing additional financial stress on health and pension programs. The magnitude of these challenges is substantial, with labor informality affecting a significant portion of the workforce, ranging from 20% to 80% in some developing countries (Perry et al., 2007; La Porta & Shleifer, 2014). The informal sector's contribution to GDP is also noteworthy, accounting for nearly one-third of the total economic activity (Schneider & Enste, 2000; Elgin et al., 2021).

Past literature has shown that informal firms differ from formal ones in several aspects. First, formal firms tend to be more productive than informal ones as a result of a selection decision, a fact that is often incorporated in models by weighting the cost of paying payroll taxes or facing the chance of being fined by the regulatory authority (Meghir et al., 2015; Haanwinckel & Soares, 2021; Cisneros-Acevedo & Ruggieri, 2022; Parente, 2022). Second, informal firms tend to offer jobs with a higher unemployment risk. While this is an empirical fact (Perry et al., 2007; La Porta & Shleifer, 2008; De Paula & Scheinkman, 2011; La Porta & Shleifer, 2014) that has not been explored explicitly in models in the literature, the idea of firms offering more stable jobs being formal can be rationalized using the payroll versus fine logic used before. Third, past research has shown that human capital accumulation in the formal sector is higher than in the informal one, which can be rationalized through labor training and having to realize more specific tasks in the formal sector (Bobba et al., 2021; Jedwab et al., 2023). Fourth, there is evidence showing that the transition rates across formal and informal jobs are heterogeneous depending on the characteristics of the job (Magnac, 1991; Meghir et al., 2015; Allen et al., 2018; Ulyssea, 2018), and therefore the underlying arrival of job offers is different across sectors.

In addition, informality it is not only a problem by its effects on taxation or the social security system, or by the characteristics of the firms in the sector. In a presence of search frictions in the labor market, informality is also a problem since informal firms are generating a negative externality over formal firms, making more difficult for them to find workers, and therefore increasing the search costs (Ulyssea, 2018, 2020).

Then, the literature has shown several ways informality can be problematic. However, little research studies the aggregate effects of the problems above on workers' career paths, particularly the value of having a formal job and how this value changes over the worker's position in their ca-

reer. Given the substantial differences between sectors, how workers progress through their careers is relevant for several outcomes, such as wages, unemployment risk, human capital accumulation, and formality status. To contribute to closing this gap in the literature, I propose a frictional search model with two sectors, with different institutional settings, in which firms in each sector are distinct in their productivity and exogenous destruction rates. In this model, workers accumulate human capital while employed and lose it when unemployed. Also, they can do off and on the job search, which implies that they will climb the job ladder, improving their current position via meeting with a more productive firm, a safer one, or a formal one in the case that they are working in the informal sector which similar or worst characteristics.

The data used to calibrate the model will be administrative records and employment survey data from Chile between 2010 and 2019. During this period, the informality rate in Chile has been relatively constant and close to 30 percent, formal employment accounts for around 63 percent, and the unemployment rate has been close to 7 percent (INE, 2024). Regarding the formal data, it corresponds to a sample of the administrative records of the unemployment insurance (*Seguro de Desempleo*), which is a random sample of 20 percent of the workers registered in the last month of the database (currently July 2023), whose work histories are reconstructed backward. As usual with these databases, these records do not consider public sector workers. The administrative records will be used to obtain information regarding the formal sector of the Chilean economy. The employment survey data corresponds to the National Employment Survey (*Encuesta Nacional de Empleo*) for the four quarters of the year, centered in February, May, August, and November. This data has a panel structure that follows individuals in a household over six quarters, and combining the entire data of those who participate in the labor market yields 1.9 million observations. Using survey data becomes necessary since it is the only way to have data relative to the informal sector, the transitions between formal and informal sectors, and unemployment. Finally, I also use the supplementary income survey (*Encuesta Suplementaria de Ingresos*) for the same period. This supplementary survey contains income data for those who answer the employment survey during the quarter centered in November each year, and it is the only source of income data for the informal sector. To calibrate the model I will match several moments from the data and the model.

Once the model is calibrated, it is possible to obtain the value of a formal and informal job in the firms operating in the labor market. It is important to notice that formal and informal jobs will take several values across the job ladder. Therefore, the extra value obtained from having a formal job concerning the informal counterpart will depend on the particular position of that job in the job ladder. This will generate a distribution of gains for formalization, allowing, for example, formal jobs to give more value than their informal counterparts at the beginning of the job ladder rather than at the top. Also, the model will shed light on the consequences of job loss for those having an informal job, something that it is not possible to see directly from the data.

The paper is organized as follows. The second section will highlight the contributions of this paper regarding the existing literature. The third section will introduce the model. The fourth section will show some relevant aspects of the data. The fifth section will present the moments used to calibrate the model and how to obtain them from the data. The sixth section will discuss some aspects of the model solution and its calibration. The seventh section shows the model fit and will present estimates of the additional value of a formal job across the job ladder. The eighth section will present the model estimates for changes in the minimum wage. Finally, the ninth section will summarize the results and discuss them.

2 Related literature

This paper contributes to three strands of literature. First, it contributes to the literature about informal labor. Previous literature has focused on the effects of complementarity between worker types (Haanwinckel & Soares, 2021), financial constraints in the labor decisions (Flabbi & Tejada, 2022), minimum wage effects over inequality and employment (Parente, 2022), different levels of human capital accumulation across sectors (Bobba et al., 2022), payroll effects on informality (Cisneros-Acevedo, 2022), and trade policy over informality (Dix-Carneiro et al., 2021). One common aspect of these papers is that while it is widely spread that there is heterogeneity in the production levels between formal and informal firms, usually using a productivity draw before selecting a sector, the exogenous destruction rates of the firms inside each sector are equal, making that keeping productivity constant, working in a formal firm is always better because the exogenous destruction rate is smaller. This paper contributes to this literature by allowing for heterogeneity in job destruction rates across firms inside a sector. Another common characteristic among this strand of literature is that they do not consider the job ladder components, in which workers can improve their situation through receiving offers from both sectors and transitioning between them. Then another contribution of this paper is considering the job ladder component in analyzing the consequences of labor informality. This component will add new results to this literature, like the value added by formal jobs concerning informal ones across the job ladder and a measure of the consequences of losing a job in a setting with informality.

