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Abdoulaye Ndiaye
Kyle F. Herkenhoff
Abdoulaye Cisse
Alessandro Dell'Acqua
Ahmadou Aly Mbaye

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

Abdoulaye Ndiaye, Kyle F. Herkenhoff, Abdoulaye Cisse, Alessandro Dell'Acqua, and Ahmadou Aly Mbaye

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ABSTRACT

This paper studies the welfare effects associated with the provision of unemployment insurance (UI) benefits when formal workers represent only a small proportion of the labor market and informal workers can submit fraudulent claims for UI benefits. We develop a model that incorporates these features and also allows for varying degrees of enforcement and funding sources. We then estimate the model's key parameters by conducting a custom labor force survey in Senegal. We show that the moral hazard response to the UI benefits among workers is small and their liquidity gains are large: an extra dollar of UI benefits yields a consumption-equivalent gain of 50–80 cents, which exceeds comparable U.S. estimates by a factor of 10–20. We then show that the welfare gains depend on the program design: UI funded through payroll taxes is effective and feasible as long as the ratio of formal workers to the benefit level is sufficiently high, while UI funded through consumption taxes generally offers lower welfare benefits but is more resistant to fraudulent claims. Our study highlights the welfare importance of the design of UI financing and suggests large liquidity and consumption smoothing gains of UI in contexts with high informality and potential fraud.

Abdoulaye Ndiaye
New York University
44 W 4th St Office 7-72
New York, NY 10012
andiaye@stern.nyu.edu

Kyle F. Herkenhoff
University of Minnesota
Department of Economics
4-101 Hanson Hall
1925 Fourth Street South
Minneapolis, MN 55455 and IZA
and also NBER
kfh@umn.edu

Abdoulaye Cisse
University of California, Berkeley
cisse@berkeley.edu

Alessandro Dell'Acqua
Bocconi University
dellacqua.alessandro.98@gmail.com

Ahmadou Aly Mbaye
Universite Cheikh Anta Diop (UCAD)
BP 16448 Dakar Fann
Dakar
Senegal
mbayealy93@yahoo.fr

1 Introduction

Wage earners in low-income African economies frequently serve as the financial backbone for a broad network of economic agents, providing insurance for their kin and peers against shocks, facilitating transfers to extended family, and fostering economic relief (Cox et al., 1998; Cox and Fafchamps, 2007). The high dependency of unemployed individuals on private transfers from wage earners highlights the need for worker protection, as stressed by recent major labor market shocks such as the COVID-19 pandemic.[1]

UI is one form of worker protection program whose prevalence is considerably lower in low-income than in high-income countries because of the difficulties of the former in tracking work statuses and funding UI budgets (Benjamin and Mbaye, 2012; Cirelli et al., 2021). The 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 labor market 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 value-added tax (VAT)/consumption taxes yield large welfare gains? Answering these questions requires overcoming 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 five 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 presence of undeclared informal workers, who could falsely claim UI targeted toward 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. (iv) Even within formal employment set-

[1] In our nationally representative labor force surveys, essentially all unemployed individuals report relying on their family members as one of their main survival strategies. See Section 2 for more details.

tings, a majority of workers lack significant work-related benefits, highlighting the need for a more robust social safety net. Finally, (v) informal networks serve as a crucial mechanism to help workers cope with job loss. In these respects, the Senegalese labor market exhibits characteristics similar to those of other low-income African countries.

Second, we extend the Chetty (2006) model by allowing informal workers to collect UI benefits while working and by distinguishing work statuses among informal employment, formal employment, and unemployment. With this conceptual framework, we consider three different schemes with varying degrees of enforcement and funding sources:

> **Model I (payroll tax with informality):** In this economy, there is a standard payroll tax–funded UI system with limited enforcement. Only formal workers contribute to funding the UI program, but a share of informal workers can fraudulently claim benefits.
>
> **Model II (payroll tax without informality):** In this economy, there is perfect enforcement of employment status. The government can fully impose UI contributions on employed workers, and there are no false claims from informal workers.
>
> **Model III (consumption tax with informality):** This economy is identical to that in Model I, except 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.

