



**Unemployment benefits in credit-constrained
informal economies**

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Thesis
M.Sc. in Economics

Universidad del Rosario
Facultad de Economía
2022

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June 2022

Abstract

This paper explores the effect of unemployment insurance (UI) on formal job search and effort allocated to a one-person informal firm. I propose a new mechanism that explores the possibility of investing the unemployment benefits in informal production. This mechanism occurs because of two main reasons. First, agents can invest their assets in a production process in the informality, shaping its profitability depending on their investment. Second, unemployment insurance can relieve consumption pressure on the unemployed's assets and decrease the burden of any liquidity constraints, so they can invest in the informal sector rather than consume them. To explore this mechanism theoretically, I develop a finite partial equilibrium model with a dual labor market and liquidity constraints. I find the Effort Allocation Effect (EAE) of the unemployment benefit on the formal job search effort and the informal job effort and present the composition of such an effect in each sector. Moreover, I show under what circumstances the UI will increase the search effort for an informal job and present the mathematical forms under which informal effort increases while the formal one decreases. I also decompose the EAE for both sectors and find that the Effort Allocation Effect in the informality is due only to a liquidity effect.

Keywords— unemployment insurance, informality, liquidity constraints

¹I gratefully acknowledge financial support from the program “Inclusión productiva y social: programas y políticas para la promoción de una economía formal, código 60185, que conforma la Alianza EFI – Economía Formal Inclusiva, bajo el Contrato de Recuperación Contingente No. FP44842-220-2018”.

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Abstract

This paper explores the effect of unemployment insurance (UI) on formal job search and effort allocated to a one-person informal firm. I propose a new mechanism that explores the possibility of investing the unemployment benefits in informal production. This mechanism occurs because of two main reasons. First, agents can invest their assets in a production process in the informality, shaping its profitability depending on their investment. Second, unemployment insurance can relieve consumption pressure on the unemployed's assets and decrease the burden of any liquidity constraints, so they can invest in the informal sector rather than consume them. To explore this mechanism theoretically, I develop a finite partial equilibrium model with a dual labor market and liquidity constraints. I find the Effort Allocation Effect (EAE) of the unemployment benefit on the formal job search effort and the informal job effort and present the composition of such an effect in each sector. Moreover, I show under what circumstances the UI will increase the search effort for an informal job and present the mathematical forms under which informal effort increases while the formal one decreases. I also decompose the EAE for both sectors and find that the Effort Allocation Effect in the informality is due only to a liquidity effect.

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Introduction

Unemployment insurance (UI) is a strategy widely used by developed countries in North America and Western Europe to insure workers during the unemployment spell³. The program consists in giving benefits to those who recently lost their jobs, during the time they remain unemployed, so people can cope with the risk it represents. It is believed that unemployment insurance not only helps people to face the shock to their incomes, but also to help them focus on finding a quality job.

The main core of Unemployment Insurance is a moral hazard problem where agents (the insured) can decide what amount of unobservable effort to put into their job search. On the other hand, the principal (the insurer: usually the government) has to decide how to deliver the benefits of the insurance so the agent has the appropriate incentives to select the level of effort as close to the optimum with perfect-information, and to move the unemployment spell to an optimal point (Shavell & Weiss, 1979; Hopenhayn & Nicolini, 1997, 2009; Cahuc & Lehmann, 2000; and Fredriksson & Holmlund, 2001).

Though unemployment insurance is widely known in the countries aforementioned, 75% of the people unemployed around the world lack any unemployment insurance protection (ILO, 2000). Following the experience of wealthy nations, many developing and less-rich countries have tried to install the same or similar schemes. In Latin America, countries like Argentina, Barbados, Brazil, Chile, Colombia, Mexico, Peru, and Uruguay have implemented analogous programs of unemployment benefits. In the particular case of Colombia, there are two coexisting programs oriented to the unemployed. They have provided a safety net for those who enter unemployment and it has been proved that the program serves as a mechanism for smoothing consumption and providing social assistance. Yet, this insurance has had unexpected collateral effects and it has been shown that informality may grow among the beneficiaries (Medina et al., 2013). Thus, one natural question arises: why can the unemployment insurance increase informality?

Multiple authors have tried to tackle informality in an unemployment insurance setting. Due to the moral hazard problem involved around UI, it may be possible that both formal and informal jobs search may be affected. Mazza (2000) explores the possibility of UI posing perverse incentives to increase the informal sector, and Camacho et al. (2014) shows that the unemployed can end up accepting lower quality jobs because of poorer job opportunities. Other authors have also argued that the unemployed agent does not only choose the amount of effort to put into their formal job search, but also how much time to dedicate

³Such a program has been applied in countries such as Austria, Belgium, Denmark, Finland, France, Germany, Iceland, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Australia, Canada, Ireland, Japan, New Zealand, the United Kingdom, and the United States (ILO, 2000).

to working in the informal sector. Thus, people use their time searching for a formal job or working in the informal sector (Cremer et al., 1995; Álvarez-Parra & Sánchez, 2009; Flórez, Flórez (2015); and Bosch, 2016), altering the cost of search effort (Bardey et al., 2015, 2020).

This article explores a new mechanism to explain the effect of Unemployment Insurance in a dual labor market. As I will show in the rest of this paper, it is based on two premises: first, that agents can increase the profitability of informality by investing assets in an informal production process; second, that unemployment benefits can release consumption-pressure of the individual's assets when seeking employment, so she can invest those assets in the informal sector instead of consuming them. I develop in this paper a theoretical framework for such a phenomenon.

To better understand the proposed mechanism, let's first analyze the Colombian context. Colombia has two different programs that are aimed to the unemployed and coexist. There is an unemployment subsidy consisting of three equal installments standardized to sum the equivalent to 2 times the monthly minimum wage. Such a subsidy is managed and delivered by the Family Compensation Funds. To access to it, the recently unemployed must have been affiliated with the Compensation Fund for at least one year prior to the unemployment. According to the National Association of Family Compensation Funds (Asocajas for its Spanish acronyms), 9.7 million Colombian employees (out of 22.1 million) are subscribed in a Compensation Fund.