The second piece of literature to which this paper is contributing is the one associated with wage and employment dynamics. Recent papers of this literature tend to focus on developed economies. Therefore, they present models in which there is only a formal sector in the labor market (Krolikowski, 2017; Burdett et al., 2020; Huckfeldt, 2022; Jarosch, 2023; Carrillo-Tudela & Visschers, 2023). Given the above, this paper contributes to the literature presenting a job ladder setting with two sectors, and where those sectors not only differ in the characteristics of the firms inside them but also institutional settings, being the most important the presence of the minimum

wage in the formal sector.

The third strand of literature is related to those papers studying the consequences of job loss. As most of the models in this literature are applied to developed economies (Flaaen et al., 2019; Lachowska et al., 2020; Jarosch, 2023; Schmieder et al., 2023), they omit components that could be crucial to characterize the consequences of job loss in a developing economy market, like the structural differences between sectors, and the presence of a minimum wage in the formal sector. Given the above, this paper contributes to this literature by adding additional components to understand the consequences of job loss, like the minimum wage in the formal sector, the possibility of doing an on-the-job search from both sectors, and providing different levels of human capital accumulation in both sectors.

3 Model

3.1 Setting

Time is assumed to be discrete. Firms are characterized by their compliance status (i.e., formal or informal) and a vector $\theta = (\theta_y, \theta_\delta)$, where θ_y is a parameter that represents the productivity of the firm, and θ_δ is the exogenous destruction rate of the jobs offered by the firm.

Workers are infinitely lived, and all of them search randomly for offers, samplying them from the same distribution. Workers can be in three possible states: unemployed, employed in the informal sector, and employed in the formal sector.

When workers are unemployed, they receive a value z. Workers are endowed with a level of human capital h, which is observable to the firms and where $h \in \mathcal{H} = [\underline{h}, \overline{h}]$. Human capital is assumed to evolve following $G_e(h'|h)$ where $e \in \{f, i, u\}$. The above implies that human capital accumulation will differ in each possible state. In particular, human capital will have a chance to increase while the worker is employed and decrease while the worker is unemployed.

When workers are unemployed, they encounter job openings in sector $c \in \{f, i\}$ with probability λ_c. When they are formally employed, they encounter job openings in formal and informal sectors with probabilities λ_{ff} and λ_{fi}. And, when they are informally employed, they encounter job openings in formal and informal sectors with probabilities λ_{if} and λ_{ii}.

Once a worker and a firm form a match, output is given by $p(\theta_y, h) = \underline{p} + \theta_y + h$, and the job opening has no continuation value to the employer if the worker goes to another firm or becomes unemployed.

The timing of the model is as follows:

1. Output $p(\theta_y, h)$ is observed, and wages are paid.
2. Workers may become unemployed following θ_δ.
3. Human capital gets updated following $G_e(h'|h)$.

4.1 If still employed: could receive an outside offer (move or re-bargain) ($\lambda_{ff}, \lambda_{fi}, \lambda_{if}$ and λ_{ii}).

4.2 If unemployed: could receive an offer (λ_f and λ_i).

Wages in this model are restricted to fixed contracts, and they can be renegotiated when either party has a credible threat, which includes unemployment for the workers, or when the workers receive an upgrade for their human capital levels. The specific wage for the informal sector setting follows Cahuc et al. (2006), while in the formal sector a modified version of this bargaining process is proposed to account for the minimum wage ($\overline{w}$).

3.2 Bargaining process

Then, let $W(c, \hat{c}, \theta, \hat{\theta}, h)$ denote the value of an employed worker in a firm with compliance status c, vector θ, and human capital h, and where $\hat{c}$ and $\hat{\theta}$ represent the sector and the firm used in the last bargaining process (i.e., benchmarks). Then $J(c, \hat{c}, \theta, \hat{\theta}, h)$ represents the value of a filled job. $U(h)$ denote the value of employment. Finally, $S(c, \theta, h)$ is the surplus of the match defined as:

$$S(c, \theta, h) \equiv max\{W(c, \hat{c}, \theta, \hat{\theta}, h) - U(h) + J(c, \hat{c}, \theta, \hat{\theta}, h), 0\}$$

And it can be proved that this surplus only depends on the actual levels θ and h, in addition to the compliance status c. The intuition for omitting the benchmark parameters is that they will rule out how to split the surplus, not its amount. The intuition for why the surplus depends on the compliance status is that the compliance affects the transition rates to the other market. We can see this in the case that $\lambda_{ff} \neq \lambda_{if}$ and $\lambda_{ii} \neq \lambda_{fi}$.

Then, If an unemployed worker with human capital h and an informal firm with θ form a match, the value of employment will be such that:

$$W(i, u, \theta, u, h) - U(h) = \alpha S(i, \theta, h)$$

Where α is the bargaining power of workers. Which is assumed to be common across sectors.

If an unemployed worker with human capital h and a formal firm with θ form a match, the value of employment will be such that:

$$W(f,u,\theta,u,h) - U(h) = \max\{\alpha, \gamma(\theta,h)\}S(\theta,h)$$

Where $\gamma(\theta,h)$ is such that $\overline{w}$ is paid, following the idea proposed by Flinn (2006) in which the minimum wage effect in a bargaining process can be seen as a *de facto* increase in the bargaining power of workers for whom the minimum wage is binding. Notice that in this case, the match will take place as long as $0 < \gamma(\theta,h) < 1$, meaning that it is feasible for the firm to pay the minimum wage.

