Insights on the theoretical causes of labour informality: the indivisibility of hours

Perspectivas sobre las causas teóricas de la informalidad laboral: la indivisibilidad de las horas

QUINTERO-ROJAS, Coralia A.†* & MÉNARD, Sébastien

Universidad de Guanajuato, Economics & Finance, Mexico.
GAINS, Le Mans University, France.

ID 1st Author: *Carolia A., Quintero-Rojas* / **ORC ID:** 0000-0003-3994-1775, CVU CONACYT ID: 36503

ID 1st Coauthor: *Sébastien, Ménard* / **ORC ID:** 0000-0003-4951-8364

Abstract

Achieving decent work for all is essential for promoting sustainable and inclusive growth and development. However, in the world prevails a marked lack of decent work, higher unemployment, and persistent inequalities; and this panorama has been exacerbated by the global effects of the pandemic caused by COVID – 19. The gap from decent work is especially pronounced in the informal economy, which affects roughly 61% of the global employed population; moreover, it implies large social and economic costs, affecting income, occupational health and safety, productivity, and welfare. In this context, our goal is to develop a suitable theoretical framework to explore the causes of informal employment, based on the wage posting approach pioneered by Burdett and Mortensen (1998). Our note adds to this line of research by considering other general characteristic of the formal sector as a cause of informality, such as the rigid contracts regarding wages and working time. This hypothesis seems pertinent given that informality affects high-skilled workers too.

Resumen

Lograr un trabajo decente para todos es esencial para promover un crecimiento y desarrollo sostenibles e inclusivos. Sin embargo, en el mundo prevalece una marcada falta de trabajo decente, mayor desempleo y desigualdades persistentes; y este panorama se ha visto agravado por los efectos globales de la pandemia provocada por COVID - 19. La falta de trabajo decente es especialmente pronunciada en la economía informal, misma que afecta aproximadamente al 61% de la población ocupada mundial; además de implicar grandes costos sociales y económicos, al afectar el ingreso, la salud y seguridad ocupacional, la productividad y el bienestar. En este contexto, nuestro objetivo es desarrollar un marco teórico adecuado para explorar las causas del empleo informal, el cual se basa en el modelo de ofertas salariales de Burdett y Mortensen (1998). Nuestra nota se suma a esta línea de investigación al considerar otra característica general del sector formal como causa de la informalidad, como es la rigidez de los contratos respecto de los salarios y la jornada laboral. Esta hipótesis parece pertinente dado que la informalidad también afecta a los trabajadores altamente calificados.

Wage dispersion, Informality, Indivisible hours

Dispersión salarial, Informalidad, Indivisibilidad de las horas de trabajo

---

* Correspondence to Author (Email: coralia@ugto.mx)
† Researcher contributing as first author.

Introduction

The Global Commission on the Future of Work has submitted and independent report on how to achieve a future of work that provides decent and sustainable work opportunities for all to the Centenary session of the International Labor Conference in June 2019. The main points were included in the Centennial Declaration of the ILO and focuses on three priority actions: increase investment in people's capacities; increase investment in labor institutions; and increase investment in decent and sustainable work. That is, decent and quality jobs that guarantee the worker, among other fundamental rights, a fair income, safe working conditions, access to social protection and non-discrimination (Centenary Declaration of the ILO, 2019).

Achieving decent work for all is so important that it is one of the 17 Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda for Sustainable Development:

> "SDG 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all." (UN, 2015)

Furthermore, since decent work promotes sustainable development and inclusive growth, the achievement of SDG 8 would foster the achievement of the other 16 Sustainable Development Goals. However, in the world prevails a marked lack of decent work, associated with higher unemployment and persistent inequalities; and this panorama has been exacerbated by the global effects of the pandemic caused by COVID - 19. As a recent ILO report highlights, "even when people have a job, there are still significant deficiencies in the quality of jobs. This gap from decent work is especially pronounced in the informal economy, which has the highest poverty rates (ILO, 2020). According to ILO estimates, roughly 61 per cent of the global employed population earned their living in the informal economy; but informality is more prevalent in Latin America, where it represents a significant part of the economy and plays an important role in production, job creation, and income generation.

The most vulnerable categories of employment due to their propensity to informality are self-employed workers and contributing family workers who lack adequate protection (ILO, 2018). Informality.

