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How to Fund Unemployment Insurance with Informality and False Claims: Evidence From Senegal

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ABSTRACT

This paper studies the welfare effects from the provision of unemployment insurance (UI) benefits in a context where formal workers represent only a small proportion of the labor market and informal workers can submit fraudulent claims for UI benefits. We model these features and allow for varying degrees of enforcement and different funding sources. We then estimate the model's key parameters by conducting a custom labor force survey in Senegal. Our findings show that the liquidity gains are large and the moral hazard response to the UI benefits among workers is relatively small: an extra dollar of UI benefits yields a consumption-equivalent gain of 60–90 cents, which exceeds comparable estimates from U.S. calibrations by a factor of three to sixteen. We then show that the welfare gains depend on the program design: UI funded through payroll taxes delivers the greatest welfare gains but becomes infeasible when there are few formal workers and high rates of fraudulent claims. On the other hand, UI funded through consumption taxes delivers lower welfare gains but remains feasible with high informality and false claims.

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1 Introduction

Unemployment insurance (UI) is one form of worker protection program that is considerably less prevalent in low-income than in high-income countries because it is more difficult for the former to track work status and fund UI budgets (Benjamin and Mbaye, 2012; Cirelli et al., 2021). Any enthusiasm for UI as a macroprudential policy tool thus often fades in the face of funding and implementation challenges in labor markets characterized by high informality and self-employment (Breza et al., 2021; Donovan et al., 2021) and frictions arising from skill mismatch and job search (Alfonsi et al., 2020; Behrman, 1999; Bryan et al., 2014; Hamory et al., 2020).

This paper advances our understanding of the impact and optimal design of UI in labor markets characterized by low formality and by the presence of informal workers who might submit fraudulent claims to qualify for UI benefits. Specifically, we address the following questions in the context of the Senegalese labor market: What are the potential welfare gains from UI in this context? What are the limits to a payroll tax–funded UI system under limited enforcement? Can broad-based funding of UI through a value-added tax (VAT)/consumption taxes yield larger welfare gains? Answering these questions requires us to overcome a few modeling and data challenges. We provide key stylized facts on the Senegalese labor market, develop a structural UI model that applies well to economies with Senegal's distinguishing labor market characteristics, and calibrate the model with a rare and highly customized labor force survey that provides a rich set of moments on worker behavior.

First, we use nationally representative living standard and labor force surveys to document four key facts about the Senegalese labor market: (i) It is mostly informal, with only a small fraction of its workers and firms being formally established. (ii) Even within formal firms, there is a substantial subset of undeclared informal workers who could falsely claim UI intended for formal workers. (iii) There are pronounced income, consumption, and asset disparities across different employment statuses and, therefore, high potential for consumption smoothing through social insurance. Finally, (iv) informal networks serve as a crucial mechanism to help workers cope with job loss, echoing (Cox et al., 1998; Cox and Fafchamps, 2007). In these respects, the Senegalese labor market exhibits characteristics similar to those of other low-income African countries.

Second, we progressively build on the model of Chetty (2006) to understand how each of these features of the Senegalese labor market affects welfare gains from UI. We start with the baseline Baily–Chetty economy where there is perfect enforcement of UI eligibility and no informality. At baseline, the government can fully impose UI payroll tax contributions on employed workers, and there are no false claims from informal workers. The standard

balance between moral hazard and liquidity effects determines the welfare gains from UI in this context.

We then extend the Chetty (2006) model by allowing a share of informal workers to submit false claims and collect UI benefits while working and by distinguishing work statuses between informal employment, formal employment, and unemployment. In this framework, we consider UI schemes that are funded by a payroll tax and those funded by a broad-based consumption tax, and we allow for varying degrees of enforcement of UI eligibility.

In the payroll tax economy, there is a standard payroll tax–funded UI system with limited enforcement. Only formal workers contribute to funding the UI program, but an endogenous share of informal workers can fraudulently claim benefits. In this setting, there is an additional liquidity effect of UI relative to the baseline Baily–Chetty formula that arises from the provision of consumption insurance for some informal workers. The moral hazard effect is negative and includes the negative effect of more informal workers submitting false claims as a result of greater UI benefits. An expansion of UI can crowd out private insurance, and accounting for this lowers the potential welfare gains of UI. In addition, matches are not permanent. Accounting for immediate exogenous job separations has an ambiguous impact on the welfare gains from UI because it reduces the magnitude of both the positive liquidity effects and the negative moral hazard effects.

The consumption tax economy is identical to the payroll tax economy, except in that the UI system is funded by a consumption tax. Formal, informal, and unemployed workers all pay the consumption tax and thus contribute to funding UI. In this setting, the consumption tax required to fund additional benefits features (1) a mechanical tax base effect equal to the average UI benefit per unit of aggregate consumption and (2) a moral hazard effect that captures the endogenous responses of formal and informal job search and the false claim rate. If moral hazard effects are small, the marginal tax change necessary to fund additional benefits is mainly driven by the mechanical tax base effect. Under the consumption tax, informal claimants and unemployed individuals enjoy welfare gains from benefit receipt, while all individuals – particularly formal and informal nonclaimants – are negatively affected by higher consumption taxes. Therefore, the consumption tax is less targeted and yields weaker welfare gains than an equivalent payroll-tax-funded UI scheme. However, the consumption-tax funded UI scheme remains feasible even at high levels of false claims.

Third, we conduct a highly customized in-person labor force survey of 1,378 individuals in Senegal to estimate the model. Our survey is representative of the major labor market and urban areas in Senegal and departs from typical labor force surveys in this context because it was specifically designed to allow calibration of the key parameters identified in our models: (i) elasticities of job search and job quit rates with respect to the benefit level for each

employment status, (ii) consumption levels by employment status, (iii) workers' risk aversion, and (iv) the degree of informal work and enforcement. After estimating these parameters, we provide welfare estimates for the value of UI and assess the relative importance of moral hazard versus liquidity effects.

Our model calibrations yield three main results that collectively illustrate the trade-offs inherent in UI schemes in imperfect labor markets. First, unemployment insurance can offer a robust safety net even in economies characterized by high informality and an increased risk of false claims. An extra dollar of UI benefits yields a consumption-equivalent gain greater than 68 cents under the payroll tax–funded scheme and 62 cents under the consumption tax–funded scheme. The magnitude of the dollar consumption gain to a representative worker per dollar of benefits—the "dollar-on-dollar" welfare metric—significantly exceeds that for the same model calibrated to the consumption gap in the US, under which an extra dollar of UI is estimated to yield a consumption-equivalent gain of 26 cents. When risk aversion is further reduced to US values, the dollar-on-dollar welfare gains from UI fall to 5 cents. Across our experiments, we find that the gains from a small UI expansion in Senegal are approximately three to sixteen times larger than comparable U.S. calibrations.

However, we show that false claims have two countervailing effects on welfare. On the one hand, compared to formal employment, informal employment typically yields lower wages and consumption. Given the estimated coefficient of risk aversion in this economy, there exists significant demand for liquidity and consumption smoothing among informal workers who derive welfare benefits from false claims. On the other hand, as more informal workers seek unemployment insurance, the tax burden necessary to fund the policy grows. Consequently, as the wage and consumption differentials between formal and informal jobs narrow after transfers are accounted for, the incentives to enter formal employment become significantly distorted by the UI policy, resulting in diminished gains.

Second, we examine how the effectiveness of UI varies with the severity of false claims between equivalent payroll and consumption tax financing schemes. We observe that the payroll tax financing scheme delivers greater welfare gains than the consumption tax scheme for lower levels of false claims. However, the tax burden becomes so large at high levels of false claims that a payroll tax system eventually becomes infeasible (i.e., there is no tax rate for which the government budget constraint holds, given equilibrium responses of households). Alternatively, a UI system funded through VAT or consumption taxes, while generally offering lower welfare benefits than a payroll tax–funded system, remains feasible even when fraudulent claims are severe. It has a broader base and ensures a minimum welfare level under the most adverse conditions.

Third, we consider the impact of the degree of formality on our analysis. At levels of

formal employment lower than those reported in our survey (and that may align more closely with the actual share of formal workers beyond urban settings), the tax burden on formal workers is so large that, even with low levels of false claims, the payroll tax–funded UI scheme might be infeasible. In these scenarios, consumption tax financing is less effective but remains feasible because of the reduced moral hazard effects. Conversely, as the economy becomes more formalized, we observe the standard outcome that a payroll tax is the most efficient instrument to finance UI.

Literature. Our paper contributes to three strands of the UI literature. First, our paper accounts for enforceability constraints in estimating the potential welfare gains from—and optimal financing mechanisms of—UI. Existing structural and semistructural models of UI in middle- and low-income countries acknowledge the importance of informality, but most do not directly model enforceability constraints. Bosch and Esteban-Pretel (2015) examine the implementation of a UI scheme in an environment with high informality using a search and matching model calibrated on Mexican data and find that the UI scheme's design and execution significantly influence its effectiveness. Doornik et al. (2018) estimate that eligibility for UI in Brazil significantly increases unemployment inflows and that such behavior is related to workers shifting sectors toward informal employment. In contrast, Gerard and Gonzaga (2021) study the Brazilian context and find that the efficiency cost of UI benefits may not be higher in countries with high informality than it is in more formalized economies because reemployment rates in the formal sector remain low regardless of the UI policy design. Similarly, Margolis et al. (2015) estimate low degrees of efficiency losses in the presence of informal work, although they assume very high levels of UI policy enforceability.

Second, thanks to our customized survey, our study is among the first to quantify the welfare gains of UI and the relative importance of the moral hazard and liquidity channels for low-income African economies. Existing empirical evidence focuses mostly on Latin American and Caribbean (LAC) countries, as these offer institutional and data environments conducive to the study of UI.[1] Although the ample evidence of moral hazard effects and enforcement constraints of UI in the Brazilian and LAC context could be informative about the impact of UI in African countries, the notable differences in income and labor market

[1]Such empirical studies include the work of Carvalho et al. (2018), who find evidence in Brazil consistent with workers having an incentive to strategically induce their own layoffs so that they can collect benefits. The authors estimate that such layoffs account for 11–13% of the average dismissal rates of eligible workers. Gonzaga (2003) argues that UI in Brazil incentivizes collusion between employee and employer in fake layoff schemes to collect UI benefits. Hijzen (2011) finds that the formal labor market turnover effects of UI in Brazil are absent near the spike in the formal sector reemployment rate around benefit exhaustion, which is consistent with job losers taking up informal jobs while receiving UI. Chahad and Fernandes (2002) find evidence that UI benefits increase the duration and frequency of nonparticipation in the labor market.

characteristics between the two regions indicate that specific evidence is needed on the potential effects of UI in low-income African countries. A notable exception to the literature's geographical focus on LAC is Liepmann and Pignatti (2021), who study UI in the Mauritian context and find that the welfare effects of UI generosity are positive and comparatively large even when informality is high.

Third, our paper is among the first to highlight the potential merits of tapping into broad-based taxation to finance UI in low-income countries and contributes to the strands of literature on the relative merits and efficiency of various UI scheme designs. Existing papers focus on the optimal duration of UI schemes in low-income countries and on the importance of the eligibility criteria, both of which are key dimensions in UI policy design. For example, Gonzalez-Rozada and Ruffo (2016) work with Argentinian data and posit that a short UI duration should be considered when a developing country with high informality introduces a new UI system. Our work is most closely related to that of Cirelli et al. (2021), who examine individual savings accounts funded by payroll taxes in middle-income countries with informality. However, we depart from Cirelli et al. (2021) in two significant ways. First, we consider broad-based taxation, such as consumption taxes, to address the binding funding constraint faced by social planners in this context. Second, we incorporate varying rates of false UI claims arising from potential variations in the ability of the social planner to observe informal work.

Outline. The remainder of this paper is organized as follows. Section 2 presents stylized facts about the Senegalese labor market. Section 3 presents the theoretical framework, explains the factors that affect welfare after a marginal increase in unemployment benefits and identifies the key sufficient statistics required to estimate the welfare gains from different UI policies. Section 4 introduces the custom labor force survey and explains our calibration strategy. Section 5 provides the numerical results and elaborates on their implications. Section 6 addresses the main caveats of our analysis. Section 7 offers concluding remarks.

2 Four Facts about the Senegalese Labor Market

This section presents four facts that characterize the Senegalese labor market and provides insights into the institutional setting behind our study. These facts motivate the models that we write in Section 3.

We construct these facts using data from nationally representative consumption and labor force surveys: the *Enquête Harmonisée sur les Conditions de Vie des Ménages 2018-2019* (EHCVM) and the *Enquête Nationale sur l'Emploi au Senegal 2015-2019* (ENES).

The EHCVM is similar in spirit to the Living Standard Measurement Surveys (LSMS) conducted in several low-income countries. The data were collected through a 2-stage sampling methodology: 598 enumeration areas (EAs) were selected in the first stage, and 12 households were randomly selected in each enumeration area in the second stage.[2] The ENES consists of 12 waves of quarterly, nationally representative labor force surveys from between 2015 and 2019. The survey uses a rotating panel of households.[3]

Fact 1: The Senegalese labor market is characterized by high informality. As shown in Figure 1, the share of formal workers, defined as those with a formal, written work contract, is 10.36% in the pooled ENES, and the share of formal firms, defined as firms with a formal accounting system or a formal registration, is only 8.25%.[4] These numbers are broadly in line with the formality levels documented in the labor literature on sub-Saharan Africa (see, for example, Rodríguez-Castelán and Vazquez (2022)).

Fact 2: There are many undeclared informal workers in formal firms who could falsely claim UI. Panel A of Figure 2 shows the firm formality status for formal and informal workers. A total of 50.7% of formal workers in the labor force surveys are in firms with no formal accounting or registration, while 3.5% of informal workers are in formal firms. Panel B of Figure 2 shows the formality status of workers in formal and informal firms. The graph shows that 38% of workers in formal firms do not have a formal contract. These two panels help us contextualize the rate of false claims in our model work in Section 3. The government can observe the firm's formality status (based on registration records

[2]The total survey sample size is 7,156 households, with 3,941 being from urban areas and 3,215 from rural areas, representing a total of 66,120 individuals. The EHVCM is a rich dataset covering education, health outcomes, employment, nonemployment income, savings and credit, food consumption, food security, nonfood consumption, nonagricultural enterprises, housing, assets, transfers, shocks and survival strategies, safety nets, agriculture, livestock, fishing, agricultural equipment and relative poverty.

[3]The ENES covers (i) demographic information on education, gender, age, and family structure; (ii) information on employment status, contract structure, industry, occupation, earnings, working hours, formality type, tenure in the current job, and any changes in employment over the past three months; (iii) job search behavior with information on whether respondents engage in job search activities, the methods they employ in their job search, reasons for not actively seeking a job, and success in finding employment; (iv) consumption expenditures with information on the amount of money spent on food and beverages, utilities, and housing and any changes in these expenditures over the past few months; and (v) savings and borrowing with information on the methods used for saving and borrowing, the amount saved or borrowed, and whether the borrowing channels are formal or informal.

[4]The share of informal workers in the labor force stays around 8–12% under alternative definitions of informal work commonly used in the literature, namely, (i) whether the worker receives a pay stub from her employer and (ii) whether the employer makes pension contributions, as in Rodríguez-Castelán and Vazquez (2022). We do not use the definition based on pension contributions in our main analysis, since the provision of insurance to formal workers is precisely the focus of this study. Nevertheless, using that definition would have no material impact on our analysis.

and mandatory fiscal reporting) but has little to no information on the status of informal workers. Therefore, workers in formal firms with no formal contract could potentially falsely claim UI benefits under a standard UI scheme that targets formal workers who lose their jobs.[5] This suggests that there is significant scope for false UI claims in Senegal.

Fact 3: There are significant gaps in income, consumption, and assets across work statuses. As shown in Figure 3, the gap in median monthly income between formal and informal workers is 65% (or $502): workers with formal contracts have median earnings of $776 per month, while informal workers have a median income of $274 per month.[6] The gap in median monthly consumption per capita between formal and informal workers is 38% (or $120 per month): formal workers have median consumption per capita of $316 per month, while informal workers have a median consumption per capita of $196 per month. The gap in consumption per capita and assets between informal workers and unemployed individuals is rather low, despite the latter group's lack of income. These gaps in income, consumption, and assets point to the potential importance of consumption-smoothing liquidity effects from additional social insurance in the Senegalese context.