At the same time, Colombia counts with a program called "cesantías"⁴, which is not properly an unemployment insurance, but a savings account that formal workers nurture for a future unemployment spell. The funds going to "cesantías" are contributed by the firm, who are obliged by the law to pay this item to the worker directly in their "cesantías" account. Even though "cesantías" are accumulated to use in a future unemployment spell, it is also legal to use them to pay for education, housing purchase, or other heritage-investments. In fact, 50% of the "cesantías" funds are used for housing purchase purposes, according to the Colombian Association of Pension and Cesantías Administrators (Asofondos for its Spanish acronym). In addition to what has been described of the "cesantías" system, it is important to highlight that this labor benefit is guaranteed by formal employers (who are the ones legally binded) and is something that most informal employees have never had.

These two programs, both of which adapt other international schemes, are designed to provide with a safety net the unemployed while they find a job. However, in developing countries with large informal sectors, it is important to understand what types of jobs people are finding after collecting the UI. Informality poses a challenge to unemployment insurance since it represents a

⁴In Spanish, the word "cesante" means unemployed. Thus, "cesantías" refers to the benefits for the unemployed.

striking alternative to the job search that can shape the moral hazard problem involved in the UI theory.

In Colombia, 57% of the workers were informal as of 2019 (according to the World Bank). This large sector is relevant policy-wise because informality is related to low wages and less returns to education, occasional ties between employer and employee, absence of internal promotions in the charges, lower levels of welfare, low levels of productivity (Bulow & Summers, 1986; Rozenweig, 1988), lesser access to formal credit (Fernández, 2018; La Porta & Shleifer, 2014)⁵, and lack of access to the pension and occupational hazard scheme (Bernal, 2009)⁶. Moreover, these characteristics are related to low intergenerational mobility and have a relevant role in current and future generations welfare. Thus, in the face of perverse incentives dragging jobseekers to the informality, it is of public interest to understand the reasons behind this phenomenon.

The explanation I propose lies on two premises. The first one is that, given that working in the informality is not observable, agents can invest their assets in a production process in the informal sector. In consequence, the profitability of such a sector may vary depending on the investment of everyone, thus creating additional perverse incentives to opt for informal jobs. Second, that when an individual is looking for work, UI can relieve consumption pressure on her assets (decrease the persistence of any liquidity/credit/savings constraints), allowing her to invest them in the informal sector rather than consume them.

Regarding the relationship between financial constraints and the effects of UI, Costain (1997) and Hopenhayn & Nicolini (1997, 2009) have analyzed the role of precautionary savings in the insurance. Chetty (2008) and Shimer & Werning (2008) have looked at liquidity, Feldstein & Altman (2007), and Sehnbruch et al. (2019) at unemployment insurance savings accounts and Rendahl (2012) at assets. Their main finding is that in the presence of better conditions in any of these financial variables, beneficiaries are less dependent on the UI, decreasing any negative effect of the unemployment benefit on search behavior. This is because UI can serve as a liquidity constraint-solver for households with little or no assets (Chetty, 2008). In general, this idea is also applicable to other financial constraints (saving, borrowing, liquidity or credit constraints).

At the same time, some authors have explored the role of these financial constraints in the informal economy. Rodríguez et al. (2020) show that the

⁵In Colombia, informal workers are 10 percentage points less likely to access to formal credit (Fernández, 2018). In the rest of the world, informal firms are 25.3% less likely to access to financing than the formal ones (La Porta & Shleifer, 2014).

⁶By definition, in Colombia, informal workers have no access either to the contributory health scheme, pensions and occupational hazard schemes. However, since there is a subsidized health scheme, it is not highlighted as a main differential. On the other hand, access to the pension and occupational hazard schemes is, indeed, a difference between both formal and informal workers.

lack of financial inclusion decreases the individual's income, even more if she is informal. Banerjee et al. (2015) and Crépon et al. (2015) prove a significant rise in investment in assets used for self-employment activities due to micro-credit access in India and rural Morocco⁷. Other researchers have found no such effect, e.g. Karlan & Zinman (2011), and while there is no much evidence on whether the informal in Colombia invest in their business, there is anecdotal evidence of law bills trying to allow the use of unemployment benefits in entrepreneurship investments⁸. Hence, whenever these financial constraints are active, releasing pressure from them can increase the investments in the informal production process. Moreover, credit access may shape insurance behavior and the formality premium when informal workers and firms cannot access to formal savings or credit. This might exacerbate the unemployment spell and informality. UI could be interacting as a liquidity constraint-solver and may be posing different incentives in an unemployment insurance framework.

Thus, this article analyzes how unemployment benefits affect search behaviour in economies with dual labor markets and borrowing constraints. In these regards, this document aims to explore, from a macroeconomic perspective, how these two imperfections in the labor and the credit markets interact. The channel I propose is that agents can use unemployment benefits to invest in productive assets in the informal sector, with a sharper impact on liquidity-constrained individuals. I proceed with a theoretical model that rationalizes the channel I am proposing and then I analyze the theoretical findings. This paper shows two main results: the first one is the nature of the Effort Allocation Effect for the informal sector after a shock on the unemployment benefit. The second one is about the composition of such an effect. Relevant policy implications can be rendered in the UI arena, as well as in the financial inclusion and in the informality intervention areas.

Model

I propose to use a search model in the manner of Pissarides (2000). In the baseline, the model is very similar to Chetty's (2008) search model with liquidity constraints, mixed with Bardley and Jaramillo's (2020) dual labor markets division. In contrast to Chetty, I include the possibility of featuring a production process in the one-man informal firm that every individual can put into action. The model features a representative agent who faces all the decisions in the model.

⁷Though self-employment is not an informal activity per se; it is positively correlated with informality (La Porta & Shleifer, 2014). Moreover, Crépon et al. (2015) refer to rural self-employment, which tends to be informal.