We derive a closed-form solution for the welfare effects of small UI expansions in each of these three models. Our theory emphasizes that in the presence of informal work and limited enforcement of eligibility criteria, funding constraints for standard payroll tax–funded UI systems can be significantly binding.

Third, we conduct a highly customized in-person labor force survey in Senegal with 1378 individuals to estimate the model. Our survey is representative of the major labor market in Senegal and departs from typical labor force surveys in our context since it was specifically designed to allow us to calibrate the key parameters identified in our conceptual framework: (i) elasticities of job search and job quit rates with respect to the benefit level for each work state, (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 constraints.

Our model calibration yields three main results that collectively draw attention to 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 of over 80 cents under the payroll tax–funded scheme (Models I & II) and over 50 cents under the consumption tax–funded scheme (Model III). The magnitude of the dollar consumption gain to an unemployed worker per dollar of benefits—the "dollar-on-dollar" welfare metric—significantly exceeds that for the U.S., where an extra dollar of UI is estimated to yield a consumption-equivalent gain of approximately 4 cents (Chetty, 2006). In other words, the gains from a small UI expansion would be approximately 10 to 20 times larger in Senegal than in the U.S.

However, we show that false claims have two countervailing effects on welfare. On the one hand, informal employment typically yields lower wages and consumption than formal employment. Given the estimated coefficient of risk aversion in our economy, there exists a 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 policy significantly distorts the incentives to enter formal employment, resulting in diminished gains.

Second, we examine how the effectiveness of UI varies with the severity of false claims across equivalent payroll and consumption tax financing schemes. We observe that the payroll tax financing scheme delivers greater welfare gains 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. 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 (which may align more closely with the actual share of formal workers in countries such as Senegal), 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 of a payroll tax being the most efficient instrument to finance UI.

Our survey also sheds light on several ways in which UI affects the macroeconomy, beyond those entertained in our structural analysis. Of particular note, we use the survey to assess the effect of the safety net on credit constraints and defaults. Our survey provides suggestive

evidence that expanding the safety net would reduce loan defaults, supporting the recent view that the safety net and credit access are complementary (e.g., Braxton et al. (2020) and Bornstein and Indarte (2022)). Our results suggest that a safety net expansion "kills two birds with one stone" by (1) improving insurance and welfare while (2) potentially fostering greater credit access.

Lastly, we conduct robustness exercises and we address several caveats. In terms of robustness, we show that our findings persist both qualitatively and quantitatively when (i) benefits crowd-out family transfers in an empirically plausible way, and (ii) food consumption is "informal" and thus not subject to the consumption tax. Our survey data allow us to discipline both channels.

In terms of caveats, we first discuss that our data cover only urban areas and neglect the large share of agricultural workers in Senegal. To address this issue, we simulate lower formal employment shares and larger informal employment shares to proxy for a larger agriculture sector, and we find that our main results are robust. We also argue that UI for non-agricultural workers will complement the large, pre-existing input subsidy programs (ISPs) for farmers, who are often self-employed. These pre-existing agriculture-specific safety nets will dampen any transitions across the two sectors induced by a UI program for non-agricultural workers. Second, dynamic aspects of the labor market are important features to capture in the design of unemployment insurance. In our context, however, the survey evidence suggests that the economy is well approximated by a static model with unemployed workers living hand-to-mouth; moreover, short- and long-run survey estimates of moral hazard are quite similar. Third, we do not model other potential insurance policies such as cash transfers and progressive taxation. However, these alternate policies insure longer-run risks (and often require annual tax filings to be completed before any transfers are disbursed) compared to short-term job loss insurance. Therefore, we believe our insights regarding UI will persist in richer settings.

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 mostly 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 the policy's 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 in more formalized economies because reemployment rates in the formal sector remain low regardless of the policy. Similarly, Margolis et al. (2015) estimate low degrees of efficiency losses in the presence of informal work, although they assume very high levels of 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 they offer institutional and data environments conducive to the study of UI.[2] Even though 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 characteristics between the two regions give rise to a need for specific evidence 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 scheme designs. Existing papers have focused 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 of the UI policy design. For example, Gonzalez-Rozada and Ruffo (2016) work with Argentinian data to posit that a short UI duration should be considered if 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

[2]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 to induce fake layoffs 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 reemployment rate in the formal sector 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.

false UI claims arising from potential variations in the ability of the social planner to observe informal work.