Fact 4: Informal networks are a significant form of insurance for workers. Reported informal transfers account for 5–8% of household consumption on average in the EHCVM data (panel A of Figure 4), while transfers sent by households are much lower on average. In terms of workers' coping strategies after job loss, panel B of the same figure shows that, on average, 17% of workers with job loss report turning to friends and family as a coping strategy. This coping strategy represents the third most-used strategy and is more common than the alternatives typically considered in developed settings. Unsurprisingly, strategies such as selling assets or engaging in other activities are seldom reported and do not seem to be a viable option in an environment where asset endowments are small and labor market frictions might limit other work opportunities. Panel B also highlights that a large share of workers has no recourse to any coping strategy upon losing a job. This suggests the presence of intrahousehold risk insurance, which is confirmed by panel C: essentially all unemployed workers report relying on family members to survive and satisfy their basic needs.

This section established four facts about the Senegalese labor market: high informality, significant scope for false UI claims, large consumption gaps, and informal networks. In the

[5]These undeclared workers in the formal sector can submit false UI claims if they can produce false payslips in collusion with their employer while not contributing to a payroll tax–funded scheme.

[6]The currency of Senegal is the CFA franc of the West African Monetary and Economic Union; however, we express money in USD PPP units for ease of comparison, where 1 USD = 219.13 CFA franc in PPP.

following, we develop and estimate the welfare gains from UI in economies consistent with these facts.

3 Model

3.1 The Baseline Baily–Chetty Model without Informality

We build on Baily (1978), Chetty (2006), and Landais et al. (2018). Following Landais et al. (2018), the economy is populated by a unit measure of ex-ante identical workers and a representative firm. There is a single final consumption good which is the numeraire.

3.1.1 Environment

Agent's problem. All workers are initially unemployed and search for a job. They choose search intensity $s_f \in [0,1]$ for a formal job, normalized to equal the probability of finding a formal job. They incur a cost for the search effort $\psi_f(s_f)$, where $\psi_f(\cdot) \in C^2([0.1])$ is positive valued, strictly increasing and convex. Some agents find jobs and become formally employed during the period (subscript f), while others do not and remain unemployed (subscript u). Jobs last during the whole period (i.e., forever). We assume initial assets a are exogenous.

The representative firm operates a production technology that is linear in labor, and so the wage w_f is constant and is unaffected by UI policies.[7] Since there is a unit measure of workers who are initially unemployed, and s_f find a job, total employment at the firm is given by s_f.

Unemployed agents receive an unemployment benefit that is fraction b of the wage, bw_f. Formally employed workers pay payroll taxes τw_f that are used to finance the unemployment benefit. Let $c_f \equiv a + (1-\tau)w_f$ denote the formal workers' consumption and $c_u \equiv a + bw_f$ denote the unemployed agents' consumption. The agents' utility function $v(\cdot) \in C^1([0,1])$ is increasing and strictly concave.[8]

Given a replacement rate b and payroll tax τ, the representative worker chooses a search effort to maximize

$$W(b,\tau) \equiv \max_{s_f \in [0,1]} \; s_f v\left(a + (1-\tau)w_f\right) + (1-s_f)v\left(a + bw_f\right) - \psi_f(s_f). \tag{1}$$

[7] There is a linear, labor-only formal production technology $y(s_f) = z_f s_f$, and so $z_f = w_f$. All workers are equally productive.

[8] To show comparative statics on job search elasticities, we the need search cost to have two continuous derivatives, while the utility of consumption may just be continuously differentiable.

Planner's problem. The Ramsey planner's problem is to choose the replacement rate b and payroll tax τ that maximizes the expected utility of the representative worker subject to agents' optimality conditions and such that the benefits paid equal taxes collected.[9] Social welfare is then given by

$$\begin{aligned} W = & \max_{(b,\tau)\in[0,1]^2} s_f v\left(a+(1-\tau)w_f\right) + (1-s_f)v\left(a+bw_f\right) - \psi_f(s_f) \qquad (2) \\ \text{s.t.} \quad & \psi_f'(s_f) = v\left(a+(1-\tau)w_f\right) - v\left(a+bw_f\right) \quad \perp \quad s_f \in \{0,1\} \\ & s_f\tau = (1-s_f)b \\ & 0 \leq s_f \leq 1. \end{aligned}$$

We analyze this problem and show, as in Chetty (2008), that the effect of unemployment benefits can be decomposed into liquidity and moral hazard effects.

3.1.2 Liquidity and Moral Hazard Effects

Proposition 1. *Suppose that the solution of the planner's problem is interior, then the marginal effect of an increase in the benefit replacement rate on social welfare is*

$$\frac{dW}{db} = \underbrace{w_f(1-s_f)\left(v'(c_u)-v'(c_f)\right)}_{\textit{liquidity effect}} + \underbrace{w_f v'(c_f)\varepsilon_{s_f,b}}_{\textit{moral hazard effect}} \qquad (3)$$

where $\varepsilon_{s_f,b} \equiv \frac{ds_f}{db}\frac{b}{s_f}$ *is the elasticity of formal employment with respect to the replacement rate.*

The proof is a standard application of the envelope theorem and is presented in Appendix A.

Unemployment insurance affects social welfare through two channels. On the one hand, the liquidity effect depends on the difference in marginal utilities between employed and unemployed states. On the other hand, the tax levied to finance the UI program reduces the attractiveness of formal employment, leading formal workers to transition to unemployment. This effect is proportional to the elasticity of formal employment with respect to the replacement rate and dampens the welfare gains from insurance.

[9] Our objective is identical to the static social welfare function maximized in Landais et al. (2018), and we therefore adopt the language and interpretation applied in that study. It is equally valid to interpret equation 2 as the expected utility of unemployed agents.

3.2 A Baily–Chetty Model with Informality and False Claims

Motivated by Facts 1 and 2 in Section 2, we add informality (subscript i) and false claims (subscript c) to the baseline Baily–Chetty model. At the beginning of the period, jobless workers search for informal jobs and formal jobs with search intensity $(s_i, s_f) \in [0;1]^2$ and $s_i + s_f \leq 1$. We assume that the search effort is separable; $\psi_f(s_f) + \psi_i(s_i)$, where $(\psi_f, \psi_s) \in C^2([0.1])^2$ are positive valued, strictly increasing and convex. The production technology of the informal sector is linear, and informal wages are lower than formal wages $w_i < w_f$. With probability $\lambda \in [0,1]$, informal workers can submit false UI claims and receive UI benefits while working. The share of false claimants is endogenously determined by a monitoring cost $\phi(\lambda)$ paid by informal workers, where ϕ is positive valued, strictly increasing and convex. Payroll taxes are only paid by formal workers. Let $c_{ic} \equiv a + w_i + bw_f$ denote the informal claimants' consumption and $c_{inc} \equiv a + w_i$ denote the informal nonclaimaints' consumption.

The planner's problem is to choose the replacement rate b and payroll tax paid by formal workers τ that maximize the expected utility of the representative worker subject to the agents' optimal formal and informal work search effort and false claim rate, such that the benefits paid equal taxes collected. Social welfare is then given by

$$
\begin{aligned}
W = \max_{(b,\tau)\in[0,1]^2} \; & s_f v\left(a + (1-\tau)w_f\right) + s_i\left(\lambda v\left(a + w_i + bw_f\right) + (1-\lambda)v\left(a + w_i\right) - \phi(\lambda)\right) \\
& + (1 - s_f - s_i)v(a + bw_f) - \psi_f(s_f) - \psi_i(s_i) \qquad (4) \\
\text{s.t.} \quad & \psi_f'(s_f) = v\left(a + (1-\tau)w_f\right) - v\left(a + bw_f\right) \quad \perp \quad s_f \in \{0,1\} \\
& \psi_i'(s_i) = \lambda v\left(a + w_i + bw_f\right) + (1-\lambda)v\left(a + w_i\right) - v\left(a + bw_f\right) \\
& \qquad - \phi(\lambda) \qquad \perp \qquad s_i \in \{0,1\} \\
& \phi'(\lambda) = v\left(a + w_i + bw_f\right) - v\left(a + w_i\right) \quad \perp \quad \lambda \in \{0,1\} \\
& s_f\tau = (1 - s_f - (1-\lambda)\, s_i)b \\
& 0 \leq s_f \leq 1, 0 \leq s_f \leq 1, 0 \leq s_f + s_i \leq 1, 0 \leq \lambda \leq 1.
\end{aligned}
$$

We can then derive the liquidity and moral hazard effects of unemployment benefits.

3.2.1 Liquidity and Moral Hazard Effects with Informality

Proposition 2. *Suppose that the solution of the planner's problem is interior, then the marginal effect of an increase in the benefit replacement rate on social welfare is*

$$\frac{dW}{db} = \underbrace{w_f \left[\lambda s_i \left(v'(c_{ic}) - v'(c_f)\right) + \left(1 - s_i - s_f\right)\left(v'(c_u) - v'(c_f)\right)\right]}_{\textit{liquidity effect}} + \underbrace{w_f v'(c_f)\left[\left(1 - s_i(1-\lambda)\right)\varepsilon_{s_f,b} + s_i(1-\lambda)\varepsilon_{s_i,b} - \varepsilon_{\lambda,b}\lambda s_i\right]}_{\textit{moral hazard effect}}, \tag{5}$$

where $\varepsilon_{s_f,b}$, $\varepsilon_{s_i,b} \equiv \frac{ds_i}{db}\frac{b}{s_i}$, *and* $\varepsilon_{\lambda,b} \equiv \frac{d\lambda}{db}\frac{b}{\lambda}$ *represent the elasticities of formal employment, informal employment, and false claims with respect to benefits, respectively.*

In addition, the moral hazard effect is negative.

The proof is presented in Appendix A. The liquidity effect depends on the marginal utility gap between formal employment and the two statuses in which benefits can be claimed, namely unemployment and the informal claimant status. That is, there is an additional liquidity effect relative to the baseline Baily–Chetty formula that arises from providing consumption insurance for some informal workers.

The moral hazard effect is proportional to the elasticities of formal employment, informal employment, and false claims with respect to benefits. Since $\varepsilon_{s_f,b} < 0, \varepsilon_{s_f,b} < 0$ and $-\varepsilon_{\lambda,b} < 0$, the moral hazard effect from an increase in the benefit replacement rate reduces welfare.

3.3 Crowding Out of Private Transfers by Public Insurance

As shown in Fact 4, informal networks are a significant form of insurance for workers in Senegal. An expansion of UI can crowd out this private insurance (Cox and Fafchamps, 2007). We capture these facts in a setting of our Baily–Chetty model with informality and false claims from Section 3.2 by allowing claimant assets (both the unemployed and informal claimants' assets) to respond to UI benefits according to $a\left(bw_f\right)$, where $a' < 0$. Specifically, we set $a\left(bw_f\right) = a - \mu b w_f$, so $a'\left(bw_f\right) = -\mu$.

Corollary 3. *Suppose that the solution of the planner's problem is interior, then the marginal payroll tax to fund the additional benefits db satisfies*

$$\frac{d\tau}{db} = \frac{1}{s_f}\left[1 - s_f - \left(1-\lambda\right)s_i - \varepsilon_{s_f,b} - \left(1-\lambda\right)s_i\left(\varepsilon_{s_i,b} - \varepsilon_{s_f,b}\right) + \varepsilon_{\lambda,b}\lambda s_i\right] \tag{6}$$

and the marginal effect of an increase in the benefit replacement rate on social welfare is

given by

$$\frac{dW}{db} = w_f \left[-s_f v'\left(c_f\right) \frac{d\tau}{db} + s_i \lambda v'\left(c_{ic}\right)\left(1-\mu\right) + \left(1-s_f-s_i\right) v'\left(c_u\right)\left(1-\mu\right) \right]. \tag{7}$$

The proof is in Appendix A. This corollary illustrates how the crowding out of private insurance by public insurance (via the term $-\mu = a'(bw_f) < 0$) reduces the welfare gains from UI.

3.4 Job Separations

In our analysis thus far, we assumed that jobs last forever. We now incorporate exogenous job separations in our model from Section 3.2 by assuming that shares δ_i and δ_f of workers who find a job in the informal and formal sectors, respectively, lose it immediately, before they start working. Given a benefit replacement rate b and income tax rate τ, the representative agent's problem is therefore

$$\begin{aligned} W = \max_{\substack{(s_f,s_i)\in[0,1]^2 \\ s_f+s_i\leq 1}} & (1-\delta_f)s_f v\left(a+(1-\tau)w_f\right) + (1-\delta_i)s_i\left[\lambda v\left(a+w_i+bw_f\right) + (1-\lambda)v\left(a+w_i\right)\right. \\ & \left. -\phi(\lambda)\right] + \left(1-(1-\delta_f)s_f-(1-\delta_i)s_i\right)v(a+bw_f) - \psi_f(s_f) - \psi_i(s_i), \end{aligned} \tag{8}$$

and the new government's budget constraint is

$$(1-\delta_f)s_f\tau = \left(1-(1-\delta_f)s_f-(1-\lambda)\left(1-\delta_i\right)s_i\right)b. \tag{9}$$

Corollary 4. *Suppose that the solution of the planner's problem is interior, then the marginal effect of an increase in the benefit replacement rate on social welfare is*

$$\begin{aligned} \frac{dW}{db} = & \underbrace{w_f\left[\lambda(1-\delta_i)s_i\left(v'(c_{ic})-v'(c_f)\right) + \left(1-(1-\delta_i)s_i-(1-\delta_f)s_f\right)\left(v'(c_u)-v'(c_f)\right)\right]}_{\textit{liquidity effect}} + \\ & \underbrace{w_f v'(c_f)\left[\left(1-(1-\delta_i)s_i(1-\lambda)\right)\varepsilon_{s_f,b} + (1-\delta_i)s_i(1-\lambda)\varepsilon_{s_i,b} - \varepsilon_{\lambda,b}\lambda(1-\delta_i)s_i\right]}_{\textit{moral hazard effect}}, \end{aligned} \tag{10}$$

The proof is presented in Appendix A. The corollary highlights that exogenous job separations have an ambiguous impact on the welfare gains from UI, as they reduce the magnitude of both the positive liquidity effects and the negative moral hazard effects.

3.5 A Model of Consumption Tax–Funded UI with Informality

We now study a model that is identical to the payroll tax economy shown in Section 3.2, with the difference that UI benefits are now funded by a consumption tax $t \in [0,1]$ levied on all consumption.

The planner's problem is to choose the replacement rate b and consumption tax t that maximize the expected utility of the representative worker subject to the agents' optimal formal and informal work search effort and false claim rate, such that the benefits paid equal taxes collected. Social welfare is then given by

$$\begin{aligned}
W = \max_{(b,t)\in[0,1]^2} \; & s_f v\left((1-t)(a+w_f)\right) + s_i\left[\lambda v\left((1-t)(a+w_i+bw_f)\right)\right. \\
& \left. + (1-\lambda)v\left((1-t)(a+w_i)\right) - \phi(\lambda)\right] \\
& + (1-s_f-s_i)v((1-t)(a+bw_f)) - \psi_f(s_f) - \psi_i(s_i) \qquad (11)\\
\text{s.t.} \quad & \psi_f'(s_f) = v\left((1-t)(a+w_f)\right) - v\left((1-t)(a+bw_f)\right) \quad \perp \quad s_f \in \{0,1\} \\
& \psi_i'(s_i) = \lambda v\left((1-t)(a+w_i+bw_f)\right) + (1-\lambda)v\left((1-t)(a+w_i)\right) \\
& \qquad - v\left((1-t)(a+bw_f)\right) - \phi(\lambda) \quad \perp \quad s_i \in \{0,1\} \\
& \phi'(\lambda) = v\left((1-t)(a+w_i+bw_f)\right) - v\left((1-t)(a+w_i)\right) \quad \perp \quad \lambda \in \{0,1\} \\
& t(a+s_iw_i+s_fw_f) = (1-t)(1-s_f-(1-\lambda)s_i)bw_f \\
& 0 \le s_f \le 1, 0 \le s_f \le 1, 0 \le s_f + s_i \le 1, 0 \le \lambda \le 1.
\end{aligned}$$

For a given consumption tax t, let $c_{f,t} \equiv (1-t)(a+w_i+bw_f)$, $c_{ic,t} \equiv (1-t)(a+w_i+bw_f)$, $c_{inc,t} \equiv (1-t)(a+w_i)$, and $c_{u,t} \equiv (1-t)(a+bw_f)$ respectively denote consumption in the formal, informal claimant, informal nonclaimant, and unemployed statuses. Aggregate consumption is defined as

$$\Omega \equiv s_f c_{f,t} + \lambda s_i c_{ic,t} + (1-\lambda)\, s_i c_{inc,t} + (1-s_f-s_i)\, c_{u,t} \qquad (12)$$

where Ω captures the taxation base for the consumption tax. The following proposition clarifies its role in funding UI.