⁸See, for instance, Law Bills No. 89/18 Senate and 13/20 Senate (Congress of the Republic of Colombia, 2018; 2020).

The agent

The model consists of T periods of time. The representative agent becomes unemployed at $t = 0$, and enters unemployment with an unemployment benefit b_t ⁹. The agent possesses an initial endowment of time, which is normalized to 1, and of assets A_0 , which may exogenously vary between agents¹⁰. The agent chooses the share of time she will dedicate to search for a formal job (s_t^f), and to work in the informal sector (s_t^i), such that $s_t^f + s_t^i \leq 1$. Alternatively, these portions of time dedicated to each activity can be seen as the effort put into every sector normalized to sum no more than one.

When working in informality, the agent also chooses at the beginning of the period a capital k_t^i which she is going to use in order to produce y_t^i . Such a capital decision is bounded by her unemployed resources. In this model, the agent keeps receiving the unemployed benefits b_t when working in informality because such an activity is not observable¹¹. The agent can save or trade her assets to amplify her unemployed resources to $b_t + A_t - A_{t+1}$. Yet, the agent faces a lower-bound restriction L on her assets, so she cannot sell under that level. This bound represents the liquidity restrictions of the agent, which are also exogenous to her. Following Evans & Jovanovic (1989), consumption only occurs at the end of the period. Hence, the individual cannot contract non-feasible amounts of capital at the beginning of the period when such quantities promise greater consumption after completing the production process.

Search intensity applies for both formal and informal jobs, and is not observable. Its costs $\psi(s_t^f)$ and $\phi(s_t^i)$ are strictly increasing and convex. If the search is successful, the agent starts working at t . Following Chetty (2008), all formal jobs last indefinitely once found. Formal jobs pay a wage w_t , to which taxes τ are discounted¹². The agent can perfectly find employment in the informal sector by creating it (i.e. self-employment, entrepreneurial activity, etcetera). When an agent dedicates herself to informality in period t , she can search again in $t + 1$. Unemployed agents can either invest their assets in their informal enterprises (by choosing k_t^i to increase the profits of their informal firm) or consume it. They receive an interest rate of zero for their assets. Following this, the interest and discount rates are both equal to zero¹³. Once utilized in production, the capital is fully depreciated. Thus, the depreciation rate of capital

⁹In the Colombian context, only formal employees have UI. Thus, this model would only apply to the individuals coming from a formal job.

¹⁰Assuming this eliminates the effects of the UI benefits on saving behavior prior to job loss.

¹¹If follow-up is not done by the government (or unemployment agency) or no penalty is imposed if you lie regarding your employment status, then it is plausible to believe that individuals will collect the benefit when working in informality.

¹²This relies in the assumption of a partial equilibrium model, where there is no reservation wage and formality is a black box in which the way wages are determined is not relevant for this model's insight. By default, one assumes that wages are fixed competitively by the labor demand in the formal firms. However, this assumption is not necessary for this model.

¹³This simplifier assumption allows the model to capture the effect of the UI on the outcomes

in informal firms is equal to one. The agent chooses the levels of s_t^i , s_t^f and k_t^i that maximize her utility.

In the three following subsections, I will formally present the agent's utility-maximization problem when they find a formal job, when they work in the informality and when they are fully unemployed. Then, in a fourth subsection, I present the core of the agent's dilemma: an uncertainty component corresponding to the stage in which she chooses how much effort to put into formality and informality.

Formal employment

The optimization problem of the agent once she has found a formal job is described by the following equation:

$$U_t^f(A_t) = \max_{A_{t+1} \geq L} u(c_t^f) + U_{t+1}^f(A_{t+1}) \quad (1)$$

$$c_t^f = A_t - A_{t+1} + w_t^f - \tau, \quad (2)$$

where $u(\cdot)$ is the agent's utility function, which depends only on consumption. Assume that $u(\cdot)$ is strictly concave. $U_t^f(A_t)$ is the utility derived from a formal job, which depends on the initial assets of an individual (A_t), the loss (or increase) of assets she makes during period t (i.e., $A_t - A_{t-1}$), and her disposable income ($w_t - \tau$). Given that the individual doesn't lose her job once she has found one, future draws of this same problem are brought to present value with no discount.

Informality

On the other hand, the following equation represents the utility maximization problem of an agent who dedicates herself to an informal job.

$$U_t^i(A_t) = \max_{k_t^i, A_{t+1} \geq L} u(c_t^i) + U_{t+1}^m(A_{t+1}) \quad (3)$$

$$\begin{aligned} c_t^i &= A_t - A_{t+1} + b_t - k_t^i + y_t^i \\ y_t^i &= \varpi (k_t^i)^\alpha \end{aligned}$$

$U_t^m(\cdot)$ is the uncertain agent's value function which she faces because she cannot know if she is going to be in the formality (if she finds a formal job) or

of the model, without the arbitrage induced by the different weights between future and present consumption.

not in the next period. b_t equals the unemployment benefit, ϖ is the exogenous productivity of the agent. The capital k_t^i is bought at the beginning of the period and is used to produce y_t^i at the end of such. Once capital is expended, it fully depreciates. Given that k_t^i is decided before production, she can only buy capital with her unemployed resources $A_t - A_{t+1} + b_t$, where $A_{t+1} \geq L$.