We consider the findings of this study to be generalizable to labor markets in low-income economies and to make a significant contribution given the scant empirical evidence on the most effective strategies for implementing UI in low-income environments characterized by labor market frictions.

Roadmap. 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 results of our welfare analysis and elaborates on their implications. Section 6 presents the robustness of our results to variation in the levels of key parameters (e.g., degree of labor market formality, workers' risk aversion, and crowding-out of informal insurance by UI), provides suggestive evidence on the impact of UI on credit constraints and defaults and addresses the main caveats of our analysis. Section 7 offers concluding remarks.

2 Five Facts about the Senegalese Labor Market

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

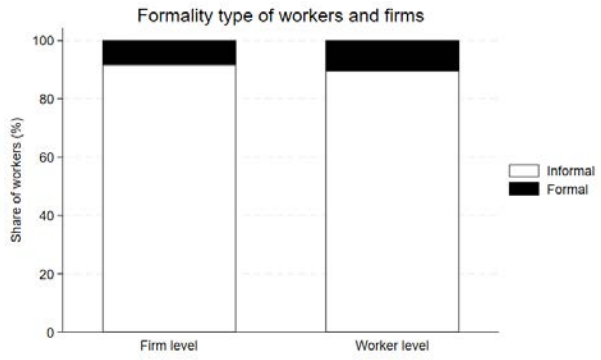
We construct these facts using data from nationally representative consumption and labor force surveys: the *Enquête Harmonisée sur les Conditions de Vie des Ménages 2018-2019* (EHCVM) and the *Enquête Nationale sur l'Emploi au Senegal 2015-2019* (ENES). The EHCVM is similar in spirit to the Living Standard Measurement Surveys (LSMS) that have been 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.[3] The ENES consists of 12 waves of quarterly, nationally representative labor force surveys from

[3]The total survey sample size is 7156 households, with 3941 from urban areas and 3215 from rural areas, for 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.

between 2015 and 2019. The survey uses a rotating panel of households.[4]

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%.[5] 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)).

Figure 1: Formality status of workers and firms in the Senegalese labor market



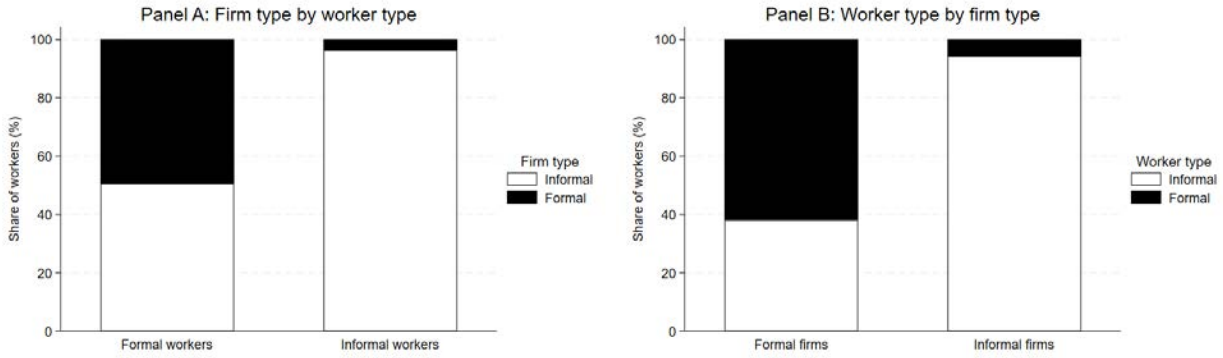
Notes: This figure shows the shares of formal and informal firms (on the left) and the shares of formal and informal workers (on the right). The shares of formal workers and firms are shown in black and those of informal workers in white. Informal workers are workers with no formal, written work contract. Informal firms are firms with no formal accounting system and no formal registration. The graph uses the pooled quarterly ENES 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.

[4]The survey 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 whether they were successful in finding employment; (iv) consumption expenditures with information on the amount of money spent on food and beverages, utilities, 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.

[5]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 work 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 scope/focus of this study. Nevertheless, using that definition would have no material impact on our analysis.