Proposition 5. *Suppose that the solution of the planner's problem is interior, then the marginal consumption tax needed to fund the additional benefits db satisfies*

$$\frac{dt}{db} = \underbrace{\frac{(1-s_f-(1-\lambda)\,s_i)\,w_f}{\Omega}}_{\textit{mechanical effect}} \underbrace{-\frac{1}{\Omega}\left(\varepsilon_{s_f,b}\frac{s_f}{s_i} + (1-\lambda)\,\varepsilon_{s_i,b} - \varepsilon_{\lambda,b}\lambda\right) s_i w_f - t\frac{1}{\Omega}\frac{d\Omega}{db}}_{\textit{behavioral effect}} \qquad (13)$$

and the marginal effect of an increase in the benefit replacement rate on social welfare is given by

$$\frac{dW}{db} = \underbrace{s_i\left(1-\lambda\right)v'\left((1-t)c_{inc,t}\right)\left(-\frac{dt}{db}c_{inc,t}\right)}_{\textit{informal nonclaimant status}} + \underbrace{s_i\lambda v'\left((1-t)c_{ic,t}\right)\left(-\frac{dt}{db}c_{ic,t}+(1-t)w_f\right)}_{\textit{informal claimant status}}$$
$$+ \underbrace{s_f v'\left((1-t)c_{f,t}\right)\left(-\frac{dt}{db}c_{f,t}\right)}_{\textit{formal status}} + \underbrace{\left(1-s_f-s_i\right)v'\left((1-t)c_{u,t}\right)\left(-\frac{dt}{db}c_{u,t}+(1-t)w_f\right)}_{\textit{unemployed status}} \tag{14}$$

The proof is presented in Appendix A. First, the consumption tax required to fund additional benefits features (1) a mechanical effect equal to the average UI benefit per unit of aggregate consumption and (2) a behavioral effect that captures the endogenous responses of formal and informal job search, the false claim rate, and the resulting change in the taxable consumption base. Absent the behavioral effect, we see—from the denominator of the mechanical effect—that a larger base of taxable consumption lowers the marginal tax increase required to fund the UI benefits *db*. In addition, the behavioral effect is proportional to the elasticities of search and informal claiming to the benefit. Therefore, if the moral hazard effects are small, we can expect the marginal tax change needed to fund additional benefits to be mainly driven by the mechanical tax base effect.

Second, the marginal effect of an increase in the benefit replacement rate on social welfare is composed of several potentially offsetting effects. Higher consumption taxes lower the welfare of those in the formal and informal nonclaimant statuses, since they pay the consumption tax without receiving benefits. At the same time, those in the informal claimant and unemployed statuses enjoy welfare gains from benefit receipt; however, they also must pay taxes on the added consumption arising from these benefits. These terms reflect the less targeted nature of consumption taxes (i.e., unemployed agents are part of the tax base, and benefits are taxed when they are spent).

3.6 Consumption Tax Evasion

As most workers in the labor force in Senegal are employed in the informal sector, part of their production is likely to be sold in the informal market, as in Bachas et al. (2023). Thus, some portion of the consumption across all agents is not subject to a consumption tax.

We capture these facts by differentiating food and nonfood consumption in the consumption-tax model of Section 3.5. Let γ_f, γ_i, and γ_u denote the share of consumption spent on food by formal, informal, and unemployed workers, respectively. We assume

that these shares are fixed and exogenous and that food consumption is purchased in the informal market and cannot be taxed. The taxable consumption base then becomes

$$\Omega = s_f \left(1-\gamma_f\right) c_{f,t} + \lambda s_i \left(1-\gamma_i\right) c_{ic,t} + \left(1-\lambda\right) s_i \left(1-\gamma_i\right) c_{inc,t} + \left(1-s_f-s_i\right)\left(1-\gamma_u\right) c_{u,t} \tag{15}$$

and the government budget constraint becomes

$$t\Omega = \left(1-s_f-\left(1-\lambda\right)s_i\right) b w_f. \tag{16}$$

The following corollary establishes the impact of consumption tax evasion on the potential gains from UI.

Corollary 6. *Suppose that the solution of the planner's problem is interior, then the marginal consumption tax needed to fund the additional benefits db satisfies equation (13) with the definition of the taxable consumption base (15), and the marginal effect of an increase in the benefit replacement rate on social welfare is given by*

$$\begin{aligned}
\frac{dW}{db} =& s_f v'\left[c_{f,t}\left(1-t(1-\gamma_f)\right)\right]\left(-\frac{dt}{db}\left(1-\gamma_f\right)c_{f,t}\right) \\
&+ s_i\left(1-\lambda\right)v'\left[c_{inc,t}\left(1-t(1-\gamma_i)\right)\right]\left(-\frac{dt}{db}\left(1-\gamma_i\right)c_{inc,t}\right) \\
&+ s_i\lambda v'\left[c_{ic,t}\left(1-t(1-\gamma_i)\right)\right]\left(\gamma_i w_f + \left(1-\gamma_i\right)\left(-\frac{dt}{db}c_{ic,t} + \left(1-t\right)w_f\right)\right) \\
&+ \left(1-s_f-s_i\right)v'\left[c_{u,t}\left(1-t(1-\gamma_u)\right)\right]\left(\gamma_u w_f + \left(1-\gamma_u\right)\left(-\frac{dt}{db}c_{u,t} + \left(1-t\right)w_f\right)\right)
\end{aligned} \tag{17}$$

The proof is in Appendix A. When benefits expand and consumption taxes rise, the tax burden depends on the relative values of γ_f, γ_i, and γ_u. When low consumption agents have high food consumption shares, taxes are more targeted and welfare gains are larger. In other words, consumption tax evasion by poor households amplifies the welfare gains from UI.

4 Data and Calibration

4.1 Survey Design

To calibrate the key model parameters in Section 3, we conducted a custom survey with a representative sample of the urban population in Senegal. This approach aligns with common

practices for labor force surveys conducted in low-income countries, which primarily focus on urban areas.[10] Thus, we abstract from the spillover effects of labor market policies on rural migration emphasized in the literature (Harris and Todaro, 1970; Imbert and Papp, 2020). Furthermore, rural areas, where agricultural workers are typically found in Senegal, have dedicated government programs, such as agricultural input subsidies, which could mitigate any potential effect of UI on rural–urban migration.[11]

The survey design follows a stratified random sampling approach. First, we define the population of the study as all active workers, which are individuals aged 15 or above, in Dakar, the capital of Senegal. Second, we use enumeration areas (EAs) as our primary sampling units (PSUs), as defined by the national statistical agency during the 2013 population census of Senegal. These EAs are distributed across the five districts in the region of Dakar: Dakar district, Guediawaye, Keur Massar, Pikine, and Rufisque. We randomly select 23 EAs from the set of 129 in Dakar. Third, within each selected EA, we randomly sample 15 households. The survey thus covers all individuals aged 15 and over within these selected households. In total, we survey 1,378 individuals across 345 households.

Table 1 compares key demographic variables, employment, and job search characteristics for two groups: the sample of respondents from our survey (columns (1)–(3)) and the urban respondents from the nationally representative labor force surveys conducted by the ANSD (columns (4)–(6)). The sample displays a relatively balanced distribution across general demographic variables, age groups, and reasons for no job search. However, respondents in our custom survey are notably more educated, more likely to be employed, more likely to be in the formal sector and earn on average higher wages than respondents in the national labor force surveys. These disparities in employment and socioeconomic characteristics can be attributed to two factors: (i) our survey was conducted in the Senegalese capital, which is the largest urban area and noted for its high literacy, and (ii) the timing of our study (May 2022) was different from that of ANSD, which was conducted between 2017 and 2019. We account for these differences when we study how our results depend on the size of the formal sector in Section 5.2.3.

The survey includes a range of modules covering demographics, employment, job search, consumption expenditures, savings and borrowing, risk aversion, and general opinions and attitudes toward UI. Data Appendix C provides more detail on the survey components.

Table C2 presents summary statistics on employment status and (in)formality. Using these data, we replicate the composition of Senegal's labor force, which serves as a key in-

[10] In our context, it would be prohibitively expensive to create a labor force survey covering both urban and rural workers.

[11] See the discussion of agricultural workers and the reasons for their exclusion in the analysis in Section 6.

put for our estimates. The labor force in our study area breaks down into 16.95% formally employed individuals, 51.29% informally employed individuals, and 31.76% unemployed individuals actively seeking employment.

Table C3 summarizes survey responses for salary and household consumption expenditures. In line with the definitions used by ANSD, we define the active population as all individuals aged 15 years or above and define the labor force as all active individuals in paid employment, actively searching for a paid job while being unemployed, or not searching for a job for involuntary reasons. The unemployment rate is thus defined as the share of the labor force represented by individuals actively searching for a paid job while being unemployed or not searching for a job for involuntary reasons.[12] In Table 5, we consider an alternate, stricter definition of unemployment that drops those not searching for a job for involuntary reasons. We then construct information on individual consumption by employment status, another crucial input for our model. We find estimates of average consumption values of \$339 for formally employed workers, \$252 for informally employed workers, and \$158 for unemployed individuals. The consumption gap between formally employed workers and the unemployed is 53%.

Our survey data indicate that a significant proportion of individuals in our context exhibit relatively high risk aversion. In this section and the remainder of the paper, we assume $v(c) = \frac{c^{1-\sigma}}{1-\sigma}$ and we estimate an average risk aversion coefficient $\sigma = 3.519$ for our sample. For a detailed explanation of the methodology employed to assess individuals' risk aversion, please refer to Appendix B1. This value exceeds typical coefficients for constant relative risk aversion (CRRA) used in macroeconomic models, emphasizing the importance of a robust safety net in this economy. We assess the robustness of our results to lower values of risk aversion.

Last, in order to measure the potential moral hazard effects of UI expansion, we asked respondents hypothetical questions. For a given replacement rate of X% on a base salary of Z\$, provided over Y months, we asked whether individuals would quit their formal or informal jobs:

> *Suppose the government puts in place a worker protection program over the next [Y] months, which would consist of offering each unemployed person \$ [X% * Z] per month during this period. Would you leave your current job (even if temporarily) during these [Y] months?*

Table 2 reports the elasticity of overall employment ($\varepsilon_{s,b}$), formal employment ($\varepsilon_{s_f,b}$),

[12] Please see Appendix B3 for detailed information on the study context and definitions of key terms related to the Senegalese labor market.

informal employment ($\varepsilon_{s_i,b}$), and false claims ($\varepsilon_{\lambda,b}$) with respect to benefits.[13] We compute elasticities using arc percent changes. Our elasticity of overall employment with respect to benefits implies that a 10 percent increase in the benefit replacement rate would only lower the overall employment share by 0.6 percent. We provide more discussion of these elasticities in Section Appendix B4.

4.2 Calibration of the Welfare Effects of a Marginal UI Expansion

Beginning *with the current Senegalese economy*, we compute the welfare gains from a marginal expansion of unemployment insurance. The current Senegalese economy corresponds to a setting with zero unemployment insurance, $(\tau, t, b) = (0, 0, 0)$. Since $b = 0$, there are zero false claims $\lambda = 0$, and informal claimants and non-claimants have identical consumption $c_{inc} = c_{ic}$ (this common value of informal consumption corresponds to c_i, which is observed in the data).[14] We then use our survey to measure the remaining variables $(s_f, s_i, c_f, c_u, c_{inc}, c_{ic})$ and corresponding elasticities $(\varepsilon_{s,b}, \varepsilon_{s_f,b}, \varepsilon_{s_i,b}, \varepsilon_{\lambda,b})$. Table 2 provides a comprehensive overview of the parameters, including their definitions, values, estimation methods, and sources. See Numerical Appendix B for detailed, step-by-step explanations of how each of these parameters is estimated.

We measure the gains from small UI expansions by adapting Chetty (2006)'s method to our framework. We compute consumption-equivalent welfare gains x from a given policy change as $x = \frac{dW}{w_f db}\frac{1}{s_u v'(c_u)}$, evaluated at the current values of Senegalese policy variables $(\tau, t, b) = (0, 0, 0)$. By normalizing the welfare gains by the marginal utility of the unemployed $s_u v'(c_u)$ and dividing by the \$ value of marginal benefits $w_f db$, our definition of consumption-equivalent welfare means that a \$1 balanced-budget increase in the monthly benefit level would raise each individual's utility by the same amount as an \$ x increase in the monthly consumption of the unemployed.[15] In other words, x is the equivalent exogenous transfer in the unemployed state that would yield the same utility as UI.

[13]The arc elasticity of false claims with respect to benefits is proxied via the informal quit elasticity. The informal quit elasticity is an imperfect metric for the fraction of informal agents who would alter their employment patterns in response to a UI system and potentially claim UI. However, it does not enter any of the headline calculations in Table 4 (the $b = 0$ initial steady state has $\lambda = 0$, and thus the elasticity $\epsilon_{\lambda,b}$ drops out). A direct measure of false claims is important for future research on this topic. As we discussed in Fact 2, there are many undeclared informal workers in formal firms who could falsely claim UI.

[14]We account for large responses in informal claims when we quantify the effects of large UI expansions in the next section.

[15]There are alternative conversions of our welfare measure, such as the marginal value of public funds found in Hendren and Sprung-Keyser (2020) or incentive-compatible uniform consumption gains as in Ndiaye (2018).

4.3 Calibration of the Welfare Effects of a Large UI Expansion

Our formulas of Section 3 provide a way of assessing the welfare gains from small UI expansions. For larger UI expansions, we compute the endogenous changes in search effort and false claims. This section summarizes our approach to computing these counterfactual values, the details of which are presented in Appendix B6.

We proceed in three steps. First, we assume iso-elastic functions for formal search, informal search, and false claims costs:

$$\psi_f(s_f) = a_f \frac{s_f^{1+\frac{1}{\epsilon_f}}}{1+\frac{1}{\epsilon_f}}, \qquad \psi_i(s_i) = a_i \frac{s_i^{1+\frac{1}{\epsilon_i}}}{1+\frac{1}{\epsilon_i}} \qquad \phi(\lambda) = a_\lambda \frac{\lambda^{1+\frac{1}{\epsilon_\lambda}}}{1+\frac{1}{\epsilon_\lambda}}.$$

Second, we estimate these parameters to match the current Senegalese economy with $(b, \lambda, \tau) = (0, 0, 0)$, since there is currently no UI. We calibrate $\{\epsilon_f, \epsilon_i, \epsilon_\lambda\}$ to match the 3 arc elasticities measured in our survey.[16] We calibrate the shifters $\{a_f, a_i\}$ to match the formal and informal employment shares when $\tau = 0$ and $b = 0$. Finally, we calibrate a_λ to deliver various false claims rates $\lambda \in [0, 1]$. We report the estimated values and corresponding moments in Table 3.

Third, if the replacement rate b is feasible—that is, if job search choices are interior and there exists a payroll tax $\tau(b)$ that satisfies the government budget constraint given these choices—we convert the discrete welfare change, $W(b, \tau(b)) - W(0, 0)$, into a dollar-on-dollar metric similar to our approach in Section 4.2 according to $x = \frac{W(b,\tau(b))-W(0,0)}{w_f b} \frac{1}{v'(c_u)s_u}$.

5 Numerical Results

In this section, we report the welfare gains from small and large UI expansions following the methodology and calibration strategy outlined above.

5.1 Welfare Gains from a Small UI Expansion

Table 4 reports the dollar-on-dollar welfare gains from a small expansion of UI, $\frac{dW}{w_f db}\frac{1}{s_u v'(c_u)}$, for each of the three model economies when evaluated using the current values for the Senegalese policy variables.

Payroll taxes. The welfare gains from a payroll-financed unemployment insurance expansion in Senegal are large relative to those calculated for an economy with consumption gaps

[16] We calibrate the elasticities assuming there is a payroll tax, and we use the same elasticities in all model economies.

similar to those in the US. In our baseline Baily–Chetty model with payroll-financed UI and no informality, the dollar-on-dollar gain is 0.83. A value of $\frac{dW}{w_f db}\frac{1}{s_u v'(c_u)} = 0.83$ means that a dollar increase in benefits yields welfare gains equivalent to an 83-cent exogenous transfer in the unemployed state. We then recalibrate the baseline Senegal economy to match the U.S. *consumption gap* between the employed and unemployed. Most U.S. estimates of the consumption loss after layoff lie between 5% and 15% relative to pre-displacement consumption, and we conservatively use the upper bound of these estimates for our comparison (e.g. Stephens Jr (2001), Saporta-Eksten (2014), and Ganong and Noel (2019)). Holding all else fixed, when we lower the consumption gap from the current Senegal level of 40% to the U.S. level of 15%, the welfare gains fall to 0.26, or by a factor of three. This implies that liquidity effects are the primary driver of the large welfare gains from UI in Senegal. Columns (2) and (3) of Table 4 formalize this intuition by showing that liquidity effects explain 103% of the total gains from UI, while moral hazard effects are more muted and lower the gains by 3%.