Full unemployment

The utility derived in full unemployment is as follows:

$$U_t^u(A_t) = \max_{A_{t+1} \geq L, k_t} u(c_t^u) + U_{t+1}^m(A_{t+1}) \quad (4)$$

$$c_t^u = A_t - A_{t+1} + b_t \quad (5)$$

Uncertainty component

Let's define $U_t^m(\cdot)$ (Equation 6) the uncertain agent's value function when she is not certain of if she is going to be in the formality (if she finds a formal job) or not in the next period. In $t = 0$, the agent enters unemployment and faces her first mixed value function problem (Equation 7).

$$U_t^m(A_t) = \max_{s_t^f, s_t^i} s_t^f U_t^f(A_t) + s_t^i U_t^i(A_t) + (1 - s_t^f - s_t^i) U_t^u(A_t) - \psi(s_t^f) - \phi(s_t^i) \quad (6)$$

$$U_0^m(A_0) = \max_{s_0^f, s_0^i} s_0^f U_0^f(A_0) + s_0^i U_0^i(A_0) + (1 - s_0^f - s_0^i) U_0^u(A_0) - \psi(s_0^f) - \phi(s_0^i) \quad (7)$$

Both time expenditure in each sector, s_t^f and s_t^i , transform 1 : 1 to the probability of each scenario happening. Hence, note that s_t^f represents both the effort spent looking for formal job and the probability of finding one. This occurs because I assume that the probability of finding a formal job (p_t^f) is a linear function of the effort: $p_t^f = p(s_t^f) = s_t^f$. If the same assumption is made for the probability of finding an informal job, then $1 - s_t^f - s_t^i$ represents the probability of remaining fully unemployed: $p_t^u = 1 - p_t^f - p_t^i = 1 - s_t^f - s_t^i$. In this setting, I assume that each sector's search costs are separable. The latter implies that the compound cost of effort equals $\kappa(s_t^f, s_t^i) = \psi(s_t^f) + \phi(s_t^i)$.

Solution of the model

In order to solve this problem, I follow Chetty's (2008) method and do a positive analysis of the effect of unemployment benefits and decompose it into liquidity and moral hazard effects. Moreover, I show that this can be done for both the informal and formal sector. Given that this decision problem consists in a two stage sequence, I find the solution by using backwards induction. I proceed as follows: I first solve the maximization problems for the formal and informal sector. Then I show the Optimal Effort decision. Afterwards, I explore the effect of unemployment benefits on multiple outcomes, with special emphasis in the effort allocation, and its composition.

Formal employment

Once the agent has found a formal job, she only chooses the level of next-period assets A_{t+1} to set her consumption level in period t . By using Equation 1 and Equation 2, we infer that the optimal level of next-period assets must satisfy:

$$u'(c_t^{f*}) = u'(c_{t+1}^{f*})$$

This equation describes the evolution of consumption along the optimal path. Specifically, it shows that once the agent finds herself a formal job, she will decide the level of next-period assets that perfectly smooths her consumption for the finite T periods of the model subject to the expected values of all future wages $w_{t+i} \forall i > 0$.

Informality

To understand the decision-making process determining search outcomes in the informality, it is necessary to first understand how the possibility of investing in an informal production function shapes the profitability of the informal sector. To do so, let's recall the maximization problem faced in the informality sector. From Equation 3, we can rewrite such a problem as follows:

$$U_t^i(A_t) = \max_{k_t^i, A_{t+1} \geq L} u\left(A_t - A_{t+1} + b_t - k_t^i + \varpi (k_t^i)^\alpha\right) + U_{t+1}^m(A_{t+1})$$

The agent is going to decide both the capital and the level of assets to start with in period $t+1$. Such decisions need to comply with the liquidity constraint of the individual. In this setting, the first order conditions when the liquidity constraint is not active are given by:

$$\begin{aligned}\frac{\partial U_t^i(A_t)}{\partial k_t^i} &= u'(c_t^{i*}) \left[-1 + \frac{\varpi\alpha}{(k_t^{i*})^{1-\alpha}} \right] = 0 \\ \frac{\partial U_t^i(A_t)}{\partial A_{t+1}} &= -u'(c_t^{i*}) + \frac{\partial U_{t+1}^m(A_{t+1}^*)}{\partial A_{t+1}^*} = 0\end{aligned}$$

Given that $u(\cdot)$ is strictly concave, the first order condition with respect to k_t^i implies that the agent will contract a level of capital in which the marginal productivity of capital equals its marginal cost (normalized to 1 in this setting). On the other hand, the first order condition with respect to A_{t+1} shows that the agent will decide to increase or decrease her assets to the point in which the marginal utility gain of an extra monetary unit of assets in period t equals the marginal utility gain of an additional monetary unit of assets in $t+1$. From the former condition, we can infer the optimal level of capital:

$$k_t^{i*} = (\varpi\alpha)^{\frac{1}{1-\alpha}}$$

k_t^{i*} , A_{t+1}^* , and c_t^{i*} denote, respectively, the optimal levels of capital, future assets and consumption. Since A_{t+1}^* and k_t^{i*} are jointly determined, note that if $k_t^{i*} = (\varpi\alpha)^{\frac{1}{1-\alpha}} > A_t - L + b_t$, she will try to approach as much as she can to the optimal level by destining her whole assets to buy capital. The latter is the case of the (liquidity) constrained individuals. Therefore, capital will be given by the Equation 8:

$$k_t^{i*} = \left\{ \begin{array}{ll} A_t - L + b_t & \text{if } A_t - L + b_t < (\varpi\alpha)^{\frac{1}{1-\alpha}} \\ (\varpi\alpha)^{\frac{1}{1-\alpha}} & \text{if } A_t - L + b_t \geq (\varpi\alpha)^{\frac{1}{1-\alpha}} \end{array} \right\} \quad (8)$$