Next, consider a worker with human capital h, current employed at an informal firm with θ, and who has as a benchmark the firm $(\hat{c}, hat\theta)$. Then, we have that the value of employment is given by:

$$W(i,\hat{c},\theta,\hat{\theta},h) - U(h) = S(\hat{c},\hat{\theta},h) + \alpha[S(i,\theta,h) - S(\hat{c},\hat{\theta},h)]$$

While for the case of a worker with the same characteristics, but currently working in a formal firm, the value of employment is given by the maximum of the binding and non-binding conditions:

$$W(f,\hat{c},\theta,\hat{\theta},h) - U(h) = max\{NB, B\}$$

Where each condition is given by:

$$\begin{aligned} NB &= S(\hat{c},\hat{\theta},h) + \alpha[S(f,\theta,h) - S(\hat{c},\hat{\theta},h)] \\ B &= \gamma(\theta,h)S(f,\theta,h) \end{aligned}$$

Then if a worker receives an offer from a firm (c',θ') we have the following options. First, we need to check whether c' corresponds to the formal sector. If that is the case, then we must check that $0 < \gamma(\theta',h) < 1$, otherwise the offer is not feasible. In the case that the offer is feasible or it comes from the informal sector, we have the following three cases:

1. If $S(c',\theta',h) > S(c,\theta,h)$, she moves to θ'. And the new value of employment (depending on the formality status c') is given by:

$$\begin{aligned} W(i,c,\theta',\theta,h) - U(h) &= S(c,\theta,h) + \alpha\left[S(i,\theta',h) - S(c,\theta,h)\right] \\ W(f,c,\theta',\theta,h) - U(h) &= max\{NB, B\} \end{aligned}$$

Where each condition is given by:

$$\begin{aligned} NB &= S(c,\theta,h) + \alpha[S(f,\theta',h) - S(c,\theta,h)] \\ B &= \gamma(\theta',h)S(f,\theta',h) \end{aligned}$$

2. If $S(c',\theta',h) < S(c,\theta,h)$ and $S(c',\theta',h) > S(\hat{c},\hat{\theta},h)$, then she re-bargain, which will lead to a new value of employment given by:

$$\begin{aligned} W(i,c,\theta,\theta',h) - U(h) &= S(c,\theta',h) + \alpha\left[S(i,\theta,h) - S(c,\theta',h)\right] \\ W(f,c,\theta,\theta',h) - U(h) &= max\{NB, B\} \end{aligned}$$

Where each condition is given by:

$$\begin{aligned} NB &= S(c,\theta',h) + \alpha[S(f,\theta,h) - S(c,\theta',h)] \\ B &= \gamma(\theta,h)S(f,\theta,h) \end{aligned}$$

Notice that this will lead to an interesting process in which, every time that the worker decides to re-bargain using a better benchmark in the informal sector, that will lead to an improve value of employment for the worker. However, this is not always the case for a worker in the formal sector. Take for example the case that the new offered firm is better than the benchmark firm, and therefore the worker change the old benchmark firm with a new one. If the non-binding value of that bargaining is smaller than the binding value, the worker would keep the actual value of employment and nothing would happen besides the change in the benchmark.

3. If $S(c',\theta',h) < S(c,\theta,h)$ and $S(c',\theta',h) < S(\hat{c},\hat{\theta},h)$ then nothing happens, and the worker keeps her current firm and benchmark.

3.3 Value functions

Given the above, the value of unemployment is given by:

$$\begin{aligned} U(h) = z + \beta \int_{\mathcal{H}} \Bigg(\lambda_f \int_M \left[W(f,u,x,u,h') - U(h')\right] dF_f(x) \ ... \\ + \lambda_i \int_M \left[W(i,u,x,u,h') - U(h')\right] dF_i(x) + U(h') \Bigg) dG_u(h'|h) \end{aligned}$$

The intuition of this equation is as follows. At the beginning of an unemployment period, the worker will received the value z and then, in the next period, she will have the chance of receiving a formal offer with probability λ_f. Any job that offers a value higher than the value of employ-

ment will be accepted. Once a worker moves from unemployment to employment, the benchmark situation is unemployment, which can be characterized by a firm producing zero. Also, with probability λ_i there is a chance of receiving an informal offer, which follows an analogous process to the mentioned above. Also, it is possible not receiving any offer an to continue unemployed to next period, in which there is a chance of losing human capital given by the process $G_u(h'|h)$.

Then, the value of being employed in the formal sector is given by:

$$
\begin{aligned}
&W(f,\hat{c},\theta,\hat{\theta},h) = \max\{w(f,\hat{c},\theta,\hat{\theta},h),\overline{w}\} + \beta \int_{\mathcal{H}} [(1-\theta_\delta) \times ... \\
&\Bigg(\lambda_{ff}\left(\int_M W(\tilde{f},f,x,\theta,h')dF_f(x) + \int_{RB} W(f,\tilde{f},\theta,\tilde{\theta},h')dF_f(x)\right) + ... \\
&\lambda_{fi}\left(\int_M W(\tilde{i},f,x,\theta,h')dF_i(x) + \int_{RB} W(f,\tilde{i},\theta,x,h')dF_i(x)\right)\Bigg) + ... \\
&\left(1-\lambda_{ff}\int_{M+RB} dF_i(x) - \lambda_{fi}\int_{M+RB} dF_f(x)\right) \times \Big[W(f,\hat{c},\theta,\hat{\theta},h)\Big] ... \\
&+\theta_\delta U(h')]\, dG_f(h'|h)
\end{aligned}
$$

A worker employed will receive the maximum value between the wage function and the minimum wage ($\overline{w}$). Then, in the next period, if the job is not exogenously destroyed, the worker could receive an offer from the formal sector or the informal sector. Given this offer, the worker could choose used them to move to new job or use it to re-bargain their current situation. If they workers do not receive an offer, the firm is the same for the worker the next period. In the case the worker continues employed in the next period there is a probability of increasing her human capital. Also it could be the case that the job is exogenously destroyed, in which case the worker starts the next period in unemployment.