In addition to the wider consumption gap in Senegal, there is a second factor generating large welfare gains: the high estimated level of risk aversion. Our baseline estimate of the CRRA risk aversion parameter in Senegal is 3.519. When we jointly reduce the consumption gap and lower the level of risk aversion to 1.75—as used by Chetty (2008)—the welfare gains fall to 0.05, or by a factor of sixteen. These alternative calibrations suggest that relative to the US, Senegal can achieve much larger welfare gains from marginal expansions of UI due to greater consumption gaps and high degrees of risk aversion relative to the U.S.

The middle three rows of Table 4 show that the large welfare gains from UI in Senegal are robust to the inclusion of informality, false claims, private transfers, and high job separation rates. First, when we add informality and false claims, the welfare gains rise relative to our baseline economy to 0.92. Informally employed households are numerous, and their consumption gap relative to that of formally employed households is 25%. By modeling informal employment, the payroll tax effectively becomes more targeted. Second, we show that our results are robust to assuming a public–private crowd-out rate of 24.6%, which is at the upper end of the estimates reported in Cox and Fafchamps (2007). Accounting for the crowding out of private transfers reduces the welfare gains to 0.68, which is still significantly larger than the U.S. calibrations. Last, we model a probability of immediate job loss. Given that we do not have good measures of labor market flows in Senegal, we conservatively select the job separation rates from Donovan et al. (2021) at the top decile and bottom decile of the income distribution to proxy for $\delta_f = 0.05$ and $\delta_i = 0.3$, respectively. These represent lower and upper bounds of the separation rates documented by Donovan et al. (2021) in developing countries. Accounting for immediate exogenous job separations has little impact on the magnitude of these welfare gains.

Consumption taxes. Our second set of numerical results compares payroll tax funding to consumption tax funding. The last two rows of Table 4 show that the welfare gains in this scenario are smaller but remain large in comparison to those from the U.S. payroll tax calibrations. Given a consumption tax, the model with informality has welfare gains of 0.62. As discussed in Section 3.5, consumption taxes are significantly less targeted: Unlike in the payroll tax economy, with consumption taxes, the unemployed and informal households partially fund the UI system via consumption taxes (including taxes levied when they spend their benefits). Columns (2) and (3) of Table 4 show that liquidity effects remain the dominant source of welfare gains, explaining 107% of the total gains from UI. In this scenario, the moral hazard effects are much smaller and lower the gains by 7%.

The last row of Table 4 shows that welfare gains from UI remain high in Senegal even when significant portions of consumption are untaxed. When we account for untaxed informal food consumption, the welfare gains actually *rise* to 0.63. The welfare gains rise because our survey estimates imply greater scope for consumption tax evasion among unemployed households. The ability of the unemployed to evade taxes effectively improves the targeting of the consumption tax. At the extreme, if the informally employed and unemployed avoid all consumption taxes, the economy would behave in a manner very similar to an economy under a payroll tax–funded system.

Moral hazard. Through all of our experiments, the losses from moral hazard are modest relative to liquidity effects of UI, ranging from -0.62% to -7.29% for our Senegalese calibrations. However, when we calibrate to U.S. levels of consumption gaps, the moral hazard effects become non-negligible relative to the liquidity effects and can result in losses in potential welfare from 33.22% to 76.17%.

5.2 Welfare Gains from a Large UI Expansion

Our next exercise computes the welfare gains from larger UI expansions. We estimate the mean welfare gains from the introduction of a UI system that delivers $25 PPP in benefits and replaces approximately 2% of the average formal workers' wage.[17] We call this a large UI expansion, since the replaced income constitutes 16% of the consumption of the unemployed and Senegal does not currently have a UI system.

[17]This policy leads exactly to a replacement of 2.03% of the formal wages in our quantitative exercise which we refer throughout the text as 2% for simplicity.

5.2.1 Aggregate Welfare Gains

We measure the dollar-on-dollar gains from labor tax–funded and consumption tax–funded UI expansions, and we show how those gains vary with the *final* false claims rate, λ.[18] We control the *final* false claims rate by varying the cost of false claims, a_λ, so that after the benefit expansion, workers endogenously choose the desired level of false claims.

Our main results are shown in Figure 5. We plot the representative worker's dollar consumption gains per dollar of benefits when the UI expansion is funded via payroll taxes (on the left) and consumption taxes (on the right).

In the left panel, the policy provides large welfare gains, since liquidity effects are very large (see Table 4). However, as explained in Section 3, when a payroll tax is used to fund the policy, a trade-off emerges as the share of false claims increases. In this baseline scenario, severe rates of false claims distort the incentives of formal workers, thereby attenuating the welfare gains derived from the provision of liquidity to other workers. Once λ reaches 80%, there is no combination of tax rates and employment shares that satisfies both the government budget constraint and the incentives of formal workers, making the policy infeasible.

Turning to the right panel of Figure 5, we show that the welfare gains from funding the UI expansion with consumption taxes are smaller and decreasing in the false claims rate λ. An increase in λ redistributes resources inefficiently by raising the tax burden on those with the highest marginal utility of consumption: unemployed individuals. As a result, the welfare gains fall as λ increases. However, the policy remains feasible even at high false claim rates.

5.2.2 Aggregate Moral Hazard Effects

We next explore the moral hazard effects of the large UI expansion. Figure 6 illustrates the changes in formal and informal employment following the introduction of UI.

In the left panel, which analyzes the payroll tax economy (the model in Section 3.2), we see that raising b lowers the shares of formal and informal workers by 6.8% and 27.7%, respectively, when $\lambda = 0$. This relatively large reduction in formal employment may dampen the gains from UI if the government weighs formal employment as a policy objective.

Figure 6 shows that an increase in the false claims rate has opposing effects on the two ratios. On the one hand, some informal workers manage to claim UI benefits, which incentivizes them to remain employed. On the other hand, as the tax burden on formal workers increases to match the higher false claims rate, the willingness to search for a formal job

[18] While we provide an initial guess for λ in the small UI exercise, we face considerable uncertainty over its value; hence, we vary λ in each experiment.

decreases. Above a false claim rate of 80%, the policy becomes infeasible because there is no payroll tax rate τ that both satisfies the budget constraint and is incentive compatible for formal workers. At that threshold, the shares of formal and informal employment decline from their levels before the introduction of UI by approximately 14.1% and 22.5%, respectively.

In the right panel, we instead analyze the consumption tax economy (the model in Section 3.5). First, we notice that the reduction in the formal shares is smaller than that under the payroll tax–funded system, as the shares of formal and informal employment decline by approximately 3.2% and 22.8%, respectively, when $\lambda = 0$. Like for the payroll tax economy, when the rate of false claims increases, some informal workers manage to claim UI benefits, which incentivizes them to remain employed. However, a larger false claims rate requires a larger consumption tax rate to be paid by all workers, and not just formal workers. Therefore, the drop in the share of formal workers after the large UI expansion need not be larger at higher false claim rates. When λ reaches 100%, the shares of formal and informal employment decline by 2.3% and 11.3%, respectively.

5.2.3 Feasibility of Funding UI by Payroll and Consumption Taxes

As seen above, a payroll tax–funded UI scheme might be infeasible at high levels of false claims. Here, we study how this feasibility cutoff varies with the size of the formal sector. This section is also motivated by the fact that, as discussed in Section 2, the share of formal workers varies with the notion of formality, in particular based on whether it is defined at the firm or at the worker level. ANSD defines unemployment to include a large segment of discouraged workers, and Table 5 summarizes the differences in the percentage of formal, informal, and unemployed between the ANSD definition of employment and a stricter definition. In addition, our dataset covers urban areas, which tend to have higher formalization rates than rural areas.

Figure 7 repeats our numerical exercise for a range of formal worker shares.[19] The left panel illustrates the adverse welfare effects stemming from the burden imposed by the payroll tax when the proportion of formal workers is low. Specifically, at formal employment rates below 20%, a sizable payroll tax is required to finance the UI benefits. The high payroll tax induces a moral hazard effect, which dampens the welfare gains as the rate of false claims increases. At large values of λ, these policies are infeasible, as the share of formal workers is too low to cover the costs of financing the policy. Figure 7 shows that with a formal worker

[19] We change the share of formal workers by reallocating workers between informal and formal status while keeping the total employment rate constant for simplicity. We do so by changing the relative costs of search, a_f and a_i, so that total employment remains the same and we achieve the desired split of employment between formal and informal sectors.

share of 12.5%, the payroll tax–funded scheme becomes infeasible at false claim rates above 20%.

When the formal employment share rises above 20%, the welfare gains from UI are concave in the false claims rate. On the one hand, as informal work can only partially offset the declines in consumption after a job loss, there are liquidity gains from extending insurance to informal workers. On the other hand, when the rate of false claimants increases too much, the moral hazard effect produced by the additional taxation surpasses the additional liquidity gains. In the figure, two of the curves have this concave shape. At a formal rate of 20%, the maximum welfare gains are reached when only 30% of informal workers claim benefits. After this threshold, the policy loses effectiveness. At a formal share of 30%, the policy is always feasible but reaches its maximum welfare potential at $\lambda = 90\%$. At this formal share, there is little loss from extending insurance to informal workers. Furthermore, as informal workers now represent a lower share of the employed, the impact of an increase in false claims (λ) on both the liquidity and moral hazard effects is smaller, given that there are fewer informal workers to claim UI benefits. Therefore, the slope of welfare as a function of λ is flatter when the formal share is higher.

In the right panel of Figure 7, we study the implications of different formal worker shares when UI is funded via a consumption tax. Since the benefits are funded by a consumption tax paid by everyone, irrespective of work status, the moral hazard effects are not as strong as they are in the payroll tax economy when the proportion of informal workers decreases. Therefore, consumption taxes can guarantee the feasibility of UI and a minimum level of welfare gains even at very low shares of formal employment by guaranteeing a broad base.

Taking stock. Payroll taxes can predictably provide large welfare gains irrespective of the rate of false claims when the economy is highly formal but can be infeasible when the economy is highly informal.

6 Discussion

Before concluding, we must discuss several caveats of our analysis.

Agriculture: As noted in Section 4, our custom survey focuses on an urban setting and does not allow us to directly model the agricultural sector in our analysis. We address this in three ways.

First, in Figure 7, we simulate lower formal employment shares—which can be viewed as a proxy for a larger agriculture/informal sector—and we show that our key qualitative

results persist: Payroll taxes provide greater welfare gains but become infeasible as false claims increase, while consumption taxes are less targeted but remain feasible as false claims increase.

Second, in Section 3.6, we let informal food consumption be untaxed, which can be interpreted as subsistence agricultural consumption (albeit in the urban context of Dakar). Given our observed shares, we find that welfare gains from the consumption tax–funded UI system are higher when we account for informal consumption. This is consistent with Bachas et al. (2023), who find that consumption taxes can be progressive when accounting for informal consumption.

Third, the agricultural workers in our context receive targeted support from the government through ISPs, which have been in Senegal since 2007 and have provided subsidized seeds, fertilizers and pesticides to farmers in the country's rural areas. These ISPs account for approximately one-third of the budget for agriculture, which in turn accounts for 7.4% of the total national budget (IPAR, 2015). We hypothesize that this pre-existing agriculture-specific safety net will dampen any potential industry switching resulting from an expansion of the non-agriculture safety net.

Dynamics: Given the limitations of our data, we conduct our analysis in a static model. Several papers highlight the importance of dynamics in unemployment insurance (Hopenhayn and Nicolini, 1997; Birinci and See, 2023). We address this in two ways.

First, in Section 3.4, we model immediate exogenous job separations in our framework. This modification effectively dampens the gains from formal employment and generates a larger share of unemployed individuals. We show in Table 4 that it does not materially change the quantitative or qualitative interpretation of our results.

Second, we argue that several characteristics of our data suggest a limited role for intertemporal smoothing. Chetty (2006) shows that in a dynamic setting, a standard Baily–Chetty formula, similar to ours, still applies.[20] However, the dynamic Baily–Chetty formula should be calibrated to match intertemporal consumption/saving choices and dynamic elasticities. We hypothesize that our static assumptions are well suited for the Senegalese context for two reasons: (i) Our survey evidence shows that benefit recipients effectively live hand-to-mouth, with extremely low asset stocks (see Figure 3),[21] and (ii) our survey evidence implies

[20] This finding holds even with additional complications such as "arbitrary borrowing constraints, durable consumption goods, private insurance arrangements, and search and leisure benefits of unemployment" (Chetty, 2006).

[21] In other developing economy settings, Gerard and Naritomi (2021) show that dismissed workers eligible for both UI and severance pay increase consumption at layoff by 35% despite experiencing a 14% long-term loss when they stop receiving any benefits. The authors explain this result by a present bias in workers in intertemporal consumption choices.

similar short-run and long-run quit elasticities (see Table B1 of our Appendix), with the caveat that at very high replacement rate levels (above 50%), long run and short-run search elasticities begin to diverge. For the relatively low replacement rate increases considered in this paper, we believe a richer dynamic setting will therefore not alter our main result that small UI expansions provide large welfare gains in Senegal and that payroll taxes—unlike consumption taxes—become infeasible as the false claims rate rises.

7 Conclusion

This paper examines the welfare effects of UI in economies characterized by high informality and low enforcement of UI eligibility criteria. Our survey findings indicate substantial drops in consumption following unemployment along with high levels of risk aversion. We find that the moral hazard effects of UI are modest relative to liquidity gains, as a significant portion of employed workers continue working even with relatively generous UI provision. With its substantial liquidity effects and limited moral hazard effects, UI has the potential to yield significant benefits in Senegal and other low-income African countries with similar labor markets. Across payroll tax– and consumption tax–funded UI schemes, we estimate that an extra dollar of UI benefits in Senegal yields a consumption-equivalent gain of 60–90 cents. This money-metric welfare gain from UI exceeds comparable estimates for consumption gaps and risk aversion calibrated to U.S. values by a factor of three to sixteen.

Ideally, UI would insure against the risk of income loss associated with informal work. Nevertheless, the challenges associated with verifying the work status and income of informal workers present practical hurdles to implementing such an unemployment insurance system. Given that the informal sector accounts for the majority of employment in Senegal, identifying the appropriate individuals to tax for financing and distinguishing between actual unemployed claimants and informal workers posing as unemployed claimants become daunting tasks. In a scenario where the government cannot effectively differentiate between informal employment and unemployment, the cost of financing and monitoring UI can become prohibitively high. We show that when the share of formal workers relative to benefits is low, a UI scheme funded by payroll taxes can become infeasible at high false claim rates.

In economies with a significant informal sector, financing a UI policy with a broad-based tax, such as a consumption tax, is a feasible compromise. This approach mitigates the moral hazard effect associated with payroll financing and is robust against the potential infeasibility of UI that may arise with a high payroll tax on a small formal base.

Once the economy achieves a higher level of formalization, characterized by an increased taxable base and a reduced share of false claimants, the payroll tax financing scheme sur-

passes the consumption tax in efficiency, confirming the findings obtained for economies with negligible levels of informality.