Note that ϖ , A_t , L , b_t , and α are exogenously determined for the individual. Hence, the case in which she is going to operate does not depend on any of her choices, but on her exogenous characteristics. One person will fall in the first case (does not contract her optimal $k_t^{i*} = (\varpi\alpha)^{\frac{1}{1-\alpha}}$, but her restricted one $A_t - L + b_t$), when she is very liquidity-restricted (i.e. her assets available to her consumption are below a certain bound). Alternatively, this can also be interpreted as when informality is very profitable (informality's profitability is over an individual certain bound). Under this setting, production and consumption would look as follows:

$$y_t^{i*} = \left\{ \begin{array}{ll} \varpi (A_t - L + b_t)^\alpha & \text{if } A_t - L + b_t < (\varpi\alpha)^{\frac{1}{1-\alpha}} \\ (\varpi\alpha)^\alpha & \text{if } A_t - L + b_t \geq (\varpi\alpha)^{\frac{1}{1-\alpha}} \end{array} \right\} \quad (9)$$

$$c_t^{i*} = \left\{ \begin{array}{ll} \varpi (A_t - L + b_t)^\alpha & \text{if } A_t - L + b_t < (\varpi\alpha)^{\frac{1}{1-\alpha}} \\ A_t - A_{t+1}^* + b_t + \left[\frac{1-\alpha}{\alpha} \right] (\varpi\alpha)^{\frac{1}{1-\alpha}} & \text{if } A_t - L + b_t \geq (\varpi\alpha)^{\frac{1}{1-\alpha}} \end{array} \right\} \quad (10)$$

On the other hand, the optimal level of next-period assets will be such that satisfies the first order condition with respect to A_{t+1} :

$$u'(c_t^{i*}) = \frac{\partial U_{t+1}^m(A_{t+1})}{\partial A_{t+1}},$$

where the marginal utility of A_{t+1} in the following period is given by the expected value of the marginal utility of an additional monetary unit of assets in $t+1$. The latter will equal the weighted-average¹⁴ marginal utility of consumption in each case scenario (formality, informality and full unemployment):

$$\frac{\partial U_{t+1}^m(A_{t+1})}{\partial A_{t+1}} = s_{t+1}^f u'(c_{t+1}^f) + s_{t+1}^i u'(c_{t+1}^i) + (1 - s_{t+1}^f - s_{t+1}^i) u'(c_{t+1}^u)$$

Full unemployment

If the agent remains in full unemployment during period t , similarly to the results in the formal sector, she only chooses the level of next-period assets A_{t+1} to set her consumption level in period t . By using Equation 4 and Equation 5, we infer that the optimal level of next-period assets must satisfy:

$$\begin{aligned} u'(c_t^{u*}) &= \frac{\partial U_{t+1}^m(A_{t+1}^*)}{\partial A_{t+1}^*} \\ &= s_{t+1}^f u'(c_{t+1}^f) + s_{t+1}^i u'(c_{t+1}^i) + (1 - s_{t+1}^f - s_{t+1}^i) u'(c_{t+1}^u) \end{aligned}$$

This optimal condition implies that the agent will decide the level of next-period assets that smooths her expected utility in $t+1$ given that she will face the same problem next period.

Optimal Effort decision

At the beginning of the period t , the agent decides the optimal levels of effort to be put into her search for a formal job and into her activity in the informality so she can maximize her expected utility. From Equation 6, we can infer that the optimal formal-job search intensity is given by the following equation:

$$\frac{\partial U_t^m(A_t)}{\partial s_t^f} = U_t^f(A_t) - U_t^u(A_t) - \psi'(s_t^{f*}) = 0$$

¹⁴Weights will be determined by the efforts put into each sector in period $t+1$.

$$\implies \psi' (s_t^{f*}) = U_t^f (A_t) - U_t^u (A_t) \quad (11)$$

This condition shows that when optimally choosing, effort is decided to equate the marginal cost to the marginal value (i.e. the difference between the optimum employment and unemployment utilities) of formal-job search effort. Similarly, the effort allocated to working in the informality is given by Equation 12:

$$\begin{aligned} \frac{\partial U_t^m (A_t)}{\partial s_t^i} &= U_t^i (A_t) - U_t^u (A_t) - \phi' (s_t^{i*}) = 0 \\ \implies \phi' (s_t^{i*}) &= U_t^i (A_t) - U_t^u (A_t) \end{aligned} \quad (12)$$

The latter equation establishes that the same intuition behind s_t^{f*} lies underneath s_t^{i*} : such an effort will necessarily equate its marginal cost to its marginal value gain. By using both Equation 11 and Equation 12, we can infer that it must be true that in the optimal decision, the following must hold:

$$U_t^f (A_t) - \psi' (s_t^{f*}) = U_t^i (A_t) - \phi' (s_t^{i*})$$

Thus, in equilibrium, the trade-off of utilities between formality and informality must equal the trade-off of marginal costs between these two sectors: $U_t^f (A_t) - U_t^i (A_t) = \psi' (s_t^{f*}) - \phi' (s_t^{i*})$, i.e. the agent will shift her effort decision to the point in which the intersectorial difference of marginal costs is exactly compensated by the intersectorial welfare difference.

Effort Allocation Effect

In this subsection, I will analyze the effect of the unemployment benefit on multiple outcomes, including the effort allocation. To exemplify, consider the effects of 1 monetary unit increase in the benefit level b_t on each sector. Once the agent finds a formal job, she will not receive any benefit, so her optimal consumption c_t^{f*} and assets decision A_{t+1}^* will not change at all after this marginal change. On the other hand, given that the informal worker still receives her unemployment benefit while working in the informality, her optimal informal capital k_t^{i*} , informal production y_t^{i*} and consumption c_t^{i*} will adapt in the margin. By using Equation 8, Equation 9, and Equation 10, I find that such effects are as follows:

$$\frac{\partial k_t^{i*}}{\partial b_t} = \begin{cases} 1 & \text{if } A_t - L + b_t < (\varpi\alpha)^{\frac{1}{1-\alpha}} \\ 0 & \text{if } A_t - L + b_t > (\varpi\alpha)^{\frac{1}{1-\alpha}} \end{cases}$$

$$\frac{\partial y_t^{i*}}{\partial b_t} = \begin{cases} \varpi\alpha \left[\frac{1}{A_t - L + b_t} \right]^{1-\alpha} & \text{if } A_t - L + b_t < (\varpi\alpha)^{\frac{1}{1-\alpha}} \\ 0 & \text{if } A_t - L + b_t > (\varpi\alpha)^{\frac{1}{1-\alpha}} \end{cases}$$

$$\frac{\partial c_t^{i*}}{\partial b_t} = \begin{cases} \varpi\alpha \left[\frac{1}{A_t - L + b_t} \right]^{1-\alpha} & \text{if } A_t - L + b_t < (\varpi\alpha)^{\frac{1}{1-\alpha}} \\ 1 & \text{if } A_t - L + b_t > (\varpi\alpha)^{\frac{1}{1-\alpha}} \end{cases}$$