Analogously, the value of employment in the informal sector is given by:

$$
\begin{aligned}
&W(i,\hat{c},\theta,\hat{\theta},h) = w(i,\hat{c},\theta,\hat{\theta},h) + \beta \int_{\mathcal{H}} [(1-\theta_\delta) \times ... \\
&\Bigg(\lambda_{if}\left(\int_M W(\tilde{f},i,x,\theta,h')dF_f(x) + \int_{RB} W(i,\tilde{f},\theta,\tilde{\theta},h')dF_f(x)\right) + ... \\
&\lambda_{ii}\left(\int_M W(\tilde{i},i,x,\theta,h')dF_i(x) + \int_{RB} W(i,\tilde{i},\theta,x,h')dF_i(x)\right)\Bigg) + ... \\
&\left(1-\lambda_{fi}\int_{M+RB} dF_i(x) - \lambda_{ii}\int_{M+RB} dF_f(x)\right) \times \Big[W(i,\hat{c},\theta,\hat{\theta},h)\Big] ... \\
&+\theta_\delta U(h')]\, dG_i(h'|h)
\end{aligned}
$$

Where the main change between this value function and the one for the formal sector, is that the probabilities of receiving offers are changing from the pair $(\lambda_{ff},\lambda_{fi})$ to $(\lambda_{if},\lambda_{ii})$, and the exis-

tence of the minimum wage in the formal sector.

Regarding firms, we have that the value of a formal filled vacancy is given by:

$$
\begin{aligned}
&J(f,\hat{c},\theta,\hat{\theta},h) = p(\theta_y,s) - \max\{w(f,\hat{c},\theta,\hat{\theta},h),\overline{w}\} + ... \\
&\beta \int_{\mathcal{H}} (1-\theta_\delta) \Bigg(\lambda_{ff} \int_{RB} J(f,\tilde{f},\theta,x,h') dF_f(x) + ... \\
&\lambda_{fi} \int_{RB} J(f,\tilde{i},\theta,x,h') dF_i(x) \; + \; ... \\
&\left(1 - \lambda_{ff} \int_{M+RB} dF_f(x) - \lambda_{if} \int_{M+RB} dF_i(x)\right) \times J(f,\hat{c},\theta,\hat{\theta},h') \Bigg) \, dG_f(h'|h)
\end{aligned}
$$

In this case, a formal firm receives the value of the production and pays the maximum between the unconstrained wage equation and the minimum wage. Then, in the next period, if the job is not exogenously destroyed, the worker could receive offers. In the case that the worker decides to move to a new job the vacancy is destroyed and has no continuation value. Then, the firm only receives value for the filled vacancy in the cases in which the worker decides to use the new offers to re-bargain or does not receive offers at all. In the case that the worker continues employed at the firm the next period, there is a probability that the level of human capital will be upgraded.

Following a similar logic, the value of an informal filled vacancy will be given by:

$$
\begin{aligned}
&J(i,\hat{c},\theta,\hat{\theta},h) = p(\theta_y,s) - w(i,\hat{c},\theta,\hat{\theta},h) + ... \\
&\beta \int_{S} (1-\theta_\delta) \Bigg(\lambda_{if} \int_{RB} J(i,\tilde{f},\theta,x,h') dF_f(x) + ... \\
&\lambda_{ii} \int_{RB} J(i,\tilde{i},\theta,x,h') dF_i(x) + ... \\
&\left(1 - \lambda_{if} \int_{M+RB} dF_f(x) - \lambda_{ii} \int_{M+RB} dF_i(x)\right) \times J(i,\hat{c},\theta,\hat{\theta},h') \Bigg) \, dG_i(h'|h)
\end{aligned}
$$

Where, as in the case of the value of employment, the main differences are the non-existence of the minimum wage and the probabilities of receiving an offer from the informal sector.

Next, the last group of value functions needed in order to solve the model are the surplus functions. This functions represent the total gains obtain from the match are then are going to be divided between the firm and the worker, according to the bargaining rules. Following the definition of surplus, it can be shown that the surplus function in the formal sector is given by:

$$
\begin{aligned}
&S(f,\theta,h) = p(\theta_y, s) - z + \beta \int_H (1-\theta_\delta) \left(S(f,\theta,h') + ... \right. \\
&\lambda_{ff} \int_M \Big[\max\{S(f,\theta,h') + \alpha[S(\tilde{f},x,h') - S(f,\theta,h)], \gamma(x,h')S(\tilde{f},x,h')\}... \\
&-S(f,\theta,h')\Big] \, dF_f(x) + \lambda_{fi} \int_M \Big[\alpha[S(\tilde{i},x,h') - S(f,\theta,h')]\Big] \, dF_i(x) \Big) \, dG_f(h'|h))... \\
&-\beta \int_H \Big\{ \lambda_f \int_M [\max\{\gamma(\theta,h')S(f,x,h')dF_f(x)\} + ... \\
&\lambda_i \int_M \alpha S(i,x,h')dF_i(x)] \Big\} \, dG_u(h'|h) + ... \\
&\beta \int_H U(h')dG_f(h'|h) - \beta \int_H U(h')dG_u(h'|h)
\end{aligned}
$$

It is important to mention that the surplus does not depend on the benchmark values $(\hat{c}, \hat{\theta})$. Conceptually this is due the fact that the benchmark values are used to split the surplus between the parts rather than generating it.