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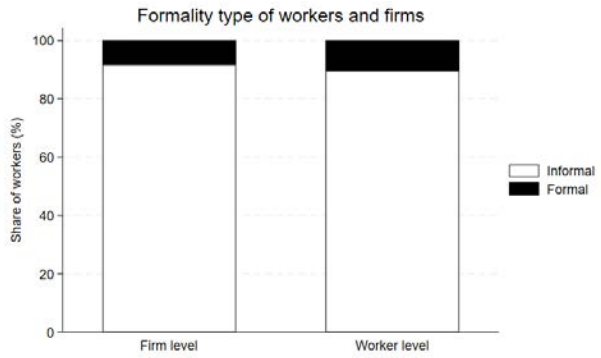
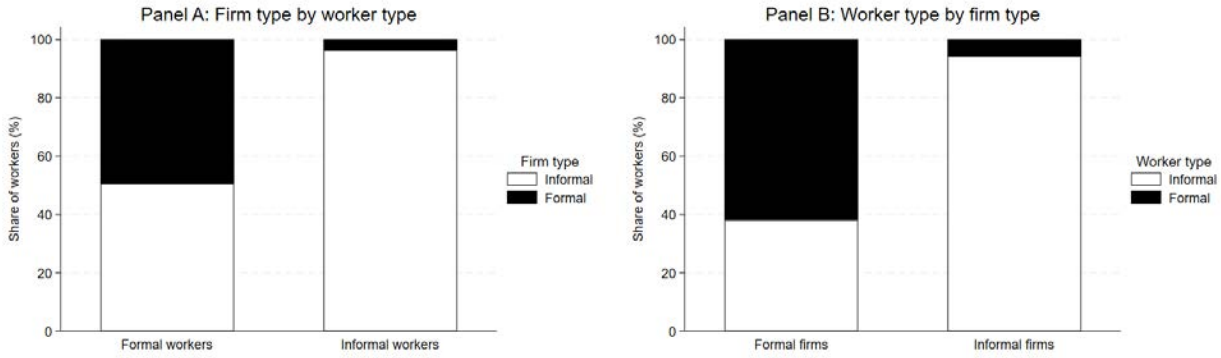
Figures

Figure 1: Formality Status of Workers and Firms in the Senegalese Labor Market



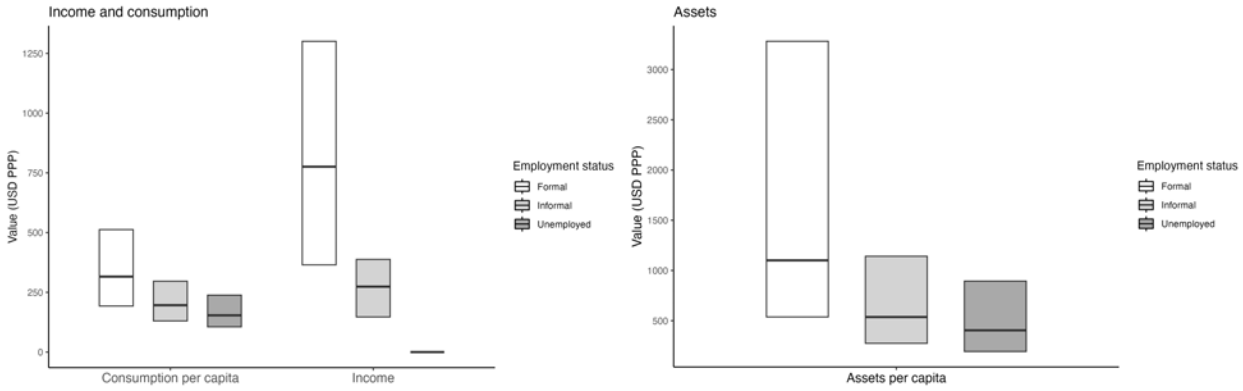
Notes: This figure shows the shares of formal and informal firms (on the left) and the shares of formal and informal workers (on the right). The shares of formal workers in firms are shown in black and those of informal workers in white. Informal workers are workers with no formal, written work contract. Informal firms are firms with no formal accounting system and no formal registration. The graph uses the pooled quarterly ENES data from between 2015 and 2019. Each observation is a household member in a chosen enumeration area. The analysis sample includes only individuals in the labor force.

Figure 2: Formality Status of Workers and Firms by Worker and Firm Type



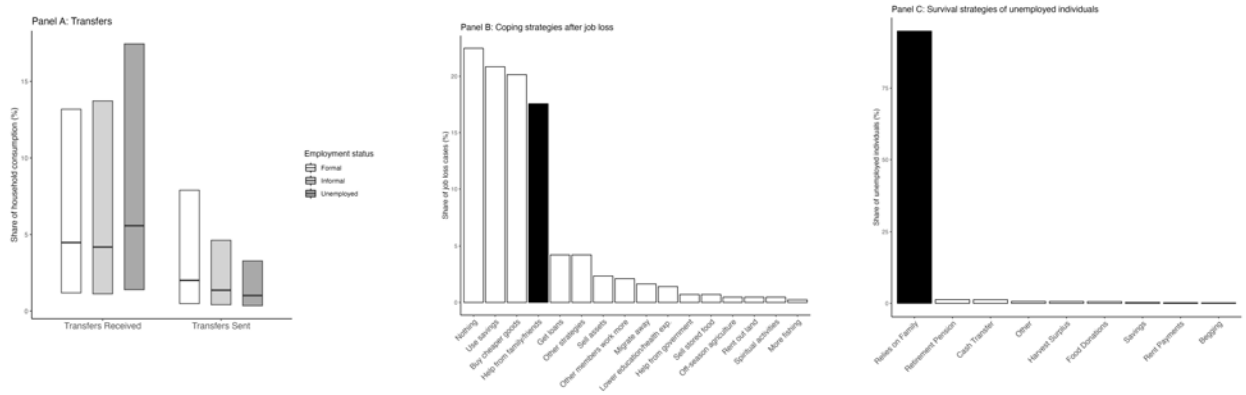
Notes: This figure shows the firm formality status of formal and informal workers (panel A) and the contract formality status for workers at formal and informal firms (panel B). The formal shares are shown in black and the informal shares in white. Informal workers are workers with no formal, written work contract. Informal firms are firms with no formal accounting system and no formal registration. The graph uses the pooled quarterly ENES data from between 2017 and 2019. The analysis sample includes only individuals in the labor force.

Figure 3: Distribution of Income, Consumption, and Assets by Work Status



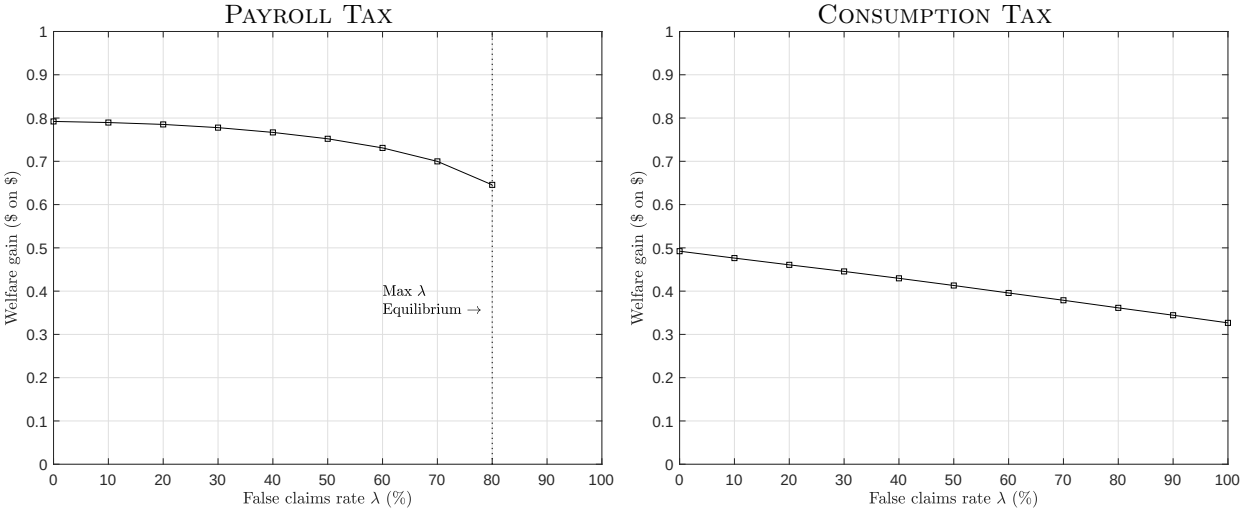
Notes: This figure shows the median, 25 percentile and 75 percentile of monthly consumption per capita and monthly income (on the left) and assets per capita (on the right) for formal workers, informal workers, and unemployed individuals. Formal workers are wage earners with formal, written work contracts. Informal workers are wage earners with no written contract. Unemployed individuals are individuals aged 15 or above with no job who are actively looking for a job or are not looking for one for involuntary reasons. Bars in white are for formal workers, those in light gray are for informal workers and those in dark gray are for unemployed individuals. The horizontal bold lines represent median values. The horizontal lines at the bottom and top of the bar graphs correspond to the 25 and 75 percentiles, respectively. Consumption per capita is calculated as reported household consumption divided by reported household size. Income is calculated as the sum of reported income and work benefits such as bonus payments, transportation subsidies, and meal subsidies. Assets per capita are calculated as the total value of reported household assets divided by household size. The analysis sample is the set of respondents aged 15 or above in the EHCVM 2018/2019. The raw values given in CFA francs are converted to US dollars using a purchasing power parity exchange rate of 1 USD = 219.13 CFA francs.

Figure 4: Informal Transfers Received and Coping Strategies After Job Loss



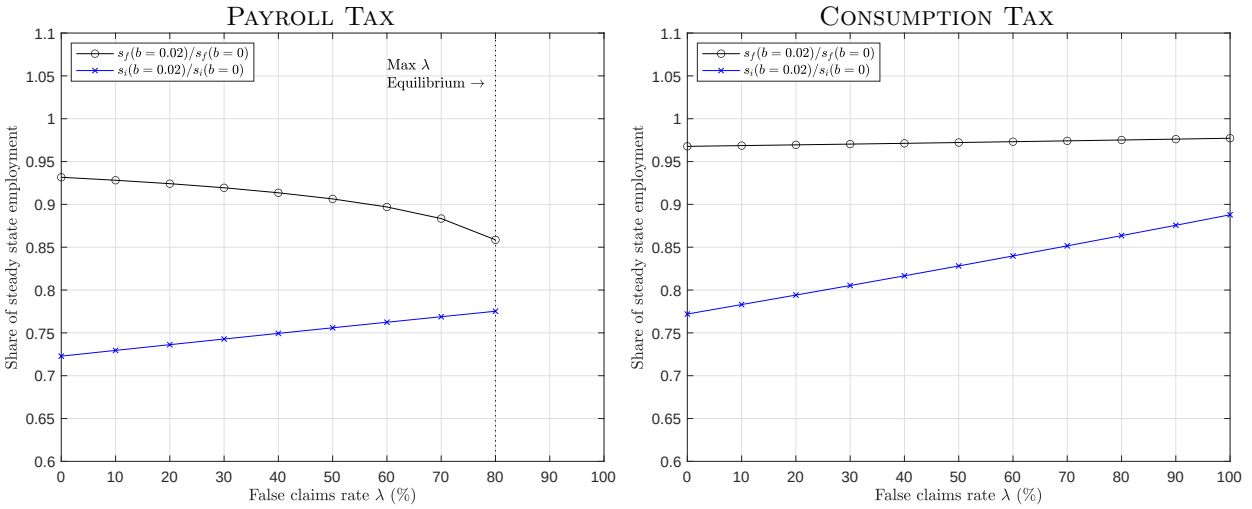
Notes: Panel A shows the median, 25 percentile, and 75 percentile of informal transfers received and sent (as a share of household consumption) for formal workers, informal workers, and unemployed workers. Formal workers are wage earners with formal, written work contracts. Informal workers are wage earners with no written contract. Unemployed individuals are individuals aged 15 or above with no job who are looking for a job or are not looking for work for involuntary reasons. Bars in white are for formal workers, those in light gray are for informal workers, and those in dark gray are for unemployed individuals. The horizontal bold lines represent median values. The horizontal lines at the bottom and top of the bar graphs correspond to the 25 and 75 percentiles, respectively. The analysis sample for panel A is the set of respondents aged 15 or above in the EHCVM 2018/2019. Panel B shows the share of workers who report using the coping strategies presented on the x-axis of the figure when they lost their jobs. The analysis sample for panel B is the set of respondents aged 15 or above in the EHCVM 2018/2019 and in the EHCVM 2021/2022. The sample is restricted to individuals who lost their jobs and reported such job loss as a major event in the last 3 years preceding the survey. Panel C reports the share of unemployed individuals who report using the option presented on the x-axis as their main survival strategy. The analysis sample for panel C is the set of respondents aged 15 or above in the EHCVM 2018/2019.

Figure 5: Money-Metric Consumption Gain per Dollar of Benefits



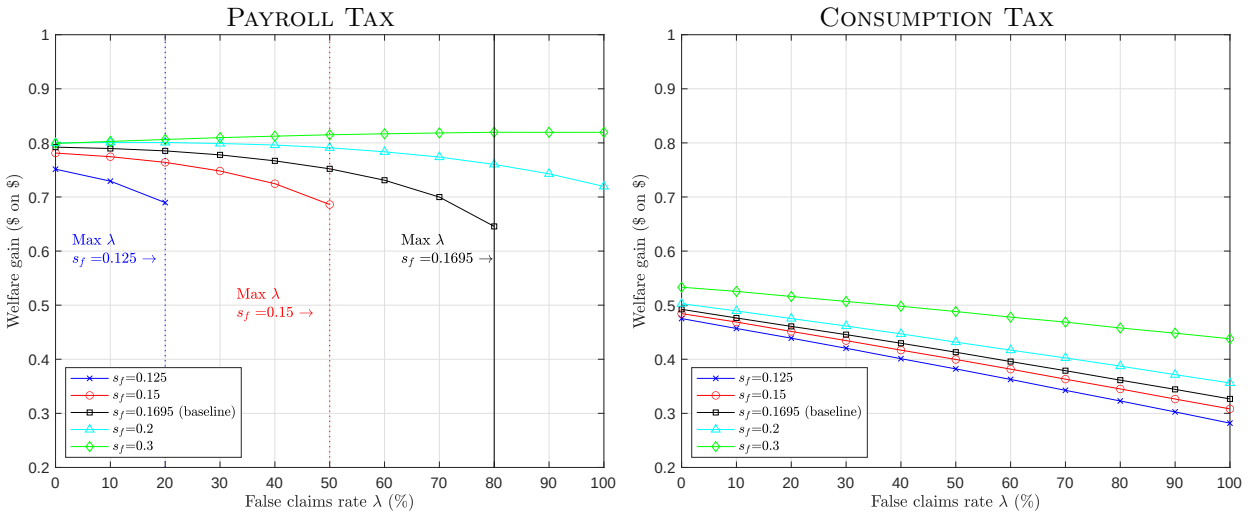
Notes: The figure shows the change in the representative worker's dollar consumption gains per dollar of benefits after an increase in the replacement rate b by 2% given changes in the share of informal workers who manage to access UI (λ). The left plot represents the gains with a payroll tax–funded UI system, in which the tax is paid by formally employed workers only; the right plot represents the gains with a consumption tax financing scheme. The dashed line represents the λ threshold over which the payroll tax–funded UI system becomes infeasible.

Figure 6: Formal and Informal Employment After Policy as a Ratio of Steady-State Values



Notes: The figure shows the formal and informal employment shares after an increase in the replacement rate of b to 2% relative to their steady values when $b = 0$. We plot the ratio as a function of the share of informal workers who manage to access UI (λ). The left plot represents the changes with a payroll tax–funded UI system, in which the tax is paid by formally employed workers only; the right plot represents the changes with a consumption tax financing scheme.

Figure 7: Money-Metric Consumption Gain per Dollar of Benefits for Different False Claim Rates and Levels of Formal Employment



Notes: The figure shows the effects of a change in the representative worker's dollar consumption gain per dollar of benefits with changes in the share of informal workers who manage to access UI (λ) for different levels of formal employment. The left plot represents the gains with a payroll tax–funded UI system, in which the tax is paid by formally employed workers only; the right plot represents the gains with a consumption tax financing scheme.

Tables

Table 1: Comparison of Summary Statistics – Custom Survey vs. Urban Population of Labor Force Surveys

	Custom Survey			Urban Population of LFS		
	Mean	**SD**	**Obs.**	**Mean**	**SD**	**Obs.**
	(1)	(2)	(3)	(4)	(5)	(6)
General Characteristics						
Is male (0/1)	0.48	0.50	1314	0.45	0.50	50597
Is household head (0/1)	0.24	0.42	1314	0.21	0.41	50597
Education						
No education (0/1)	0.17	0.38	1199	0.49	0.50	50597
Highest level of education is primary (0/1)	0.23	0.42	1199	0.16	0.36	50597
Highest level of education is secondary (0/1)	0.40	0.49	1199	0.31	0.46	50597
Highest level of education is tertiary (0/1)	0.19	0.40	1199	0.04	0.20	50597
Age						
Age is less than 25 yrs (0/1)	0.30	0.46	1373	0.36	0.48	50597
Age is 25-34 yrs (0/1)	0.24	0.43	1373	0.21	0.41	50597
Age is 35-44 yrs (0/1)	0.16	0.37	1373	0.16	0.37	50597
Age is 45-54 yrs (0/1)	0.13	0.33	1373	0.11	0.32	50597
Age is 55+ yrs (0/1)	0.17	0.38	1373	0.15	0.36	50597
Employment						
Paid employment (0/1)	0.47	0.50	1309	0.43	0.49	50597
Unpaid employment (0/1)	0.09	0.29	1309	0.03	0.16	50597
No employment (0/1)	0.45	0.50	1309	0.54	0.50	50597
Labor Force Only						
Formal employment (0/1)	0.17	0.37	900	0.12	0.32	27211
Informal employment (0/1)	0.51	0.50	900	0.64	0.48	27211
Unemployed (0/1)	0.32	0.46	900	0.24	0.43	27211
Salary						
Reported salary (in $ PPP)	534	515	1309	368	609	7534
Receives non-wage benefits (0/1)	0.20	0.40	616	0.27	0.44	8683
Job Search						
Reason for no search is voluntary (0/1)	0.52	0.50	601	0.53	0.50	22102
Reason for no search is involuntary (0/1)	0.48	0.50	601	0.47	0.50	22102

Notes: This table shows the mean ("Mean"), standard deviation ("SD"), and number of observations ("N") for our survey sample (1378 respondents) and the sample of urban respondents in the different rounds of the quarterly Enquête Nationale sur l'Emploi au Senegal (ENES) national labor force survey conducted by the Agence Nationale de la Statistique et de la Démographie (ANSD) in Senegal between 2017 and 2019. Columns (1)–(3) correspond to our custom labor force surveys. Columns (4)–(6) correspond to the ENES. The number of observations corresponds to the number of non-missing values for each variable. The mean and the standard deviation are both unweighted. Both samples are restricted to respondents aged 15 years or above and living in urban areas. See Appendix B3 for definitions of key terms related to employment, the labor force, and job search. The raw monetary values given in CFA francs are converted to US dollars using a purchasing power parity exchange rate of 1 USD = 219.13 CFA francs.