Two main findings result from the former equations. First, that a marginal change in b_t will increase both the informal capital hired and the informal production, but only for the (liquidity) constrained individuals. This shows that the unemployment benefit may increase the size of informal production if the individual was experimenting liquidity constraints prior to the benefit. Second, that informal consumption will naturally arise with the unemployment benefit. However, such an increase will be greater in constrained individuals than in non-constrained ones¹⁵. The latter occurs because for the constrained agents, the unemployment benefit will not only alter her unemployed resources, but also her informal production.

Next, let's consider the effects of the same marginal rise of b_t on the effort allocated to each sector. By derivation of Equation 11 with respect to b_t , we obtain that the effect on formal-job search follows:

$$\psi''(s_t^{f*}) \frac{\partial s_t^{f*}}{\partial b_t} = \frac{\partial U_t^f(A_t)}{\partial b_t} - \frac{\partial U_t^u(A_t)}{\partial b_t}$$

$$\implies \frac{\partial s_t^{f*}}{\partial b_t} = \frac{\frac{\partial U_t^f(A_t)}{\partial b_t}}{\psi''(s_t^{f*})} - \frac{\frac{\partial U_t^u(A_t)}{\partial b_t}}{\psi''(s_t^{f*})}$$

¹⁵Note that in the restricted case, $\frac{\partial c_t^{i*}}{\partial b_t} > 1$. This can be demonstrated as follows. In the constrained case, it is true that $A_t - L + b_t < (\varpi\alpha)^{\frac{1}{1-\alpha}}$. Hence,

$$\begin{aligned} (\varpi\alpha)^{\frac{1}{1-\alpha}} &> A_t - L + b_t \\ \varpi\alpha &> (A_t - L + b_t)^{1-\alpha} \\ \varpi\alpha \left(\frac{1}{A_t - L + b_t} \right)^{1-\alpha} &> 1 \end{aligned}$$

This holds as long as $L < A_t + b_t$. It is not possible for the individual to ever have an assets level below L (it would be a contradiction of the lower bound assumption). Then, if $b_t > 0$, $L < A_t + b_t$ always holds. If $b_t = 0$, $L < A_t + b_t$ will only occur if the individual's at-the-beginning-of-the-period assets were not at the lower bound. Thus, $\varpi\alpha \left(\frac{1}{A_t - L + b_t} \right)^{1-\alpha} > 1$ whenever b_t is positive or whenever the individual's at-the-beginning-of-the-period assets were above the lower bound L .

Given that $\frac{\partial U_t^u(A_t)}{\partial b_t} = u'(c_t^{u*})$ and $\frac{\partial U_t^f(A_t)}{\partial b_t} = 0$, then the latter equation may be re-written as:

$$\frac{\partial s_t^{f*}}{\partial b_t} = -\frac{u'(c_t^{u*})}{\psi''(s_t^{f*})} < 0 \quad (13)$$

Since $u'(c_t^u) > 0$ and $\psi''(s_t^f) > 0$ for all $\langle c_t^u, s_t^f \rangle$, this effect is negative. Intuitively, this occurs because the benefit releases whatever liquidity pressure the individual is experimenting. Such an effect of b_t on s_t^{f*} is the same as in Chetty (2008). Given that the effort put into the formal-job search transforms directly into the probability of finding a formal job, b_t will affect both the probability of such a case and the unemployment spell. Thus, since the expected time that it takes to an individual to find a formal job is given by $\frac{1}{s_t^{f*}}$, then the effect of increasing marginally b_t on the average time that will pass before finding a formal job is:

$$\frac{\partial \left(\frac{1}{s_t^{f*}} \right)}{\partial b_t} = -\left(\frac{1}{s_t^{f*}} \right)^2 \frac{\partial s_t^{f*}}{\partial b_t} > 0$$

Hereby, the effect of increasing marginally b_t is negative on s_t^{f*} , and positive on the average time that it takes to an individual to find a formal job. This is consistent with the empirical findings of Moffitt (1985), Meyer (1990), and others for the case of the United States.

At the same time, by derivation of Equation 12, we can find that the effect of a marginal increase of the unemployment benefit on the effort allocated to the informal sector is as follows:

$$\begin{aligned} \phi''(s_t^{i*}) \frac{\partial s_t^{i*}}{\partial b_t} &= \frac{\partial U_t^i(A_t)}{\partial b_t} - \frac{\partial U_t^u(A_t)}{\partial b_t} \\ \implies \frac{\partial s_t^{i*}}{\partial b_t} &= \frac{\frac{\partial U_t^i(A_t)}{\partial b_t}}{\phi''(s_t^{i*})} - \frac{\frac{\partial U_t^u(A_t)}{\partial b_t}}{\phi''(s_t^{i*})} \end{aligned}$$

Additionally, by using Equations 3 and 4, we can also find that $\frac{\partial U_t^u(A_t)}{\partial b_t} = u'(c_t^{u*})$ and $\frac{\partial U_t^i(A_t)}{\partial b_t} = u'(c_t^{i*}) \left[\frac{\partial c_t^{i*}}{\partial b_t} \right]$. Hence the marginal effect of b_t on s_t^{i*} may be re-written as:

$$\frac{\partial s_t^{i*}}{\partial b_t} = \left\{ \begin{array}{ll} \Psi \frac{u'(c_t^{i*})}{\phi''(s_t^{i*})} - \frac{u'(c_t^{u*})}{\phi''(s_t^{i*})} & \text{if } A_t - L + b_t < (\varpi\alpha)^{\frac{1}{1-\alpha}} \\ \frac{u'(c_t^{i*})}{\phi''(s_t^{i*})} - \frac{u'(c_t^{u*})}{\phi''(s_t^{i*})} & \text{if } A_t - L + b_t > (\varpi\alpha)^{\frac{1}{1-\alpha}} \end{array} \right\}, \quad (14)$$

where $\Psi = \varpi\alpha \left(\frac{1}{A_t - L + b_t}\right)^{1-\alpha} > 1$ in the liquidity-constrained case (look at footnote 15). Thus, the effect of b_t on the effort put into informality will have differentiated magnitudes between constrained and unconstrained individuals. Moreover, since $\Psi > 1$, this effect is greater in constrained agents than in non-constrained.