Finally, the surplus for the informal sector is given by:

$$
\begin{aligned}
&S(i,\theta,h) = p(\theta_y, s) - z + \beta \int_H (1-\theta_\delta) \left(S(i,\theta,h') + ... \right. \\
&\lambda_{ii} \int_M \Big[\alpha[S(\tilde{i},x,h') - S(f,\theta,h')]\Big] \, dF_i(x) + ... \\
&\lambda_{if} \int_M \Big[\max\{S(i,\theta,h') + \alpha[S(\tilde{f},x,h') - S(i,\theta,h)], \gamma(x,h')S(\tilde{f},x,h')\}... \\
&-S(f,\theta,h')\Big] \, dF_f(x)) \, dG_i(h'|h) + ... \\
&-\beta \int_H \Big\{ \lambda_f \int_M [\max\{\gamma(\theta,h')S(f,x,h')dF_f(x)\} + ... \\
&\lambda_i \int_M \alpha S(i,x,h')dF_i(x)] \Big\} \, dG_u(h'|h) + ... \\
&\beta \int_H U(h')dG_i(h'|h) - \beta \int_H U(h')dG_u(h'|h)
\end{aligned}
$$

4 Data

The period studied in this paper corresponds to the years between 2010 and 2019. This period is characterized by being relative stable in terms of unemployment, since the country was recovering from the Great Recession, and since a significant fall in the unemployment rate during 2010 and 2011, the economy kept an unemployment rate of roughly 7 percent during the rest of the decade. In terms of the composition of employment, during this period about 72 percent of workers (67

percent of labor force) had a job in the formal sector, and 28 percent of them (26 percent of labor force) had a job in informal sector.

The data used to calibrate this paper comes from two datasets. On one hand, I am using the administrative records of the unemployment insurance system. This dataset accounts for 20 percent of randomly selected workers who have a job in the formal sector, excluding the public sector. The procedure to obtain the sample consists in randomly select 20 percent of the workers in the last month of the dataset (currently July 2021), and then reconstruct their labor histories until 2002, when the unemployment insurance system started. This dataset contains IDs to identify both workers and firms, information about the labor income at the individual and firm level, gender, education, citizenship, age and region and economic sector. An additional factor to consider is that individuals will pay contributions to the unemployment insurance for any formal job they have. Then, individuals with two formal jobs will appear twice a month in the administrative records. To deal with this situation, I will just consider the main employment in the analysis, where the main employment is considered to be the one with the highest wage and other criteria. The specific procedure to determine the main employment is detailed in the Appendix. Given that the dataset follows individuals over time, it is possible to determine employment spells in the formal sector. Once the data is structured as a panel following the procedure detailed in the Appendix, it will contain approximately 147 million of observations.

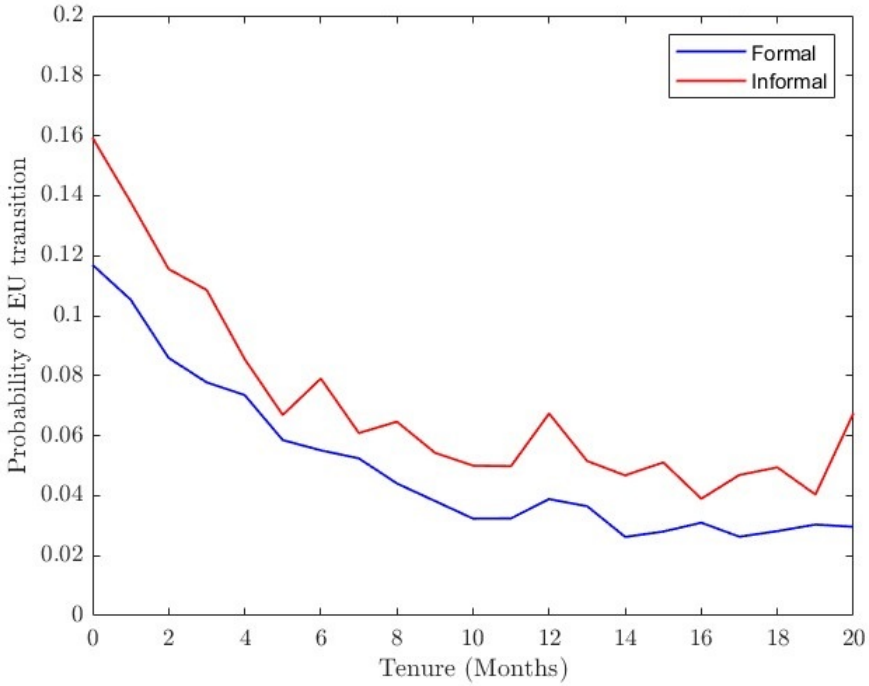
Once relevant assumption I will make is that once workers are not employed in the formal sector they are unemployed, and not employed in the informal sector. This assumption will be useful to compute the loss of human capital while unemployed and it is reasonable to make, since the transition rates from the formal to the informal sector are small, as I will show later in the moment section.

Regarding the informal sector, I will use survey panel data from the employment survey. This survey follows households over six quarters and collects information about employment status, age, gender, education, tenure on the current job, region, economic sector and occupation. Although I cannot reconstruct the labor histories of the individuals participating in the survey, I will have enough data to construct their history since they arrived to the current firm. Regarding income, I will also use the supplementary income survey, which is a complement for the employment survey that is collected during the last quarter of the year and has information about different measures of labor income. In particular, I will focus exclusively on the main employment, to make consistent this analysis with the one for the formal sector. This procedure will lead to roughly 1.9 million observations.