The social and economic costs of informality are quite large. First, firms operating in the informal sector do not comply with labour market statutes and do not pay social security contributions of any sort, thereby reducing the size of the government tax base. Second, informality increases the risk of vulnerability and precariousness of workers. Finally, the informal sector is generally less productive than the formal sector since it is usually more labour-intensive sector and operates on a small-scale production with very limited access to public or private physical capital (Elgin and Erturk 2019). Thereby, informality has a strong adverse impact on income, occupational health and safety, general working conditions, productivity, and welfare.

Because labour informality has been a persistent problem, the *2015 International Labour Conference* adopted Recommendation No. 204 , which emphasizes the need to facilitate the transition of workers and economic units from the informal to the formal economy; promote the creation, preservation and sustainability of enterprises and decent jobs in the formal economy; and prevent the informalization of formal economy jobs. This consensus was also integrated into SDG 8, as discussed before.

However, to formulate effective policies for the transition to formality it is necessary to identify the causes or reasons for the existence and persistence of the informal economy. Since access to paid work is not a guarantee of decent work or an adequate income, workers are induced to accept informal, low-paid jobs without access to social protection or labour rights. Informality primarily affects own-account workers and contributing family workers in low- and middle-income countries, but salaried workers are also frequently subject to uncertain contracts, low income, and informality. Furthermore, informal work is often characterized by longer work shifts.

In this context, the goal of this paper is to develop a suitable theoretical framework to explore the effects of the indivisibility of working hours as a cause of informal employment. The model builds on the wage posting approach pioneered by Burdett and Mortensen (1998). The labour market is composed by two sectors: (1) An informal competitive sector in which workers are paid their marginal productivity and choose the hours they want devote to informal activities. (2) A formal sector with search frictions and rigid contracts regarding working hours, so the labour journey has a fixed length. Moreover, as in the Burdett-Mortensen model, firms post wage offers that can be accepted by both unemployed and on-the-job workers. Thereby, there is an endogenous distribution of wage offers, and this is different to the distribution of actually paid wages.

Our main intuition is that the rigid contracts in the formal sector are related to informality, and to the observed wage distribution in the formal sector, where similar working journeys are often paid at different wages. This wage dispersion influences the decision to work or not in the informal sector. That is, when the wages paid in the formal sector are very low, workers prefer to work in the informal sector, where their marginal productivity is better valued. Another option would be to accept the formal job even when the pay is very low and supplement their income by working a few hours in the informal sector. Therefore, low wages can be an important factor in understanding informality.

Two previous contributions on informality based on this framework are Zenou (2008) and Meghir *et al.* (2015). Zenou (2008) evaluates the consequences of different policies on workers' labour-market outcomes in the formal and informal sectors; he assumes free mobility between the two sectors; a competitive informal sector; and search frictions in the formal sector. Perhaps, the main result is that under some condition of the parameters a decrease of these policy variables can lead to higher formal employment but also higher unemployment, because of the immigration of workers from the informal sector. Meghir *et.al.* also stress the fact that for low skilled workers, in countries like Mexico, transitions between formal and informal sector seem to be equally probable in both directions.

So, they built a model economy with search frictions and heterogeneous firms in their productivity, but identical low skill workers that may receive offers either from formal or informal firms. Among other results, the authors find that informality has implications for the wage distribution both within and between sectors, so that equilibrium wages are on average higher in the formal sector (similarly to Burdett and Mortensen 1998).

A previous contribution on informality based on this framework is Zenou (2008), who evaluates the consequences of different policies on workers' labour-market outcomes in the formal and informal sectors; he assumes free mobility between the two sectors, a competitive informal sector, and search frictions in the formal sector. The author shows that under some condition of the parameters, a decrease of the policy variables can lead to higher formal employment but also higher unemployment, because of the immigration of workers from the informal sector. Meghir *et al*. (2015) also stress the fact that for low skilled workers, in countries like Mexico, transitions between formal and informal sector seem to be equally probable in both directions. So, they built a model economy with search frictions and heterogeneous firms in their productivity, but identical low skill workers that may receive offers either from formal or informal firms. Among other results, the authors find that informality has implications for the wage distribution both within and between sectors, so that equilibrium wages are on average higher in the formal sector (as in the Burdett – Mortensen framework).