Table 2: Model Parameters

Parameter	Description	Value	Notes
σ	CRRA parameter	3.519	Consistent with Halek and Eisenhauer (2001)
s	Employment share	0.6824	As fraction of total labor force
s_f	Share of formal workers	0.1695	As fraction of the total labor force
s_i	Share of informal workers	0.5129	As fraction of the total labor force
s_u	Unemployment share	0.3176	As fraction of the total labor force
$\varepsilon_{s,b}$	Arc-elasticity of employment	-0.06703	Computations in Appendix B4
$\varepsilon_{s_f,b}$	Arc-elasticity of formal employment	-0.01717	Computations in Appendix B4
$\varepsilon_{s_i,b}$	Arc-elasticity of formal employment	-0.08461	Computations in Appendix B4
$\varepsilon_{\lambda,b}$	Arc-elasticity of false claims	0.19797	Computations in Appendix B4
w_f	Salary of formal workers	1,225.35	In $ PPP
c_e	Consumption of employed	277.92	In $ PPP
c_u	Consumption of unemployed	157.75	In $ PPP
c_f	Consumption of formal workers	339.29	In $ PPP
c_i	Consumption of informal workers	251.76	In $ PPP
λ	Share of UI false claims	0	Zero without UI
γ_f	Non-taxable formal consumption	0.518	As fraction of total expenditure
γ_i	Non-taxable informal consumption	0.473	As fraction of total expenditure
γ_u	Non-taxable unemployed consumption	0.539	As fraction of total expenditure
μ	Crowd out of private insurance	0.246	Consistent with Cox and Fafchamps (2007)
δ_f	Exogenous separation of formal workers	0.05	Lower bound of Donovan et al. (2021)
δ_i	Exogenous separation of informal workers	0.35	Upper bound of Donovan et al. (2021)

Notes: This table shows each parameter of the model specified in Section 3, the meaning of the parameter, its value (converted to $USD using a PPP value of 219.13 CFA francs per 1 US dollar for monetary values) when used in our calculations, and clarifying notes on meaning or sources.

Table 3: Large UI Changes, Estimated Parameters

Var.	Description	Value	Moment	Model	Data
ϵ_λ	Power of false claim costs	0.15	Elast. false claims WRT b	0.20	0.20
ϵ_f	Power of formal search costs	0.10	Elast. formal empl. WRT b	-0.02	-0.02
ϵ_i	Power of informal search costs	0.55	Elast. informal empl. WRT b	-0.09	-0.08

Notes: This describes the model moments and targets for the payroll tax economy (the model in Section 3.2) when $\tau = 0, b = 0, \lambda = 0$. These elasticities are also applied to the other model economies. Appendix B6 provides additional details on the estimation as well as the values of a_f, a_i, and a_λ.

Table 4: Welfare Gains from an Infinitesimal UI Expansion Starting from the Current Senegalese Policy Value of $b = 0$.

	(1) Welfare gain ($ on $)	(2) Welfare gain ($ on $) No Moral Hazard	(3) Percent Loss Moral Hazard
Model of 3.1 (No informality with payroll tax)	0.83	0.86	-3.33 %
Model of 3.1 Calibration to ($c_f = 1.15c_u$)	0.26	0.39	-33.22 %
Model of 3.1 Calibration to ($c_f = 1.15c_u$, $\sigma = 1.75$)	0.05	0.22	-76.17 %
Model of 3.2 (Informality with payroll tax)	**0.92**	**0.93**	**-1.18 %**
Model of 3.3 (Informality with payroll tax and private transfers),	0.68	0.69	-1.60 %
Model of 3.4 (Informality with payroll tax and exogenous job separation)	0.93	0.93	-0.62 %
Model of **3.5 (Informality with consumption tax)**	**0.62**	**0.67**	**-7.29 %**
Model of 3.6 (Informality with consumption tax and informal consumption)	0.63	0.68	-6.87 %

Notes: The table shows the dollar-on-dollar gains under the three models from Section 3 for a marginal expansion of UI. In column (1), we compute the effects using the arc elasticity presented in Table 2. In column (2), we set the elasticities of employment and false claims to 0 to obtain the welfare gains in the absence of moral hazard, i.e., the liquidity effects. In column (3), we compute the percentage difference between columns (2) and (1) to find the impact of moral hazard on the total welfare effect.

Table 5: Variability in the Definition of Labor Force.

		ANSD employment definition	Strict employment definition
s	Employment share	0.6824	0.8054
s_f	Share of formal workers	0.1695	0.2001
s_i	Share of informal workers	0.5129	0.6053
s_u	Unemployment share	0.3176	0.1946

Notes: This table shows the employment share in our custom survey based on two definitions of the labor force. Column (1) defines unemployment based an extended definition of the labor force used by ANSD that considers labor force participants to include both those who have actively been searching for employment and those who have not due to reasons beyond their control. This extended definition aims to include discouraged workers and to account for search frictions in the Senegalese labor market. Column (2) uses an alternative definition of the labor force that excludes groups of workers who are clearly non-participants, even though they are included in the formal definitions of ANSD (e.g., disabled workers or those on maternity leave). For both columns, informal workers are those whose employment is not subject, by law or in practice, to national legislation, employment, income tax, worker protection, or the right to certain benefits (regardless of the formality status of the firm). Formal workers are workers with a formal contract (regardless of the formality status of the firm).

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A Analytic Appendix

A.1 Proofs of Propositions 1 and 2

We consider the environment of Section 3.2. The objective of the government is to choose b to maximize social welfare subject to a balanced budget and the optimality of agent choices (implementation constraints). Applying the envelope theorem, assuming the solution is interior, the first order condition for b is

$$\frac{dW}{db} = s_f v'\left(c_f\right)(-1)\frac{w_f d\tau}{db} + s_i \lambda v'\left(c_{ic}\right) w_f + \left(1 - s_f - s_i\right) v'\left(c_u\right) w_f, \tag{18}$$

and the derivative of the tax rate is

$$\begin{aligned} s_f \frac{d\tau}{db} + \frac{ds_f}{db}\tau &= \left(1 - s_f - (1-\lambda)\, s_i\right) + \left(0 - \frac{ds_f}{db} - (1-\lambda)\frac{ds_i}{db} - \left(0 - \frac{d\lambda}{db}\right) s_i\right) b \\ \frac{d\tau}{db} &= \frac{1}{s_f}\left[\left(1 - s_f - (1-\lambda)\, s_i\right) - \left(\frac{ds_f}{db} + (1-\lambda)\frac{ds_i}{db} - \frac{d\lambda}{db} s_i\right) b - \frac{ds_f}{db}\tau\right]. \end{aligned} \tag{19}$$

Now, defining $\varepsilon_{s_f,b} = \frac{ds_f}{db}\frac{b}{s_f}, \varepsilon_{s_i,b} = \frac{ds_i}{db}\frac{b}{s_i}, \varepsilon_{\lambda,b} = \frac{d\lambda}{db}\frac{b}{\lambda}$ and replacing the tax rate from the budget constraint $\tau = \frac{1}{s_f}\left(1 - s_f - (1-\lambda)\, s_i\right) b$,

$$\begin{aligned} \frac{d\tau}{db} &= \frac{1}{s_f}\left[\left(1 - s_f - (1-\lambda)\, s_i\right) - \left(\frac{ds_f}{db} + (1-\lambda)\frac{ds_i}{db} - \frac{d\lambda}{db} s_i\right) b \right. \\ &\quad \left. - \frac{ds_f}{db}\frac{1}{s_f}\left(1 - s_f - (1-\lambda)\, s_i\right) b\right] \\ \frac{d\tau}{db} &= \frac{1}{s_f}\left[\left(1 - s_f - (1-\lambda)\, s_i\right) - \left(\frac{ds_f}{db}\frac{b}{s_i} + (1-\lambda)\frac{ds_i}{db}\frac{b}{s_i} - \frac{d\lambda}{db} b\right) s_i \right. \\ &\quad \left. - \frac{ds_f}{db}\frac{b}{s_f}\left(1 - s_f - (1-\lambda)\, s_i\right)\right] \\ \frac{d\tau}{db} &= \frac{1}{s_f}\left[1 - s_f - (1-\lambda)\, s_i - \varepsilon_{s_f,b} - (1-\lambda)\, s_i\left(\varepsilon_{s_i,b} - \varepsilon_{s_f,b}\right) + \varepsilon_{\lambda,b}\lambda s_i\right]. \end{aligned} \tag{20}$$

Replacing the expression of the marginal tax rate $\frac{d\tau}{db}$ into the marginal welfare $\frac{dW}{db}$, we

obtain the sufficient statistics formula of Proposition 2

$$\begin{aligned}
\frac{dW}{db} &= s_f v'(c_f)(-1)\frac{w_f}{s_f}\left[1-s_f-(1-\lambda)s_i-\varepsilon_{s_f,b}-(1-\lambda)s_i\left(\varepsilon_{s_i,b}-\varepsilon_{s_f,b}\right)+\frac{d\lambda}{db}bs_i\right] \\
&\quad + s_i\lambda v'(c_{ic})w_f+(1-s_f-s_i)v'(c_u)w_f \\
&= s_f v'(c_f)(-1)\frac{w_f}{s_f}\left[1-s_f-(1-\lambda)s_i-\varepsilon_{s_f,b}-(1-\lambda)s_i\left(\varepsilon_{s_i,b}-\varepsilon_{s_f,b}\right)+\frac{d\lambda}{db}bs_i\right] \\
&\quad + s_i\lambda v'(c_{ic})w_f+(1-s_f-s_i)v'(c_u)w_f \\
\frac{dW}{db} &= w_f\left[\lambda s_i\left(v'(c_{ic})-v'(c_f)\right)+(1-s_i-s_f)\left(v'(c_u)-v'(c_f)\right)\right]+ \\
&\quad w_f v'(c_f)\left[(1-s_i(1-\lambda))\varepsilon_{s_f,b}+s_i(1-\lambda)\varepsilon_{s_i,b}-\varepsilon_{\lambda,b}\lambda s_i\right]. \qquad (21)
\end{aligned}$$

Since ψ_i' is continuously differentiable, we can compute ds_i/db from the first order condition for s_i applies for all b, that is

$$\frac{ds_i}{db}=w_f\frac{\lambda v'(c_{ic})-v'(c_f)}{\psi_i''(s_i)}\leq 0. \qquad (22)$$

Since $\lambda<1$, v is strictly concave and ψ_i is strictly convex, $\frac{ds_i}{db}<0$ and the elasticity of informal employment to the benefits replacement rate is negative $\varepsilon_{s_i,b}<0$. Similarly, from similar derivatives, the elasticity of formal employment to benefits is negative $\varepsilon_{s_f,b}<0$, and the elasticity of the false claim rate to benefits is positive $\varepsilon_{\lambda,b}>0$. That is, the moral hazard is negative. Setting $s_i=0,\lambda=0$, we obtain the marginal welfare formula of Proposition 1:

$$\frac{dW}{db}=w_f(1-s_f)\left(v'(c_u)-v'(c_f)\right)+w_f v'(c_f)\varepsilon_{s_f,b}. \qquad (23)$$

□

A.2 Proof of Corollary 3

To account for the crowding out of private transfers by public funds, we assume that for informal claimants and the unemployed, assets respond to benefits according to $a(bw_f)$, where a' is negative valued.

Applying the envelope theorem, the first order condition for b is

$$\begin{aligned}
\frac{dW}{db} &= s_f v'(c_f)(-1)\frac{w_f d\tau}{db}+s_i\lambda v'(c_{ic})\left[a'(bw_f)w_f+w_f\right] \\
&\quad +(1-s_f-s_i)v'(c_u)(c_{ic})\left[a'(bw_f)w_f+w_f\right]. \qquad (24)
\end{aligned}$$

Assume $a(bw_f)=a-\mu bw_f$, so $a'(bw_f)=-\mu$, and then

$$\frac{dW}{db}=w_f\left[-s_f v'(c_f)\frac{d\tau}{db}+s_i\lambda v'(c_{ic})(1-\mu)+(1-s_f-s_i)v'(c_u)(1-\mu)\right]. \qquad (25)$$

The government budget constraint remains the same, since they continue to claim benefits.

$$\frac{d\tau}{db} = \frac{1}{s_f}\left[1 - s_f - (1-\lambda)\, s_i - \varepsilon_{s_f,b} - (1-\lambda)\, s_i \left(\varepsilon_{s_i,b} - \varepsilon_{s_f,b}\right) + \varepsilon_{\lambda,b}\lambda s_i\right]. \tag{26}$$

□

A.3 Proof of Corollary 4

We observe that the solution to the planner's problem in the model with exogenous job separations is isomorphic to the solution to (4) with the change of variables $\tilde{s_f} = (1-\delta_f)s_f, \tilde{s_i} = (1-\delta_i)s_i, \tilde{\psi}_f(s) = \psi_f((1-\delta_f)^{-1}s), \tilde{\psi}_i(s) = \psi_i((1-\delta_i)^{-1}s)$. Therefore,

$$\begin{aligned}\frac{dW}{db} =& w_f\left[\lambda(1-\delta_i)s_i\left(v'(c_{ic}) - v'(c_f)\right) + \left(1 - (1-\delta_i)s_i - (1-\delta_f)s_f\right)\left(v'(c_u) - v'(c_f)\right)\right] + \\ & w_f v'(c_f)\left[\left(1 - (1-\delta_i)s_i(1-\lambda)\right)\varepsilon_{\tilde{s_f},b} + (1-\delta_i)s_i(1-\lambda)\varepsilon_{\tilde{s_i},b} - \varepsilon_{\lambda,b}\lambda(1-\delta_i)s_i\right].\end{aligned} \tag{27}$$

In addition, for $j \in \{f,i\}, \varepsilon_{\tilde{s_j},b} \equiv \frac{(1-\delta_j)ds_j}{db}\frac{b}{(1-\delta_j)s_j} = \frac{ds_j}{db}\frac{b}{s_j} = \varepsilon_{s_j,b}$, which yields the desired result.