Given the survey data it is possible to compute several moments for both sectors, as it will

detailed in the next section. However, it is interesting to highlight a couple of facts regarding the job ladder component present in both sectors and that justifies the model chosen to study this component. The first is shown in Figure 1, where it is possible to see the evolution of the unemployment risk in both sectors as tenure increases. At the beginning both sectors display high destruction rates, of roughly 12 and 16 percent for the formal and the informal sector respectively. Then, as tenure on the job increases the destruction rate is decreasing. By the time workers reach the year of tenure on the job the destruction rates seem to be stabilized around 3.5 and 5 percent for the formal and informal sector, respectively.

Figure 1: Employment to unemployment transitions by tenure and sector (2010-2019)

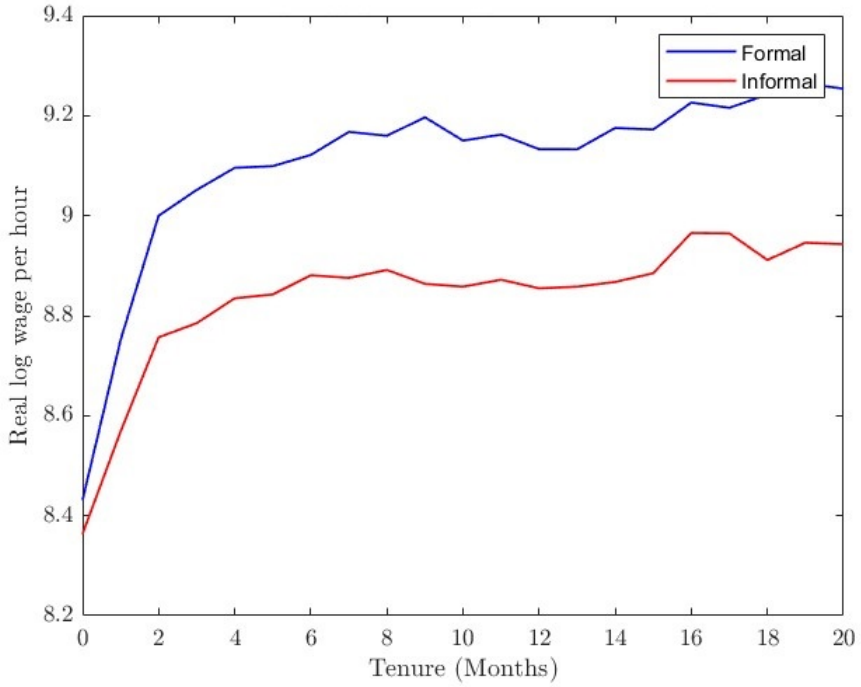


Source: Data from ENE surveys between 2010 and 2019.

Regarding the changes in income, Figure 2 shows how the wage increases with tenure in both sectors. Here the figure shows that although a job could start with relative similar wages in both sectors, and that both sectors give a relevant increase in wages furing the first three months of tenure, the increase in the formal sector is more substantial than the one observed in the informal sector. Also, while the informal sector tends to keep the wage constant during the rest of the year, we continue observing wage increases in the formal sector.

Then, we can confirm the intuition that the formal sector in Chile offers safer and more productive jobs than the informal sector.

Figure 2: Evolution of real log wage per hour by tenure and sector (2010-2019)



Source: Data from ESI surveys between 2010 and 2019.

5 Parameters and Moments

Regarding the parameters and moments to calibrate the model, I will calibrate 20 parameters using 26 moments. The first parameters to calibrate will be the arrival probability of job offers from the formal and informal sector to those workers who are unemployed, represented by λ_f and λ_i. The moment used to calibrate these parameters will be the transition rates from unemployment to each sector. These transition rates will be computed using the survey data.

Next, I will calibrate the arrival of job offers for those workers already employed in both sectors. The parameters associated with this are $\lambda_{ff}, \lambda_{fi}, \lambda_{if}$ and λ_{ii}. The moments used to calibrate these parameters will be the employment to employment transition rates between and inside the formal and informal sectors. These transition rates will be computed using the survey data.

Next, the destruction rates of the firms, associated with the parameter θ_δ will be obtained from a Beta distribution with parameters $(\eta_\delta, \mu_\delta)$. The first shape parameter, η_δ, will be obtained through computing the average rate of job loss in each sector. The second shape parameter, μ_δ will be computed to adjust the evolution of the decay in the destruction rate of jobs in each sector while tenure increases. To obtain this moment, I will follow the procedure of Jarosch (2023), and run the following regression:

$$I_{it}^{EU} = \alpha_0 + \sum_{\tau=1}^{\tau_{max}} \beta_\tau D_{it}^{\tau} + X_{it} + \varepsilon_{it}$$

Where I_{it}^{EU} is a binary variable indicating whether the worker i did a transition to unemployment in the period t. The variable D_{it}^{τ} is a binary variable indicating whether the worker has been employed in the same firm for D consecutive quarters. Then the coefficients β_τ indicate how the tenure on the job decreases the destruction rate that is faced by the workers. Matrix X contains a set of control variables, including gender dummies, month and year fixed effects, age group dummies for (16-24, 25-34, 35-44, 45-54, and 55-64), education categories, and gender interacted with those categories. Then I will compute the average of the β_τ coefficients for the first, second, fifth and tenth year of tenure. Finally, the moments used to calibrate μ_δ will be the differences between the averages of the last three groups and the first one:

$$\frac{1}{4}\sum_{\tau=5}^{8} \hat{\beta}_\tau - \frac{1}{4}\sum_{\tau=1}^{4} \hat{\beta}_\tau$$
$$\frac{1}{4}\sum_{\tau=17}^{20} \hat{\beta}_\tau - \frac{1}{4}\sum_{\tau=1}^{4} \hat{\beta}_\tau$$
$$\frac{1}{4}\sum_{\tau=37}^{40} \hat{\beta}_\tau - \frac{1}{4}\sum_{\tau=1}^{4} \hat{\beta}_\tau$$

Then, the pairs $(\eta_{\delta,f}, \mu_{\delta,f})$ and $(\eta_{\delta,i}, \mu_{\delta,i})$ will be identified.