Our note adds to this line of research by considering another general characteristic of the formal sector as a cause of informality, namely the rigid contracts regarding wages and working time. This hypothesis seems pertinent given that informality affects high-skilled workers too. The remaining is organized as follows. In next section we present and develop the elements of the model economy. Next, we show the main result of the paper, namely, the steady state equilibrium of the model, and discuss the possible strategy to simulate and evaluate the model implications. Finally, we discuss the next stage of this research agenda.

Article

The model economy

In this theoretical note, we develop a model economy that will be useful to explore the effects of several labour market policies for a wide range of economies. So, in this section we present the elements of model and discuss their main features.

The economy is composed of two sectors: a frictionless informal sector in which workers choose the fraction of time they devote to work; and a formal sector with search frictions and rigid working hours contracts. In other words, the extent of coordination failures in the formal sector give rise to search frictions; conversely, since in the informal sector most firms are family related, coordination failures and thus search frictions should not be too large.[2] Time is continuous and agents discount future at rate $r > 0$.

Labour market flows

The work force is normalized to 1. It is composed by the unemployed workers, u, the formal workers, e_f, and the informal workers, e_i. The unemployed seek for a job in the formal sector in a full-time basis, allocating a fraction of time z. In return, they receive an unemployment allowance b. Formal sector employees work a fixed amount of time z at the hourly wage rate w. Finally, informal workers choose the time h they devote working in the informal sector and are paid their marginal productivity.

Formal and informal workers may receive job offers in the formal sector even if they are not engaged in search activities. Following Postel-Vinay and Robien (2002), we normalize the job search efficiency of the unemployed to 1 while the efficiency of employed workers, μ is assumed to be lower since they must wait for the arrival of job opportunities; then, μ > 1. Thereby, the arrival rate of job offers is higher for unemployed than for employed workers: $p_u > p_e$.

The contacts between unemployed workers or on-the-job workers and firms is governed by the matching function $M(u,v)$, which depends on the number of unemployed workers, the number of employed workers in the economy (formal and informal), and vacancies, v, as follows:

$$M(u,v) = m[u + \mu(1-u)]^{1-\eta} v^{\eta} \qquad (1)$$

The matching function is increasing and concave on its two arguments. $\mu\epsilon(0,1)$ represents the elasticity of the matching function and m is a parameter reflecting the efficiency of the matching process. This function can be expressed in terms of the arrival rates as:

$$M(u,v) = p_u u + p_e(1-u) \qquad (2)$$
with $p_e = \mu p_u = \mu m \left(\frac{v}{u+\mu(1-u)}\right)^{\eta}$.

Formal sector jobs are destroyed at the exogenous rate $\delta\epsilon(0,1)$. The instantaneous utility function of the agents, $\Gamma(c,l)$, depends on consumption, c, and leisure, l. Agents are risk adverse and do not have access to financial markets to smooth their income over time, so they consume all their income each period. We consider the following utility function, where σ is the coefficient of risk aversion:

$$\Gamma(c,l) = \frac{\left(c^{\alpha} l^{1-\alpha}\right)^{1-\sigma}}{1-\sigma} \qquad (3)$$

The informal sector

We assume that even if workers are ex-ante identical, they do not have the same opportunities, and so the same productive capacities in the informal sector. This heterogeneity can be explained by diverse factors, such as the different networks their belong to, their family situation or their geographic location, among other factors. Then, a worker with a productive capacity x produces $xY(h)$, where $Y(h)$ is the production function in the informal sector.[3] Remark that informal sector jobs do not require investment in specific human capital, so they are on average less productive than formal sector jobs.

---

[2] In developing countries such as Mexico, self-employment and workers employed in family enterprise are prevalent in the informal sector. According to Maloney (1999), self-employment represents the bulk of informality in many economies, so that the informal sector behaves as an unregulated micro-entrepreneurial sector.

[3] The productive capacities x follow an exogenous distribution $L(x)$.