A.4 Proofs of Proposition 5 and Corollary 6

We consider the environment of Section 3.6. The objective of the government is to choose b to maximize social welfare subject to a balanced budget and the optimality of agent choices (implementation constraints). Applying the envelope theorem, the first order condition for b is

$$\begin{aligned}\frac{dW}{db} =& s_f v'\left(\gamma_f c_{f,t} + (1-t)\left(1-\gamma_f\right)c_{f,t}\right)\left(-\frac{dt}{db}\left(1-\gamma_f\right)c_{f,t}\right) \\ &+ s_i\lambda v'\left(\gamma_i c_{ic,t} + (1-t)\left(1-\gamma_i\right)c_{ic,t}\right)\left(\gamma_i w_f + \left(1-\gamma_i\right)\left(-\frac{dt}{db}c_{ic,t} + (1-t)\, w_f\right)\right) \\ &+ s_i\left(1-\lambda\right)v'\left(\gamma_i c_{inc,t} + (1-t)\left(1-\gamma_i\right)c_{inc,t}\right)\left(-\frac{dt}{db}\left(1-\gamma_i\right)c_{inc,t}\right) \\ &+ \left(1-s_f-s_i\right)v'\left(\gamma_u c_{u,t} + (1-t)\left(1-\gamma_u\right)c_{u,t}\right)\left(\gamma_u w_f + \left(1-\gamma_u\right)\left(-\frac{dt}{db}c_{u,t} + (1-t)\, w_f\right)\right).\end{aligned} \tag{28}$$

In particular, setting $\gamma_i = \gamma_f = \gamma_u = 0$, we obtain the formula for the consumption tax–funded UI model of Section 3.5.

$$\begin{aligned}\frac{dW}{db} =& s_f v'\left((1-t)c_{f,t}\right)\left(-\frac{dt}{db}c_{f,t}\right)s_i\left(1-\lambda\right)v'\left((1-t)c_{inc,t}\right)\left(-\frac{dt}{db}c_{inc,t}\right) \\ &+ s_i\lambda v'\left((1-t)c_{ic,t}\right)\left(-\frac{dt}{db}c_{ic,t} + (1-t)w_f\right) + \left(1-s_f-s_i\right)v'\left((1-t)c_{u,t}\right)\left(-\frac{dt}{db}c_{u,t} + (1-t)w_f\right).\end{aligned} \tag{29}$$

Defining the taxable consumption base

$$\Omega \equiv \left[s_f\left(1-\gamma_f\right)c_{f,t} + \lambda s_i\left(1-\gamma_i\right)c_{ic,t} + \left(1-\lambda\right)s_i\left(1-\gamma_i\right)c_{inc,t} + \left(1-s_f-s_i\right)\left(1-\gamma_u\right)c_{u,t}\right] \tag{30}$$

the government budget constraint is

$$t\Omega = \left(1-s_f-\left(1-\lambda\right)s_i\right)bw_f. \tag{31}$$

and we obtain the marginal consumption tax to fund benefits b

$$\begin{aligned}
\frac{dt}{db}\Omega + t\frac{d\Omega}{db} &= \left(1-s_f-\left(1-\lambda\right)s_i\right)w_f - \left(\frac{ds_f}{db} + \left(1-\lambda\right)\frac{ds_i}{db} - \frac{d\lambda}{db}s_i\right)bw_f \\
\frac{dt}{db} &= \frac{\left(1-s_f-\left(1-\lambda\right)s_i\right)w_f}{\Omega} - \frac{1}{\Omega}\left(\varepsilon_{s_f,b}\frac{s_f}{s_i} + \left(1-\lambda\right)\varepsilon_{s_i,b} - \frac{d\lambda}{db}b\right)s_i w_f - t\frac{1}{\Omega}\frac{d\Omega}{db}.
\end{aligned} \tag{32}$$

□

B Numerical Appendix

B.1 Risk Aversion

Our estimation of the marginal welfare change with respect to benefits requires us to estimate the marginal utilities of consumption for the employed and unemployed respondents in our sample. This estimation of the marginal utilities, in turn, requires us to estimate the risk aversion level of these respondents.

Risk aversion is estimated from the responses to three questions on willingness to participate in a hypothetical job lottery:

> *Let's also assume that you are forced to change professions for reasons beyond your control. You have the option to choose between two jobs. The first job guarantees a monthly salary of $ [Y]. The second job offers (i) a 50% chance of earning a monthly salary of $[2*Y] and (ii) a 50% chance of earning a monthly salary of $[X * Y]. Between the two options available to you, which one would you choose?*

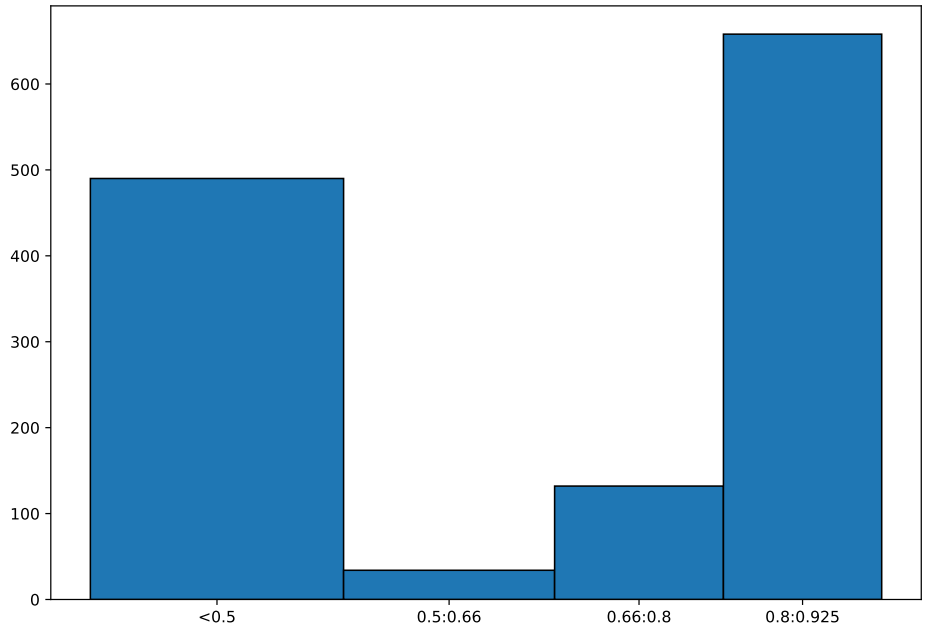
We asked the question twice. The first time, we used $X = 2/3$. The second time, we used $X = 1/2$ if the respondent picked the lottery and $X = 4/5$ if she picked the safe job. We map the answers on risk aversion back to theory, assuming that individuals have a von Neumann–Morgenstern utility function $v(\cdot)$ defined over lifetime income. For an individual who is exactly indifferent between job 1 (with a sure income y) and job 2 (with a downside income of χy), the scale factor χ is implicitly defined by

$$\frac{1}{2}v(2y) + \frac{1}{2}v(\chi y) = v(y).$$

Depending on the answer given to the hypothetical questions, we can infer which of the following intervals the χ of the respondent belongs to: $[0,\ \frac{1}{2}]$, $(\frac{1}{2},\ \frac{2}{3}]$, $(\frac{2}{3},\ \frac{4}{5}]$, or $(\frac{4}{5},\ 1]$. Figure

B1 shows the distribution of the values of χ after an interval is assigned to each respondent based on her responses.

Figure B1: Bins of Scale Factor χ



Notes: This figure shows the distribution of the intervals into which the scale factor χ values for the respondents fall. The y-axis shows the number of respondents for each interval, and the x-axis shows the size of the interval.

The distribution in Figure B1 is concentrated in the tails, which is at odds with the usual representations of risk aversion in the literature. To address this issue, we parameterize the shape of our resulting distribution of the CRRA coefficients to that of U.S. households, following Halek and Eisenhauer (2001) (see Figure B2). To do so, we make the choice to have hard cutoffs for the possible values of the CRRA coefficient at approximately 0.4 on the left side and 9.9 on the right side. We then draw a value of χ to assign to each individual from the uniform distributions inside her bin. For the two lowest and highest intervals, we use $\mathcal{U}(0.3,\ 0.5)$ and $\mathcal{U}(0.8,\ 0.925)$, respectively.

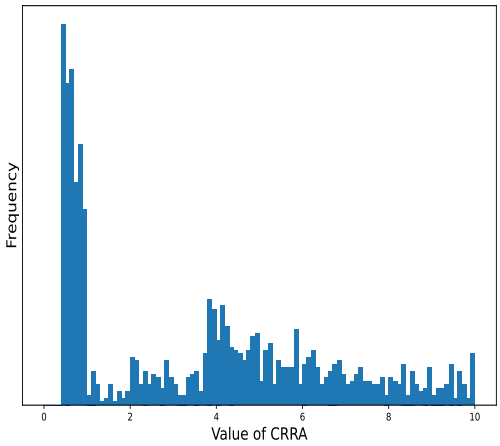
Under an assumption of CRRA, there is a one-to-one positive relationship between χ and the respondent's coefficient of relative risk aversion R, or $\frac{v''(\cdot)}{v'(\cdot)}$, as follows. We use an implicit function solver to find the exact value of the CRRA coefficient, using the formula

$$\chi = (2 - 2^{(1-A)})^{\frac{1}{1-A}},$$

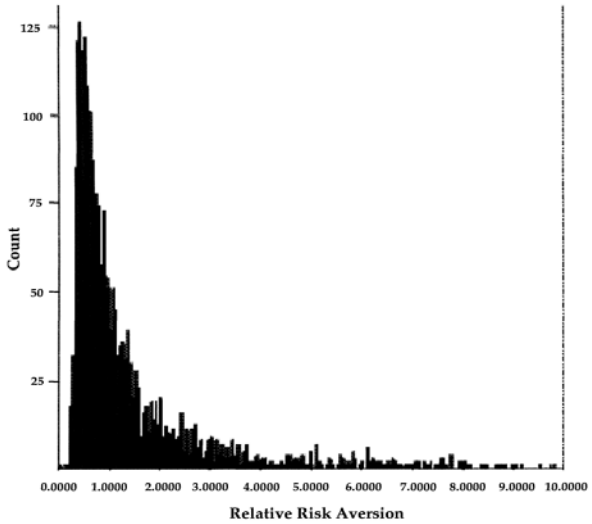
where A is the CRRA coefficient. Figure B2 displays the distribution of the CRRA coefficient resulting from the above mapping:

Figure B2: Distribution of the Coefficient of Risk Aversion

(a) Survey



(b) Halek and Eisenhauer (2001)



Notes: The left panel of this figure shows the distribution of the CRRA coefficient for the respondents in our sample, and the right panel shows the distribution of the CRRA coefficient in Halek and Eisenhauer (2001).

The portion of the distribution between 1 and 4 is extremely low because of the low number of responses in the middle two bins for χ. Nonetheless, the mean of our CRRA coefficient distribution is close to that of the distribution from Halek and Eisenhauer (2001) (3.51908 against 3.7350).

B.2 Consumption

Our survey asks questions concerning the respondents' wage and assets owned. However, only 67 out of 294 workers we consider unemployed have reported an asset value. To circumvent this limtation, we asked questions about the monthly expenditure in four categories (food, utilities, housing, and other). We then aggregate them to obtain a direct measure of monthly consumption. To increase the number of data points, we also use the answer to the question "*How much would your monthly expenditure decrease if you became unemployed?*". We interpret the answers to the question as referring to household expenditure and divide the reported expenditure by household size. The mean expenditure obtained for employed and unemployed individuals is, respectively, \$278 and \$158.[22]

Our survey presents four categories of expenditure: utilities, housing, food, and other expenditures. We use the share of expenditures on food over the total to estimate the parameters $\gamma_i, \gamma_f, \gamma_u$.

[22]The levels of consumption that we obtain are consistent with secondary data. Using data from the World Bank (WB), we see that the GDP per capita in Senegal in 2020 was \$3735 PPP. Taking the monthly value and considering a weight of consumption in total GDP of 82.3% (again using WB data), we obtain an average monthly consumption of \$256, which is consistent with our findings.

B.3 Employment Shares

We use the answers to our survey to obtain data for the shares of employed, formal, informal, and unemployed workers.

For employed workers, we consider all respondents above age 15 (the minimum legal age to participate in economic production activity) who either were involved in economic activity for a wage or remuneration or owned a company that produced goods or services at the time of the survey.

For unemployed workers, we use two definitions: the extended definition of unemployment that the ANSD uses, and an alternative more restrictive definition of unemployment that excludes non-participation. Given the frictions of the Senegal labor market, which impedes job search, the ANSD includes as unemployed both those who have actively been searching for employment and those who have not been searching for jobs for reasons beyond their control. To identify the latter category, both our custom survey and the ENES ask respondents why they did not search for a job during the reference period. The response options presented to the survey respondents are as follows: (0) He/she already has a paid job; (1) No reason given; (2) There is no suitable/adequate job (in relation to his/her skills, abilities); (3) He/she does not think he/she can get a job given their qualification; (4) Illness, accident; (5) Disability; (6) Maternity; (7) Personal or family reasons; (8) Does not know how to search for a job; (9) Low season for the job that he/she does; (10) Salaries are very low; (11) It is not easy to start a personal business; (12) Lack of funding; (13) He/she has not yet started looking for work; (14) He/she does not need to work to live or does not want to work; (15) He/she is waiting for a response to a job application; (16) He/she has a job that starts later; (17) He/she is waiting to be reinstated in his/her previous job; (18) He/she has already made arrangements to start self-employment in the future; (19) Training; (20) Other reasons. As classified by ANSD, we consider the response options 2–12 to be involuntary reasons and the rest to be voluntary reasons. Using these definitions of employment and unemployment, we can construct the measures of employment and unemployment over the labor force which are, respectively, 0.6824 and 0.3176.

In our analysis, we also use an alternative definition of unemployment that excludes groups of workers that are non-participants, even though they are included in the formal definition by ANSD. For this alternative definition, we include among the unemployed only those who answered the "why not search" question described above with one of the response options (2), (3), (8), (9), (11), (12), (15), (17), since these are the respondents who are not working for true involuntary reasons.

Individuals in informal employment are those whose employment is not subject, by law or in practice, to national legislation, employment, income tax, worker protection, or the right to certain benefits (e.g., notice in the event of dismissal, severance pay, paid annual or sick leave). Given the context of our study, we consider a worker to have an informal job if the job does not have a formal, written work contract. Following this definition, we estimate from our survey a share of formal workers in the labor force of 0.1695 and a share of informal workers of 0.5129.

Formal firms are defined as firms with a formal accounting system or a formal registration. The formal status of a company is generally defined based on criteria such as its official recognition through, for example, affiliation with the Social Security Fund (*Caisse de*

Sécurité Sociale), obtaining of a tax identification number (National Identification Number of Companies and Associations, or *Numéro d'Identification National des Entreprises et des Associations (NINEA)*), or a trading register that allows them to formally conduct business. We consider firms to be formal if they hold either of these above registration forms or if they follow a formal accounting system.

B.4 Arc Elasticities

To compute the elasticities in Table 2, we use an arc elasticity. Our survey collects information on the formal quit rate $\frac{dq_f}{db}$ and the share of formal workers s_f. For the hypothetical benefit change in our survey, $db = b' - b$, we can compute ${s_f}' = s_f \left(1 - \frac{dq_f}{db}\right)$. This yields our formal arc elasticity:

$$\varepsilon_{s_f,b} = \frac{\frac{{s_f}' - s_f}{\frac{1}{2}\left({s_f}' + s_f\right)}}{\frac{b' - b}{\frac{1}{2}(b' + b)}}.$$

In our survey, we also collect information on the informal quit rate $\frac{dq_i}{db}$ and share of informal workers s_i. For the hypothetical benefit change in our survey, $db = b' - b$, we can compute ${s_i}' = s_i \left(1 - \frac{dq_i}{db}\right)$. This yields our informal arc elasticity:

$$\varepsilon_{s_i,b} = \frac{\frac{{s_i}' - s_i}{\frac{1}{2}({s_i}' + s_i)}}{\frac{b' - b}{\frac{1}{2}(b' + b)}}.$$

To compute the quit elasticities, we asked respondents questions to estimate the changes in their incentives to search for a job in the context of the introduction of a UI system:

> *Suppose the government puts in place a worker protection program over the next [Y] months, which would consist of offering each unemployed person $ [X% * Z] per month during this period. Would you leave your current job (even if temporarily) during these [Y] months?*

where X represents different values of the replacement rate (10, 25, 50, 100, and 200) and Y represents the duration of the program (two months vs. six months). The variable Z corresponds to the respondent's salary, which was provided earlier in the survey.[23] The results over the entire population are presented in Table C5.

In Table B1, we illustrate the responses to the questions (for employed, formal, and informal workers) for all replacement rates. The answers are presented as the share of people who would stay in their jobs after the introduction of UI.

[23] For unemployed individuals, their last earned salary is used. For individuals with no salary information, the mean salary is used.

Table B1: Effects of Unemployment Insurance at Different Durations

2 Months of UI

Replacement rate	Employed	Formal	Informal
10%	0.992	0.994	0.992
25%	0.974	0.994	0.968
50%	0.876	0.953	0.851
100%	0.597	0.701	0.563
200%	0.348	0.549	0.282

6 Months of UI

Replacement rate	Employed	Formal	Informal
10%	0.992	0.994	0.992
25%	0.972	0.994	0.965
50%	0.874	0.966	0.844
100%	0.577	0.687	0.541
200%	0.281	0.487	0.212

To compute the arc elasticities used in our model and presented in Table 2, we use a replacement rate of 50% for 6 months of UI.
Finally, for false claims elasticity, we assume at baseline, since there are no benefits yet in Senegal, that $\lambda = 0$. The moral hazard term arising from false changes in the false claim rate is just zero $\varepsilon_{\lambda,b}\lambda s_i = 0$. However, we account for large endogenous changes in the false claim rate when we quantify the effect of large UI expansions.

B.5 Informal Transfers

To estimate the share of workers who would receive informal transfers in case of unemployment—the $-\mu = a'(bw_f)$ parameter that we use as the crowding out parameter in Section 3.3—we use the responses to the following question from the questionnaire:

> *If you lost your job today, would you be able to borrow money from an informal lender, someone in your network, or any other source?*

B.6 Calibration for Large Changes in b

Calibration of search costs at baseline. Let $s_{f,data}$ and $s_{i,data}$ be the observed values of the formal and informal employment shares, respectively, and let $c_{f,data}, c_{i,data}$ and $c_{u,data}$ be the observed levels of consumption for formal workers, informal workers (nonclaimants and claimants are equal since $b = 0$) and unemployed workers, respectively. Let $w_{f,data}$ denote the wage of formal workers.[24] We treat the data as the $\tau = 0$, $b = 0$ equilibrium. We assume isoelastic functions for formal search, informal search, and false claims costs:

[24]Note that we calibrate to match consumption levels and wages. So the residual gap between consumption and wages – which maps to a in our notation – is effectively capturing the flow consumption from the stock of assets in the data.