Next, the destruction rates of the firms, associated with the parameter θ_δ will be obtained from a Beta distribution for each sector with parameters (η_y, μ_y). These parameters, together with the baseline productivity $\underline{p}$ and the bargaining power α will be identified through the use of the following moments. First, I will compute the residualized wages from the following regression:

$$w_{it} = \rho_0 + \rho_1 x_i + \rho_2 T_{it} + e_{it}$$

Where w_{it} are the log wages, x_i is a vector of individual fixed effects, and T_i is matrix containing year fixed effects. Once I have the residualized wages, I will compute the difference between the 90th percentile and the median $(w_{90} - w_{50})$, and the median and the 10th percentile $(w_{50} - w_{10})$ for each sector. Then, I will compute wage growth in annual terms and the wage gap for those entering the market. Specifically, the wage gap will be computed following this expression:

$$\mathrm{G}_c = 1 - \frac{\overline{w}_c^0}{\overline{w}_c}$$

Where $\overline{w}_c^0$ is the average wage for those starting a job after unemployment in the sector c, and $\overline{w}_c$ is the average wage in that sector.

Then,for the process to update human capital. I will assume that the underlying function is equivalent to a Markow process, in which while employed the human capital will be upgraded with probability ψ_c and lost with probability ψ_u. For the loss of human capital while unemployed, I will run the following regression:

$$w_{it}^0 = \alpha_0 + \gamma_1 \tau_{it}^u + \zeta_1 \overline{w}_i + \varepsilon_{it}$$

Where w_{it}^0 is the log wage after an unemployment spell, τ_{it} are the months of duration of the unemployment spell, and $\overline{w}$ is the average log wage of the worker. Then the parameter $\hat{\gamma}_1$ relates to the parameter ψ_u.

For the accumulation of human capital, I will run the following regression:

$$w_{it}^t = \alpha_0 + \gamma_2 \tau_{it}^t + \zeta_2 w_{it} + \varepsilon_{it}$$

Where w_{it}^t is the log wage after t periods of continued tenure, τ^t is measuring those months, and w_{it} is the wage at the first period of employment in that firm. Then the measure associated with γ_2 identifies the component ψ_c for both sectors.

6 Solution and calibration

To solve the model, I will make some additional assumptions. First, I will assume that there are only 5 types of productivity and 5 types of destruction rate in each sector. So I will discretize the Beta distributions. Also, I will assume that there are only 5 levels of human capital.

Given this, I will solve the model through value function iteration. In this case, solving the model means to find the values of the surplus of firms and wages for every possible combination of current and benchmark firm. However, the fact that the model for the formal sector considers the existence of a minimum wage, implies to understand the values of the vector $\gamma(\theta, h)$.

In order to solve the model, the surpluses in both sector must be solved simultaneously. Also, given the interdependence within sectors, the minimum wage in the formal sector will affect the informal firms which are similar to those formal firms for which the minimum wage is binding. Then, it is necessary to guess how binding is the minimum wage across formal firms in order to start solving the problem. Given this, I propose the following algorithm:

1.1 Guess $\gamma(\theta, h)$

2.1 Guess $S_f(\theta, h)$

3.1 Guess $S_i(\theta, h)$

3.2 Compute $U(h)$

3.3 $S_i(\theta, h) = \max\{S_i(\theta, h), 0\}$

3.4 Check and update $S_i(\theta, h)$ until convergence.

2.2 Compute $w(f, \hat{\tau}, \theta, \hat{\theta}, h)$ using $J(\cdot)$

2.3 Update $\gamma(\theta, h) = \max(\max(Aux(f, :, \theta, :, h)))$

2.4 $S_f(\theta, h) = \max\{S_f(\theta, h), 0\}$

2.5 $S_f(\theta, h) = S_f(\theta, h) \times (\gamma(\theta, h) \leq 1)$

2.6 Check and update $S_f(\theta, h)$ until convergence.

1.2 Check and update $\gamma(\theta, h)$ until convergence.

Finally, it is important to allow for some margin of error in the movement across firms. Since the values of the surplus are obtained through value function iteration, and there is a link between both sectors, a great precision is needed in order to guarantee that there will be no mistakes in the changes across firms. To avoid this, I request an additional 0.01 points of surplus to move across jobs.

7 Results

Once the model is solved, I simulate the model during 420 months (representing 35 years) for 10.000 workers. This workers will start unemployed and with the lowest levels of human capital, and will start receiving offers and taking decisions about the employment. Once the model is simulated, I can compute the moments running the same kind of procedure done to actual data to compute the target values. Finally, I use a non-linear solver to find the set of parameters that minimize the loss function between the real moments and the simulated ones. In order to simulate the model with a minimum wage, the minimum wage is normalized.

The results of this procedure can be seen in Table 1. First of all, it is important to mention that the overall calibration has a good fit. In general terms, the fit is very good for the informal sector, while it has some differences with the formal one.