Available time is normalized to unity. Workers in the informal sector do not actively seek employment in the formal sector, so that they have the same probability of receiving a job offer on the formal market as the formal sector employees; that is, p_e. However, unlike the unemployed, they may be full-time workers in the informal market. By normalizing the available time to 1, we can find the optimal supply of labour in the informal sector by solving:

$$max\ \Gamma(c, 1 - h)\ subject\ to\ c = xY(h) \qquad (4)$$

This implies:

$$h_i = 1 - \frac{1-\alpha}{\alpha} \frac{Y(h_i)}{Y'(h_i)} \qquad (5)$$

$$c_i = xY(h_i) \qquad (6)$$

Then, the Bellman equation for an informal sector worker is:

$$rI(x) = \Gamma(xY(h_i), 1 - h_i) + p_e \int_{\widetilde{w_i}(x)}^{\bar{w}} [W(w', x) - I(x)dF(w')] \qquad (7)$$

In last expression, $\widetilde{w_i}(x)$ is the reservation wage of a formal worker with productive capacity x. That is, the job offer is accepted for wages higher than this value, which is given by $W(\widetilde{w_i}(x), x) = I(x)$.

The formal sector

All formal sector workers work the same fixed amount of time (formal jobs are full-time) and are ex-ante identical. Search friction prevents the instantaneous meeting of workers and firms, causing unemployment and recruitment costs for firms, so that vacant jobs are expensive. To reduce their recruiting costs, firms may choose to post higher salaries than their rivals. This strategic behaviour explains the existence of a non-degenerated distribution of offered wages, even if workers are identical ex-ante. Unemployed workers are full-time job seekers in the formal sector, and all have the same productive capacities in this sector. However, they can supplement their income by working an additional time h in the informal market, where their productive capacities are heterogeneous. Given the full-time constraint, z, faced by employed and unemployed workers in the formal sector, the optimal job offer in the formal market is given by:

$$max\Gamma(c, l - z - h)\ subject\ to: c = \omega + xY(h) \qquad (8)$$

Where ω represents the formal sector income, which is b for the unemployed workers, and w for the employed workers. It follows that:

$$h_\omega = 1 - z - \frac{1-\alpha}{\alpha} \left[\frac{\omega}{xY'(h_\omega)} + \frac{Y(h_\omega)}{Y'(h_\omega)} \right] \qquad (9)$$

In case of refusal, the unemployed worker is sanctioned, so the unemployment benefit drops from b to $\underline{b}$. This means that the value of the sanction, θ, can be written as:

$$\theta = \Gamma(c_b, 1 - z - h_b) - \Gamma(c_{\underline{b}}, 1 - z - h_{\underline{b}}) \qquad (10)$$

The Bellman equation for a formal worker earning a wage w is written as:

$$rW(w, x) = \Gamma(c_w, 1 - z - h_w) + p_e \int_w^{\bar{w}} [W(w', x) - W(w, x)]dF(w') + \delta [\max [U(x)I(x)] - W(w, x)] \qquad (11)$$

Similarly, the Bellman equation of an unemployed worked with productive capacity x is written as:

$$rU(x) = \Gamma(c_b, 1 - z - h_b) + p_u \int_{\widetilde{w}(x)}^{\bar{w}} [W(w', x) - U(x)]dF(w') - p_u F(\widetilde{w}(x))\theta \qquad (12)$$

Where the probability of refusing a formal job is $p_u F(\widetilde{w}(x))$. Thus, for each productive capacity x, the reservation wage is such that $W(\widetilde{w}(x), x) = U(x) - \theta$. Then, the reservation wage is given by:

$$\Gamma(c_{\widetilde{w}(x)}, 1 - z - h_{\widetilde{w}(x)}) = \Gamma(c_b, 1 - z - h_b) + (p_u - p_e) \int_{\widetilde{w}(x)}^{\bar{w}} [W(w', x) - W(\widetilde{w}(x), x)]dF(w') - [p_u + r + \delta]\theta \qquad (13)$$

Labour market flows

In the formal sector, on-the-job workers accept all job offer with a wage pay above their current wage; unemployed workers accept all wages higher than the reservation wage $\widetilde{w}(x)$; and informal sector workers accept a formal job if the wage is higher than $\widetilde{w_i}(x)$. Given $p_e < p_u$, the reservation wage is necessarily higher than b.