Subsequently, let's evaluate whether the effect of a marginal increase in the unemployment benefits is greater in the formal or informal sector. By using the Equation 13 and Equation 14, we can show that the relationship between $\frac{\partial s_t^{i*}}{\partial b_t}$ and $\frac{\partial s_t^{f*}}{\partial b_t}$ is given by:

$$\frac{\partial s_t^{i*}}{\partial b_t} = \left\{ \begin{array}{ll} \Psi \frac{u'(c_t^{i*})}{\phi''(s_t^{i*})} + \left[\frac{\psi''(s_t^{f*})}{\phi''(s_t^{i*})} \right] \frac{\partial s_t^{f*}}{\partial b_t} & \text{if } A_t - L + b_t < (\varpi\alpha)^{\frac{1}{1-\alpha}} \\ \frac{u'(c_t^{i*})}{\phi''(s_t^{i*})} + \left[\frac{\psi''(s_t^{f*})}{\phi''(s_t^{i*})} \right] \frac{\partial s_t^{f*}}{\partial b_t} & \text{if } A_t - L + b_t > (\varpi\alpha)^{\frac{1}{1-\alpha}} \end{array} \right\}$$

Note that in both cases, $\frac{\partial s_t^{i*}}{\partial b_t} > \frac{\partial s_t^{f*}}{\partial b_t}$ whenever the following conditions are met:

$$\begin{aligned} \Psi \frac{u'(c_t^{i*})}{u'(c_t^{u*})} + \frac{\phi''(s_t^{i*})}{\psi''(s_t^{f*})} &> 1 \quad \text{if } A_t - L + b_t < (\varpi\alpha)^{\frac{1}{1-\alpha}} \\ \frac{u'(c_t^{i*})}{u'(c_t^{u*})} + \frac{\phi''(s_t^{i*})}{\psi''(s_t^{f*})} &> 1 \quad \text{if } A_t - L + b_t > (\varpi\alpha)^{\frac{1}{1-\alpha}} \end{aligned}$$

Since the marginal effect of the unemployment benefit on s_t^{f*} is negative, the latter can happen either when $\frac{\partial s_t^{f*}}{\partial b_t} < \frac{\partial s_t^{i*}}{\partial b_t} < 0$ or $\frac{\partial s_t^{i*}}{\partial b_t} > 0$. The former case occurs when $\frac{\partial s_t^{i*}}{\partial b_t}$ remains negative, but not as large in absolute value than $\frac{\partial s_t^{f*}}{\partial b_t}$. The latter case is the one in which informal effort is actually increasing while the formal one is decreasing. Thus, the effect of b_t on s_t^{i*} will be positive when the criteria in the equation below are met. Under such circumstances, not only will the marginal effect of the unemployment benefit on the effort put into informality will be greater than the marginal effect of the unemployment benefit on formal-job search, but will also be positive. The latter means that when those conditions are met, the unemployment benefit will increase the probability of staying in the informality.

$$\begin{aligned} \Psi u'(c_t^{i*}) &> u'(c_t^{u*}) \quad \text{if } A_t - A_{t+1} + b_t < (\varpi\alpha)^{\frac{1}{1-\alpha}} \\ u'(c_t^{i*}) &> u'(c_t^{u*}) \quad \text{if } A_t - A_{t+1} + b_t > (\varpi\alpha)^{\frac{1}{1-\alpha}} \end{aligned}$$

Given that $\Psi > 1$ in most of cases (look at footnote 15), an interesting result is that liquidity-constrained individuals are more likely to hold these conditions

than the unconstrained ones. The latter is because of the greater marginal effects on capital and informal production that constrained individuals have. This is an important finding. Such a result implies that it is more probable to see that $\frac{\partial s_t^{i*}}{\partial b_t} > \frac{\partial s_t^{f*}}{\partial b_t}$ and $\frac{\partial s_t^{i*}}{\partial b_t} > 0$ in liquidity-constrained individuals.

Decomposition of the Effort Allocation Effect

Following Chetty (2008), we find that the Effort Allocation Effect can be decomposed in two parts for each sector. These components are the *liquidity* and the *moral hazard effects*. Consider two scenarios in formal employment. First, one in which the agent receives an extra monetary unit in her at-the-beginning-of-the-period assets. Secondly, one in which the individual receives an additional monetary unit in the formal wage. If we calculate the effect of each scenario on formal-job search, we obtain the following two equations:

$$\frac{\partial s_t^{f*}}{\partial A_t} = \frac{u'(c_t^{f*})}{\psi''(s_t^{f*})} - \frac{u'(c_t^{u*})}{\psi''(s_t^{f*})} \quad (15)$$

$$\frac{\partial s_t^{f*}}{\partial w_t} = \frac{u'(c_t^{f*})}{\psi''(s_t^{f*})} \quad (16)$$

Equation 15 stands as the liquidity effect, i.e. the agent has more cash so she can consume more while unemployed and thus she does not need to find a job as quick. Equation 16 is the moral hazard effect: through a substitution effect, a higher benefit lowers the agent's net wage, reducing the incentive to search. Thus, the Effort Allocation Effect on the formal labor market may be decomposed in both effects and be expressed as follows:

$$\frac{\partial s_t^{f*}}{\partial b_t} = \frac{\partial s_t^{f*}}{\partial A_t} - \frac{\partial s_t^{f*}}{\partial w_t} \quad (17)$$