Once the model is calibrated, we can compute the value of a formal job relative to an informal one. There are several ways in which this procedure can be done. A first intuition could be work

Table 1: Parameters and moments used to calibrate model

Moment	Target	Model	Parameter
Job finding rate - Formal	9.3%	9.8%	$\lambda_f = 0.100$
Job finding rate - Informal	10.0%	12.2%	$\lambda_f = 0.147$
E-E Transitions - FF	3.2%	0.3%	$\lambda_{ff} = 0.014$
E-E Transitions - FI	0.7%	0.4%	$\lambda_{fi} = 0.095$
E-E Transitions - IF	1.1%	0.7%	$\lambda_{if} = 0.041$
E-E Transitions - II	2.9%	0.3%	$\lambda_{ii} = 0.042$
Mean job loss - Formal	0.9%	1.5%	$\eta_{\delta,f} = 0.724$
Mean job loss - Informal	1.4%	2.5%	$\eta_{\delta,f} = 1.601$
Decay destruction - Formal (2 years)	-0.7%	-0.9%	$\mu_{\delta,f} = 0.735$
Decay destruction - Formal (5 years)	-1.2%	-1.9%	
Decay destruction - Formal (10 years)	-1.4%	-2.4%	
Decay destruction - Informal (2 years)	-0.8%	-0.6%	$\mu_{\delta,i} = 1.985$
Decay destruction - Informal (5 years)	-1.3%	-1.2%	
Decay destruction - Informal (10 years)	-1.4%	1.3%	
$w_{90} - w_{50}$ - Formal	0.620	0.485	$\eta_{y,f} = 0.568$
$w_{50} - w_{10}$ - Formal	0.841	0.508	$\mu_{y,f} = 0.224$
$w_{90} - w_{50}$ - Informal	0.515	0.497	$\eta_{y,i} = 0.067$
$w_{50} - w_{10}$ - Informal	0.454	0.441	$\mu_{y,f} = 0.317$
Wage growth - Formal	6.7%	9.1%	$\underline{p}_f = 1.601$
Wage growth - Informal	10.0%	11.7%	$\underline{p}_i = 1.000$
Wage gap - Formal	0.233	0.285	$\alpha = 0.5$
Wage gap - Informal	0.291	0.307	
Human capital acc - Formal	0.32%	0.32%	$\psi_f = 0.149$
Human capital acc - Informal	0.20%	0.23%	$\psi_i = 0.026$
Human capital destruction	-0.3%	-0.5%	$\psi_u = 0.219$
Employment - Formal	63.5%	73.6%	
Employment - Informal	29.5%	20.4%	

with the employment values, however, this process could be difficult to measure correctly, since the value functions of employment require the use of a benchmark. Given this, and precisely to avoid the use of benchmarks, I will compare the value of the surpluses across jobs.

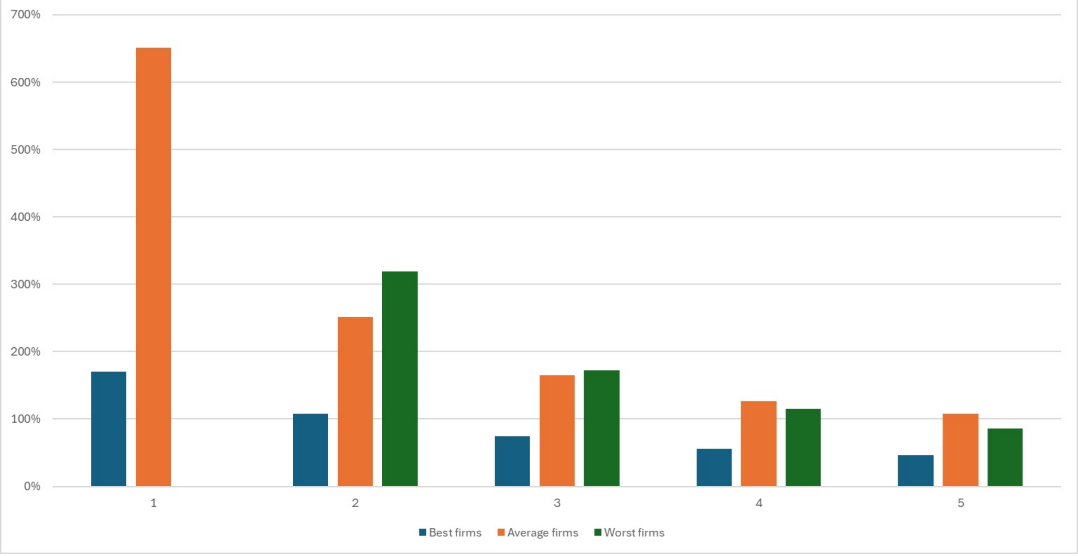
Now, which jobs should be considered? Since there are 5 types of productivity and destruction rates, each sector has 25 different types of firms. If we account for the fact that there are also 5 levels of human capital, that means that there is a total of 125 possible surpluses, and therefore 250 if we account the two sectors. To account the value of a formal job, the entire distribution of firms and levels of human capital should be considered. However, just in order to simply the exposition of the results, I will compare just 15 types of firms between the two sectors. I will use the worst firm type both in productivity and destruction rate, and see how the value of formality changes over the five types of human capital. Then, I will compute the same values but for a

middle productivity and destruction rate firm. Finally, I will repeat the calculation for the best type of firms available.

The results of this evaluation can be seen in Figure 3. In general, it can be seen that formalizing a job increases the value received. There are several reasons that explain this change. First of all, keeping productivity and destruction rate constant, the formal sector has better probabilities of receiving offers than the informal sector. Of course, the sector presents better productivity and smaller destruction rates than the informal sector, and that also contributes to improve the value of formal firms.

However, one interesting result is that when we are comparing formal and informal firms at the top of the distribution the gains are significantly smaller than with firms in the middle of the distribution or the bottom. Another interesting observation is that the value of formalizing a job decreases with the levels of human capital, implying that those workers with low levels of human capital are who benefit the most of increasing the formalization levels. The logic behind this finding is that the formal sector provides safer jobs, a better option for on-the-job search, and higher accumulation rates for human capital, characteristics that are relevant for workers who are just starting they labor career.

Figure 3: Gains of formalization over different levels of human capital and firm types



Source: Own source. These surpluses are obtained through solve the model.

8 Consequences of job loss

[PENDING]

9 Changes in the minimum wage

[PENDING]

10 Discussion

[PENDING]

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