Let δ be the exogenous job destruction rate; $F(w)$ the distribution function of offered wages; $l(x)$ the mass of workers with productive capacity x; $e(x)$, the mass of formal employed workers with capacity x; and $u(x)$ the mass of unemployed workers with capacity x. There are two cases at the steady state:

- For $x < \tilde{x}$ the laid-off formal workers prefer formal unemployment than informal employment since their job opportunities in the informal sector are too weak. Then, the outflow of unemployment is $p_u\left(1 - F(\tilde{w}(x))\right)u(x)$; and the inflow to unemployment is $\delta(l(x) - u(x))$. Since no one chooses to work exclusively in the informal sector, $e(x) = 0$. Consequently, the mass of workers for $x < \tilde{x}$ is:

$$\frac{u(x)}{l(x)} = \frac{\delta}{\delta + p_u(1 - F(\tilde{w}(x)))} \tag{14}$$

- For $x > \tilde{x}$, all laid off workers decide to switch to the informal sector because they have high productive capacities that are better valued in that sector. Then, the exit rate from informal work is $p_e\left(1 - F(\widetilde{w_i}(x))\right)e(x)$ and the entry flow into informal work is $\delta(l(x) - e(x))$. Since in this case nobody chooses formal unemployment, then $u(x) = 0$. Consequently, the mass of informal workers for $x > \tilde{x}$ is:

$$\frac{e(x)}{l(x)} = \frac{\delta}{\delta + p_e(1 - F(\widetilde{w_i}(x)))} \tag{15}$$

From this, we compute total unemployment, u, and total employment, e, in the formal sector as $u = \int_0^{+\infty} u(x)dx$ and $e = \int_0^{+\infty} e(x)dx$.

Let $G(w)$ be the wage distribution of occupied positions in the formal sector. Then, the mass of workers whose salary is lower than w is given by $G(w)(1 - u - e_i)$. At the steady state, the outflow of workers whose wage is lower than w must be equal to the entering flow:

$$\left[\delta + p_e(1 - F(w))\right]G(w)(1 - u - e) =$$
$$p_u \int_{\tilde{w}(0)}^{w} [F(w) - F(z)]u(x(z))dz +$$
$$p_e \int_{\widetilde{w_i}(0)}^{w} [F(w) - F(z_i)]e(x(z_i))dz_i \tag{16}$$

In last equation, $x(z)$ is the productive capacity of unemployed workers with reservation wage of z, and $x(z_i)$ is the productive capacity of informal worker with reservation wage of z_i. From this, the wage distribution of occupied positions is given by:

$$G(w) = \frac{p_u \int_{\tilde{w}(0)}^{w}[F(w)-F(z)]u(x(z))dz + p_e\int_{\widetilde{w_i}(0)}^{w}[F(w)-F(z_i)]e(x(z_i))dz_i}{[\delta + p_e(1 - F(w))](1 - u - e)} \tag{17}$$

The strategy to solve the model and deducing the theoretical distributions $F(w)$ and $G(w)$ is discussed in section 2.2.

Specific capital matching and wage posting

Each firm has a single position. Following Burdett and Mortensen (1998), we assume that firms post wages that can be accepted or rejected by both unemployed workers and employed workers of both sectors. This posting strategy implies the existence of a non-degenerate wage distribution, even though workers were ex-ante identical. In fact, low-wage workers tend to quickly leave their jobs for better-paid ones. Moreover, the higher the remuneration, the lower the job turnover rate. So, companies face a trade-off between wages and recruitment costs.

Each firm posts a wage w and chooses the investment in specific human capital, $k(w)$, which cannot be transferred to other firms. Once hired, the worker produces $Q(k)$, with $Q(k)$ an increasing and concave function representing production of the post and generates a stream of income $J(w, k)$. Then, the present value of an occupied position is given by the following Bellman equation:

$$rJ(w, k) = Q(k) - w + [p_e(1 - F(w)) + \delta](V - J(w, k)) \tag{18}$$

Where r is the interest rate, V is the value of a vacant position, and the probability of separation for the worker is $p_e(1 - F(w)) + \delta$. Note that given that working time in the formal sector is rigid, production depends only on the firm's investment in specific human capital. This investment implies a higher average productivity in the formal sector than in the informal sector.

The free entry condition implies that wages and vacancies are such that $V = 0$. Let c be the cost of posting a vacancy. The present value of a vacancy is given by the Bellman equation:

$$rV = \max_{(w,k)\geq 0} \left\{ \left[\frac{p_e}{v}(1-u-e)G(w) + \frac{p_u}{v}\int_{\tilde{w}(0)}^{\infty} u(x(z))dz + \frac{p_e}{v}\int_{\tilde{w}_i(0)}^{\infty} e(x(z_i))dz_i \right] (J(w,k)-k-V) - c \right\} \quad (19)$$

In this expression, the probability that the vacancy will be filled by an unemployed worker is $\frac{p_u}{v}\int_{\tilde{w}(0)}^{w} u(x(z))dz$; the probability that the position will be filled by a formal worker is $\frac{p_e}{v}(1-u-e)G(w)$; and the probability that the position will be filled by an informal worker is $\frac{p_e}{v}\int_{\tilde{w}_i(0)}^{w} e(x(z_i))dz_i$.