Table B2: Large UI Changes, Estimated Parameters

Var.	Description	Value	Moment	Model	Data
ϵ_λ	Power of false claim costs	0.15	Elast. false claims WRT b	0.20	0.20
ϵ_f	Power of formal search costs	0.10	Elast. formal empl. claims WRT b	-0.02	-0.02
ϵ_i	Power of informal search costs	0.55	Elast. informal empl. claims WRT b	-0.09	-0.08
a_λ	Scaling of false claim costs	1.00	Initial false claims	0.00	0.00
a_f	Scaling of formal employment search costs	6.40e-05	Formal employment	0.17	0.17
a_i	Scaling of informal employment search costs	3.41e-12	Informal employment	0.51	0.51

Notes: This table describes the model moments and targets for the payroll tax economy when $\tau = 0, b = 0, \lambda = 0$. Appendix B6 provides additional details on the estimation.

$$\psi_f(s_f) = a_f \frac{(s_f)^{1+\frac{1}{\epsilon_f}}}{1+\frac{1}{\epsilon_f}}, \qquad \psi_i(s_i) = a_i \frac{(s_i)^{1+\frac{1}{\epsilon_i}}}{1+\frac{1}{\epsilon_i}} \qquad \phi(\lambda) = a_\lambda \frac{\lambda^{1+\frac{1}{\epsilon_\lambda}}}{1+\frac{1}{\epsilon_\lambda}}.$$

For any positive cost of false claims $a_\lambda > 0$, when $b = 0, \tau = 0$ (treated as our data), the household's optimal false claims rate is $\lambda = 0$, and so our choice of a_λ is arbitrary in the initial equilibrium. We set $a_\lambda = 1$ and verify that it has no effect on our measured elasticities.[25] We calibrate $\{a_f, a_i\}$ to the formal employment share $s_{f,data}$ and the informal employment share $s_{i,data}$ at $b = 0$, $\tau = 0$.[26] We then compute baseline welfare $W(0,0)$ using these functional forms and observed data.

We then increase benefits to $b = 0.01$ and jointly calibrate $\{\epsilon_f, \epsilon_i, \epsilon_\lambda\}$ to match (1) the arc elasticity of formal employment with respect to benefits; (2) the arc elasticity of informal employment with respect to benefits; and (3) the arc elasticity of false claims with respect to benefits, which we proxy via the informal quit elasticity (Table 2). Table B2 reports the constants and calibrated elasticities.

Ex-post false claims and matching elasticities. Different endogenous $\lambda(b)$ realizations after an increase in unemployment benefits will be interpreted as resulting from different a_λ parameters. That is, given a counterfactual replacement rate $b = 0.0203$ and a post-policy false claim rate $\lambda(b)$, we invert the a_λ (and monitoring cost) that would deliver the optimal claim rate $\lambda^* = \lambda(b)$ as follows:

$$a_\lambda = \frac{1}{\lambda(b)^{\frac{1}{\epsilon_\lambda}}} \left(v\left(\underbrace{c_{inc,data} + bw_{f,data}}_{c_{ic}} \right) - v\left(c_{inc,data}\right) \right).$$

We hold the values of $\{\epsilon_f, \epsilon_i, \epsilon_\lambda\}$ constant at the values reported in Table B2.

Solution method. Given a counterfactual $b = 0.0203$ and $\lambda(b)$ as obtained above, we calculate $s_f(b), s_i(b), \tau(b)$. We solve the model by taking first-order conditions for households

[25] In practice, in order to avoid degenerate false claim arc elasticities, we set $b = 1e{-}3 \approx 0$ when calibrating our Baseline Senegal economy.

[26] Our calibration is done under payroll taxes. When we compare to the consumption tax economy, we keep the calibrated elasticities in Table B2 the same.

and then using grid search to solve for the tax rate that clears the government budget constraint. We solve the model economy ignoring the constraints on s_i and s_f and then check ex-post whether the feasibility constraints are satisfied. A solution must satisfy

1. First-order condition for λ:

$$\phi'(\lambda) = v\left(\underbrace{c_{inc,data} + bw_{f,data}}_{c_{ic}(b)}\right) - v\left(c_{inc,data}\right).$$

2. First-order condition for s_f:

$$\psi_f'(s_f) = v\left(\underbrace{c_{f,data} - \tau w_{f,data}}_{c_f(b)}\right) - v\left(\underbrace{c_{u,data} + bw_{f,data}}_{c_u(b)}\right).$$

3. First-order condition for s_i:

$$\psi_i'(s_i) = \lambda v\left(\underbrace{c_{inc,data} + bw_{f,data}}_{c_{ic}(b)}\right) + (1-\lambda)\, v\left(c_{inc,data}\right) - v\left(\underbrace{c_{u,data} + bw_{f,data}}_{c_u(b)}\right) - \phi\left(\lambda\right)$$

4. Government budget constraint:

$$s_f\tau = \left(1 - s_f - (1-\lambda)\, s_i\right) b.$$

5. Feasibility:

$$s_i + s_f \leq 1, \qquad s_i \geq 0, \qquad s_f \geq 0, \qquad 0 \leq \lambda \leq 1, \qquad 0 \leq \tau \leq 1$$

Finally, if there exists a solution—that is, if the resulting job finding rates from (1.)-(3.) are interior and feasible (5.) and there exists a payroll tax that satisfies the budget constraint (4.)—the welfare change from the large UI expansion b is $dW = W(b, \tau(b)) - W(0, 0)$.

B.7 Model Parameters in FCFA Currency

Table B3: Model Parameters in FCFA Currency

Parameter	Description	Value	Notes
w_f	Salary of formal workers	268,511.27	In FCFA
c_e	Consumption of employed	60,900.79	In FCFA
c_u	Consumption of unemployed	34,566.80	In FCFA
c_f	Consumption of formal workers	74,349.11	In FCFA
c_i	Consumption of informal workers	55,168.81	In FCFA

Notes: This table contains the FCFA values for wages and consumption shown in Table 2. All models are calibrated using these values.

C Data Appendix

The survey introduced in Section 4 includes a range of modules covering various aspects of worker behavior, including

1. Demographic information: This includes data on education, gender, age, and family structure.

2. Employment information: This module captures details such as employment status, type of employment, contract structure, industry, occupation, earnings, working hours, formality of employment, tenure at current job, and any changes in employment over the past three months.

3. Job search: This module explores whether respondents engage in job search activities, the methods that they employ in their job search, reasons for not actively seeking a job, and whether they were successful in finding employment.

4. Consumption expenditures: This module provides information on the amount of money spent on food and beverages, utilities, housing, and any changes in these expenditures over the past few months.

5. Savings and borrowing: This module surveys the mechanisms used for saving and borrowing, the amount saved or borrowed, and whether the borrowing channels are formal or informal.

6. Elasticities of job exit rates and job search rates: To estimate the elasticities of job exit rates and job search rates, we asked respondents questions about the potential implementation of a worker protection program. Let X represent different values (10, 25, 50, 100, and 200) and Y represent the duration of the program (two months vs. six months). The variable Z corresponds to the respondent's salary, which was provided earlier in the survey.[27] The elasticities questions were as follows:

   C1 *Suppose the government puts in place a worker protection program over the next [Y] months, which would consist of offering each unemployed person $ [X% * Z] per month during this period. Would you leave your current job (even if temporarily) during these [Y] months?*

   C2 *Suppose the government puts in place a worker protection program over the next [Y] months, which would consist of offering each unemployed person $ [X% * Z] per month during this period. Would you stop looking for a job or stop trying to start a business?*

7. Risk aversion: This module explores respondents' risk preferences, particularly their preferences between a stable job and a job with a comparable expected wage but higher variance.

[27] For unemployed individuals, their last earned salary was used. For individuals with no salary information, the mean salary was used.

8. General opinion toward a UI program: This section investigates respondents' opinions and attitudes toward a potential UI program.

9. Peer effects: This module explores the influence of peers and social networks on individuals' employment decisions and outcomes.

We present below different tables with summary statistics for the different modules of the survey.

Table C1: Summary Statistics – Socioeconomic and Demographic Variables

Statistic	N	Mean	St. Dev.	Min	Max
General characteristics					
Is male	1,314	0.48	0.50	0	1
Is HH head	1,314	0.24	0.43	0	1
Age					
Age is less than 25 yrs	1,373	0.30	0.46	0	1
Age is 25–34 yrs	1,373	0.25	0.43	0	1
Age is 35–44 yrs	1,373	0.16	0.37	0	1
Age is 45–54 yrs	1,373	0.13	0.33	0	1
Age is 55+ yrs	1,373	0.17	0.38	0	1
Financial situation					
Financial situation of HH (1=good, 3=bad)	1,314	2.36	0.63	1	3
Relative rank of HH (1=Low, 4=High)	1,314	1.99	0.79	1	4
Total value of assets (in $ PPP)	3455	2415	12,075	0	182,540
Missed payments in L6M	1,314	0.20	0.40	0	1
Dependency level					
Is the only support of HH	1,314	0.12	0.32	0	1
Is the main support of HH	509	0.60	0.49	0	1
No. of financial dependents	1,309	2.44	3.49	0	28
School attainment					
Still at school	1,314	0.22	0.42	0	1
Has attended Quranic school	1,314	0.20	0.40	0	1
Never attended school	1,199	0.17	0.38	0	1
Attended primary school	1,199	0.23	0.42	0	1
Attended secondary school	1,199	0.40	0.49	0	1
Attended university	1,199	0.19	0.40	0	1
School achievement					
Has no diploma	1,294	0.45	0.50	0	1
Highest diploma is primary	1,294	0.18	0.39	0	1
Highest diploma is secondary	1,294	0.22	0.42	0	1
Highest diploma is university	1,294	0.15	0.35	0	1

Notes: This table shows the summary statistics for select variables from our custom survey described in Section 4. "HH" stands for household, and "L6M" stands for last 6 months.

Table C2: Summary Statistics – Employment Status and Job Search

Statistic	N	Mean	St. Dev.	Min	Max
Current employment status of active population					
Paid employment (0/1)	1,309	0.47	0.50	0	1
Unpaid employment (0/1)	1,309	0.09	0.29	0	1
No employment (0/1)	1,309	0.45	0.50	0	1
Current status of labor force population					
Formal employment (0/1)	900	0.17	0.37	0.00	1.00
Informal employment (0/1)	900	0.51	0.50	0.00	1.00
Unemployed (0/1)	900	0.32	0.46	0.00	1.00
Job search in last three months					
Searched for a job (0/1)	1,309	0.15	0.36	0	1
Hours spent searching for a job in a week	53	13.36	14.20	1	70
Found job upon search (0/1)	199	0.03	0.17	0	1
Accepted job after search (0/1)	10	0.80	0.42	0	1
Reason for no search is involuntary (0/1)	1,110	0.35	0.48	0	1

Notes: This table shows the summary statistics for select variables from our custom survey described in Section 4. Active population includes individuals aged 15 years or above. Labor force includes (i) formally and informally employed individuals, (ii) individuals actively searching for work, and (iii) individuals not searching for work for involuntary reasons. See Appendix B3 for definitions of key terms related to employment, the labor force, and job search.

Table C3: Summary Statistics – Salary, Aid, and Consumption

Statistic	N	Mean	St. Dev.	Min	Max
Salary					
Monthly salary (in $ PPP)	1,309	534	515	8	3,103
Receive nonwage benefits at work (0/1)	616	0.20	0.40	0	1
Expects a salary increase in NTM (0/1)	617	0.45	0.50	0	1
Expects a salary decrease in NTM (0/1)	617	0.02	0.15	0	1
Expects no change in salary in NTM (0/1)	617	0.16	0.37	0	1
Has no info about salary change in NTM (0/1)	617	0.36	0.48	0	1
Monthly expenditures (in $ PPP)					
Food expenditures	392	652	341	68	2,738
Utility expenditures	387	236	1513	0.00	29,663
Housing expenditures	298	252	281	0.00	1,369
Other expenditures	332	256	347	0.00	2,054
Total expenditures	254	1,302	1,968	160	30,265
Expected change in expenditures if unemployed	298	361	300	0	2,282
Benefits					
Currently receives some aid (0/1)	1,314	0.06	0.24	0	1
Total value of aid (in $ PPP)	78	565	1,117	0	9,127

Notes: This table shows the summary statistics for select variables from our custom survey described in Section 4. NTM stands for "next 12 months".

Table C4: Summary Statistics – Savings, Bills and Loan Payments

Statistic	N	Mean	St. Dev.	Min	Max
Bills					
Does not have bills	377	0.17	0.37	0	1
Able to pay bills if unemployed	377	0.37	0.48	0	1
Can pay bills if receives UI when unemployed	377	0.76	0.43	0	1
Loans					
Does not have loans	617	0.44	0.50	0	1
Able to pay loans if unemployed	617	0.17	0.38	0	1
Can pay loans if receives UI when unemployed	344	0.70	0.46	0	1
Does not borrow from formal institutions	617	0.39	0.49	0	1
Can borrow from formal sources if unemployed	617	0.07	0.25	0	1
Expected loan from formal sources if unemployed (in $ PPP)	25	3,454	7,452	0	31,947
Does not borrow from informal sources	617	0.36	0.48	0	1
Can borrow from informal sources if unemployed	617	0.24	0.43	0	1
Expected loan from informal sources if unemployed (in $ PPP)	125	479	932	0	9,129
Savings					
Has a bank account	1,314	0.18	0.39	0	1
Has real estate investment	1,314	0.09	0.28	0	1
Has mobile money wallet	1,314	0.82	0.39	0	1
Saves salary at bank	177	0.50	0.50	0	1
Amount saved at bank (in $ PPP)	52	407	688	46	4,564
Saves salary in real estate	81	0.26	0.44	0	1
Amount saved in real estate (in $ PPP)	6	1,369	1,750	228	4,564
Saves salary in mobile wallet	573	0.40	0.49	0	1
Amount saved in mobile wallet (in $ PPP)	193	129	106	0	456
Saves salary at home	617	0.23	0.42	0	1
Amount saved at home (in $ PPP)	112	171	166	9	914

Notes: This table shows summary statistics for select variables from our custom survey described in Section 4.

Table C5: Summary Statistics – Elasticities

Statistic	N	Mean	St. Dev.	Min	Max
Job quit rates					
Would quit job if received 10% of salary as UI for 2 months	617	0.01	0.09	0	1
Would quit job if received 25% of salary as UI for 2 months	617	0.03	0.17	0	1
Would quit job if received 50% of salary as UI for 2 months	617	0.14	0.34	0	1
Would quit job if received 100% of salary as UI for 2 months	617	0.42	0.49	0	1
Would quit job if received 200% of salary as UI for 2 months	617	0.66	0.47	0	1
Would quit job if received 10% of salary as UI for 6 months	617	0.01	0.09	0	1
Would quit job if received 25% of salary as UI for 6 months	617	0.03	0.18	0	1
Would quit job if received 50% of salary as UI for 6 months	617	0.14	0.35	0	1
Would quit job if received 100% of salary as UI for 6 months	617	0.44	0.50	0	1
Would quit job if received 200% of salary as UI for 6 months	617	0.73	0.45	0	1
Job search					
Would stop job search if received 10% of salary as UI for 2 months	201	0.01	0.10	0	1
Would stop job search if received 25% of salary as UI for 2 months	201	0.04	0.21	0	1
Would stop job search if received 50% of salary as UI for 2 months	201	0.16	0.37	0	1
Would stop job search if received 100% of salary as UI for 2 months	201	0.44	0.50	0	1
Would stop job search if received 200% of salary as UI for 2 months	201	0.65	0.48	0	1
Would stop job search if received 10% of salary as UI for 6 months	201	0.01	0.10	0	1
Would stop job search if received 25% of salary as UI for 6 months	201	0.06	0.24	0	1
Would stop job search if received 50% of salary as UI for 6 months	201	0.21	0.41	0	1
Would stop job search if received 100% of salary as UI for 6 months	201	0.49	0.50	0	1
Would stop job search if received 200% of salary as UI for 6 months	201	0.75	0.44	0	1
Formal vs. informal					
Would quit job if there were UI program for formal jobs	122	0.22	0.42	0	1
Would move to informal sector if there were UI program for informal jobs	122	0.18	0.39	0	1
Would move to formal sector if there were UI program for formal jobs	171	0.75	0.44	0	1

Notes: This table shows summary statistics for select variables related to elasticities from our custom survey. See section 4 for the exact framing of the hypothetical questions asked.