The values in Equations 15, 16, and 17 are consistent with Chetty (2008). On the other hand, let's consider the same case in which the agent receives an additional monetary unit in her at-the-beginning-of-the-period assets. Thus, the liquidity effect on the informal labor market is given by:

$$\frac{\partial s_t^{i*}}{\partial A_t} = \frac{u'(c_t^{i*})}{\phi''(s_t^{i*})} \left(\frac{\partial c_t^{i*}}{\partial A_t} \right) - \frac{u'(c_t^{u*})}{\phi''(s_t^{i*})}$$

$$\Rightarrow \frac{\partial s_t^{i*}}{\partial A_t} = \left\{ \begin{array}{ll} \frac{\Psi \frac{u'(c_t^{i*})}{\phi''(s_t^{i*})} - \frac{u'(c_t^{u*})}{\phi''(s_t^{i*})}}{\phi''(s_t^{i*})} & \text{if } A_t - L + b_t < (\varpi\alpha)^{\frac{1}{1-\alpha}} \\ \frac{u'(c_t^{i*})}{\phi''(s_t^{i*})} - \frac{u'(c_t^{u*})}{\phi''(s_t^{i*})} & \text{if } A_t - L + b_t \geq (\varpi\alpha)^{\frac{1}{1-\alpha}} \end{array} \right\}$$

Let's recall that the informality Effort Allocation Effect is as follows:

$$\frac{\partial s_t^{i*}}{\partial b_t} = \left\{ \begin{array}{ll} \Psi \frac{u'(c_t^{i*})}{\phi''(s_t^{i*})} - \frac{u'(c_t^{u*})}{\phi''(s_t^{i*})} & \text{if } A_t - L + b_t < (\varpi\alpha)^{\frac{1}{1-\alpha}} \\ \frac{u'(c_t^{i*})}{\phi''(s_t^{i*})} - \frac{u'(c_t^{u*})}{\phi''(s_t^{i*})} & \text{if } A_t - L + b_t \geq (\varpi\alpha)^{\frac{1}{1-\alpha}} \end{array} \right\}$$

Hence, in the informality, the Effort Allocation Effect can only be decomposed into the liquidity effect:

$$\frac{\partial s_t^{i*}}{\partial b_t} = \frac{\partial s_t^{i*}}{\partial A_t}$$

This finding is consistent with the result that in the optimal point, unconstrained agents do not change either their contracted amount of capital nor their informal production. This is because her optimal decisions in both variables are independent of her wealth whenever she is unconstrained. This can be alternatively seen as follows: if an individual has perfect access to credit, savings, or liquidity, she will go to the financial markets to borrow/get the cash she needs to contract the optimal level of capital and optimally produce in the informality. Thus, it is logical that her informal wage $(y_t^{i*} - k_t^{i*})^{16}$ would not vary as a result of receiving an additional monetary unit of unemployment benefit. Therefore, any Effort Allocation Effect occurs because the agent's liquidity constraint is being relaxed, i.e. the whole Effort Allocation Effect is due to the liquidity effect.

Conclusion

This paper presents a new mechanism to explain the increase of informality when implementing an unemployment insurance. By developing a partial equilibrium model, I show two main results: the first one is the nature of the Effort Allocation Effect (EAE) for the informal sector, i.e. the effect of a marginal change in the unemployment benefit on the effort dedicated into the informality. In addition, I show under what circumstances will this marginal variation imply an increase in the search effort for an informal job. I present the mathematical forms under which the informal effort is actually increasing while the formal one is decreasing, which explains the empirical findings of Medina et al.

¹⁶Note that the unemployment benefit increases the income during full unemployment up to b_t . Hence, the formal net wage is given by the disposable formal earnings ($w_t^f - \tau$) minus the benefit: $w_t^f - \tau - b_t$. The same procedure can be done for the informal sector. Thus the informal net wage would be given by the difference between her whole informal salary ($b_t + y_t^{i*} - k_t^{i*}$) and the full unemployment income (b_t):

$$b_t + y_t^{i*} - k_t^{i*} - b_t = y_t^{i*} - k_t^{i*}.$$

(2013). I also find the conditions under which such an effect may be negative, but not as large in absolute value than the formal EAE. More importantly, I show that any case is more probable in liquidity constrained individuals than in non-constrained ones. Given the direct relation between effort and the probability of each scenario occurring, an increase in informal effort can be indirectly interpreted as a hint of what is going to happen with the incidence of informality.

As a second result, I show the decomposition of the Effort Allocation Effect. This paper successfully recreates a model in which Chetty's (2008) findings hold for the formal employment market (i.e. that an increase in the unemployment benefit decreases the search effort). However, this article's model includes the possibility of featuring a production process in the one-man informal firm that every individual can put into action. Thus, I find the equivalent Effort Allocation Effect decomposition for the informal sector when facing a marginal change in the unemployment benefits: the entirety of the Effort Allocation Effect in the informality is due only to the liquidity effect. The latter reinforces the idea that policymakers should complement unemployment benefits with financial inclusion. By doing this, they may avoid unexpected effects in informal economies.

These findings are explained by the two premises of the model: first, agents can invest their assets in a production process in the informality, reshaping its profitability depending on the investment of everyone. The latter creates additional perverse incentives to opt for informal jobs. Second, that when an individual is looking for work, UI can relieve consumption pressure on her assets and decrease the persistence of any liquidity/credit/savings constraints, allowing her to invest them in the informal sector rather than consume them. Understanding how the mechanism interacts with informality effort and these two premises may be of help for policy makers. Since effort and informal production are hard to observe for the insurer part, policy implications could be oriented to help relaxing liquidity constraints as a complementary measure to unemployment benefits, or to create mechanisms to enforce accountability of the beneficiary in terms of her use of the UI in any informal production.

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