The arbitrage condition implies that each wage w must provide the same profit to the firm. Then, the free entry condition together with equations (18) and (19) give:

$$cv = \max_{(w,k)\geq 0} \left\{ \Omega(w) \left[\frac{Q(k(w))-w}{r+p_e(1-F(w))+\delta} - k \right] \right\} \quad (20)$$

$\Omega(w)$ is the job-filling probability for a post paying w, that is:

$$\Omega(w) = p_e(1-u-e)G(w) + p_u\int_{\tilde{w}(0)}^{w} u(x(z))dz + p_e\int_{\tilde{w}_i(0)}^{w} e(x(z_i))dz_i \quad (21)$$

Using the expressions for the mass of unemployed workers with capacity x (equation 14) and the distribution of occupied jobs (equation 17), we obtain:

$$\Omega(w) = \frac{1}{\delta+p_e(1-F(w))} \left[p_u\int_{\tilde{w}(0)}^{w} \delta + p_e(1-F(z)) \right] u(x(z))dz + p_e\int_{\tilde{w}_i(0)}^{w} [\delta + p_e(1-F(z_i))] e(x(z_i))dz_i \quad (22)$$

The optimal investment for a wage w is given by the maximization of equation (20):

$$k(w) = argmax\{Q(k(w)) - w - (r + p_e(1 - F(w)) + \delta)k\} \quad (23)$$

Thus, the probability for a worker to find a better paid job decreases with the wage for an occupied position, w. Thereby, firms that post higher wages invest more in specific human capital; and this investment is profitable over a long period. That is why poorly paid jobs are less productive although formal workers are ex-ante identical. Equation (22) leads to:

$$k'(w) = -\frac{p_e F'(w)}{Q''(k)} > 0 \quad (24)$$

Results

The main goal of this paper has been achieved by developing a useful model economy to explore the effects of rigid contracts and other labour market policies on key variables such unemployment, employment, productivity, real wages and the size of the informal sector. As a main result from this exercise, in this section we compute the equilibrium of the model and discuss the resolution and simulation strategy that will be implement in a future research to evaluate the model implications for a wide range of economies.

The Steady State Equilibrium

At the stationary equilibrium, the offered-wages distribution, $F(w)$, guarantees the same expected profits for any wage w. We assume the existence of a minimum wage $\underline{w}$ such that $F(w) = 0 \; \forall \; w \leq \underline{w}$. Remark that this distribution is different from the wage distribution of occupied posts, $G(w)$. This is because the unemployed workers can refuse job offers while the formal sector employees can still accept higher wages and move to better paid jobs.

The equilibrium of this model economy is characterized by the number of vacancies, v, and the distribution F assuring that firms are indifferent between any wage w. We assume that the minimum bound for this wage distribution is given by $\underline{w}$. Using equation (23) we can find the minimun level of capital by setting $F(\underline{w})$. This yield:

$$Q'(\underline{k}) = r + p_e + \delta \quad (25)$$

From this, we deduce the optimal vacancy rate:

$$cv = \Omega(\underline{w}) \left[\frac{Q(\underline{k})-\underline{w}-\underline{k}(r+p_e+\delta)}{r+p_e+\delta} \right] \quad (26)$$

Mortensen (2000) has shown that $v = 0$ is an unstable solution. In our model, there exists a stable solution provided that the minimun wage is accepted by at least one unemployed worker, so that $\tilde{w}(0) < \underline{w}$.

Then, by offering higher wages, firms increase their job-filing probability and retention rates. This explains why $F(w)$ is not a degenerated distribution. There exists however a maximum borne to the distribution $\overline{w}$. We will assume that the productive capacities of informal workers are nor higher enough to get a job with salary $\overline{w}$ in the formal sector. This maximum wage implies that $F(\overline{w}) = 1$ and both unemployed and informal workers will accept that wage.

The maximun investment in specific human capital is given equation (25). Since each element in the support $[\underline{w}, \overline{w}]$ provides the same profit, the wage distribution $F(w)$ is given by

$$\Omega(\underline{w})\left[\frac{Q(\underline{k}) - \underline{w} - \underline{k}(r + p_e + \delta)}{r + p_e + \delta}\right] =$$
$$\Omega(w)\left[\frac{Q(k(w)) - w - k(r + p_e(1 - F(w)) + \delta)}{r + p_e(1 - F(w)) + \delta}\right] \quad (27)$$

Resolution and simulation

This type of models has not analytical solution. So, a standard procedure to evaluate the explanative power of the model consist of calibrating and simulating the equilibrium equations of the model. Calibration involves the comparison of model outputs with empirical data, leading to the identification of model parameter values that achieve a good fit with data. This provides the researcher a virtual space to test different policy changes. However, calibration is an issue, since while some parameters can be fixed directly from empirical data, such as the rates of unemployment and informality or the minimum wage, others have no empirical counterpart, either because they are not measured systematically or because they are theoretical abstractions; for instance, the research effort furnished by unemployed worker to find employment in the formal sector, the workers' productive capacities, or the structural parameters of the matching or consumption function.

In broad terms, to solve this model numerically, we must assume an arbitrary initial value for the reservation wages, the job vacancies, and the contact rate. From these initial guesses we can compute the value of posting a job for the minimum value of the wage ($w = \underline{w}$).

As each job offers the same expectation of profit, we can use equation (27) to solve for $f(w)$, for each w ensuring the same profits as $\underline{w}$. Once we have found $f(w)$, we can deduce $F(w)$ from equation (27). Next, we must iterate the value functions to find the reservation wages and to deduce the distribution $g(w)$. Then, we can compute a new guess for the job vacancies and the contact rate by using equations (22) and (27). We repeat this procedure until the set of values for $f(w)$, $g(w)$, the reservation wages, and the job vacancies have converged. Finally, the function $G(w)$ can be obtained from the labour flows summarized by equation (17).

Conclusions and future research agenda

The next stage in our research agenda is to calibrate and simulate the economy we have developed to assess the implications of the model for various labour market policies and for a wide range of economies. For instance, a relevant exercise would be assessing the introduction of unemployment benefits in Mexico.

In several European welfare states there exist public insurance against unemployment. Generally, this type of insurance coexists with high unemployment rates but also with a small informal sector. In contrast, in countries like Mexico there is no equivalent public coverage for unemployment, but the average unemployment rate is lower than in Central European countries, while the informal sector is very large. However, since informal employment is very important, the relatively low unemployment rate is far from indicating decent jobs, in the OIT conception of this concept. In this context, it would be interesting to analyse whether the implementation of a public unemployment insurance would favour the achievement of SDG 8 of the United Nations Agenda 2030. Likewise, in countries where public unemployment insurance already exists, and the unemployment rate is large, this economy would be useful to compare the effects on unemployment of different unemployment compensation rules.

References

Burdett, K., & Mortensen, D. T. (1998). Wage differentials, employer size, and unemployment. *International Economic Review*, 257-273.

Elgin, C., & Erturk, F. (2019). Informal economies around the world: measures, determinants, and consequences. *Eurasian Economic Review*, 221-237.

International Labour Organization. (2018). *Decent Work and the Sustainable Development Goals: A Guidebook on SDG Labour Market Indicators.* Geneva: ILO.

International Labour Organization. (2019). ILO Centenary Declaration for the Future of Work. *108th Session of the International Labour Conference.* Geneva.

International Labour Organization. (2020). *World Employment and Social Outlook: Trends 2020.* Geneva: ILO.

Maloney, W. F. (1999). Does Informality Imply Segmentation in Urban Labor Markets? Evidence from Sectoral Transitions in Mexico. *World Bank Economic Review*, 275-302.

Meghir, C., Narita, R., & Robin, J.-M. (2015). Wages and Informality in Developing Countries. *The American Economic Review*, 1509-1546.

Postel-Vinay, F., & Robin, J. M. (2002). Equilibrium wage dispersion with worker and. *Econometrica*, 2296-2350.

Zenou, Y. (2008). Job search and mobility in developing countries. Theory and policy implications. *Journal of Development Economies*, 336-355