Fact 2: There is a significant share of undeclared informal workers in formal firms. Panel A of Figure 2 shows the firm formality status for formal relative to 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 relative to 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 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.[6] These numbers suggest that the formality status of a job does not map one-to-one with the formality status of the firm, and this fuzziness in formality applies to both formal and informal firms.

Figure 2: Formality status of workers and firms by worker/firm type



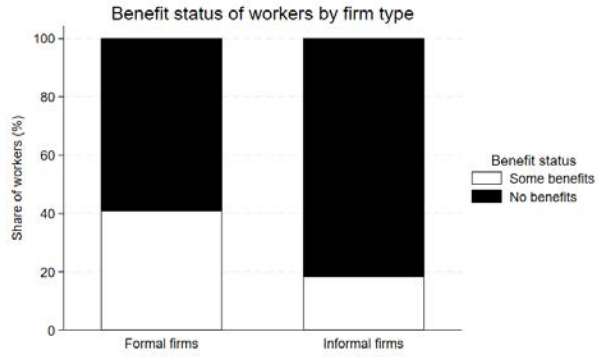
Notes: This figure shows the firm formality status of formal and informal workers (panel A) and the contract formality status for workers at formal and informal firms (panel B). The formal shares are shown in black and the informal shares in white. Informal workers are workers with no formal, written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

Fact 3: Good jobs are rare, even in formal firms. As shown in Figure 3, 59% of workers in formal firms have no work-related benefits. The benefits considered here are transportation subsidies, meal subsidies, paid vacation, sick days, pension, severance pay, overtime pay, health insurance, performance pay, training, work security, childcare, maternal/paternal leave, and work accident insurance. For informal firms, the share of

[6]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.

workers with benefits is lower (19%) but is, interestingly, nonzero. The absence of work benefits for most workers in the labor market implies that the exacerbation of worker moral hazard from a strengthening of the social safety net could be small in the Senegalese context.

Figure 3: Benefits status of workers by firm type

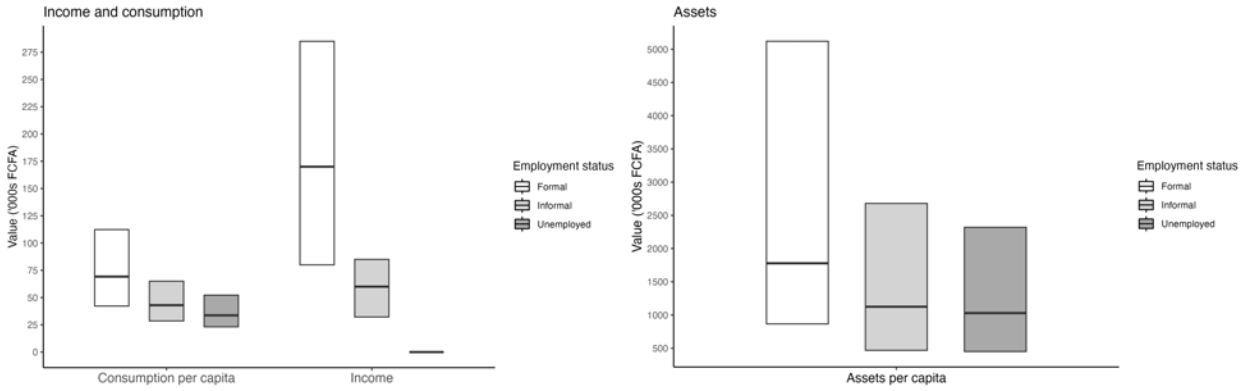


Notes: This table shows the share of workers with some work benefits (in white) and no work benefits (in white) by firm type. Work benefits include transportation subsidies, meal subsidies, paid vacation, sick days, pension, severance pay, overtime pay, health insurance, performance pay, training, work security, childcare, maternal/paternal leave, and work accident insurance. The category "Some benefits" refers to workers who receive at least one of the above benefits, while the category "No benefits" represents workers with none of the benefits. Informal firms are firms with no formal accounting system and no formal registration. Data include only workers who declared having a job in the seven days preceding the ENES. All surveys from 2017 to 2019 are included, and each observation represents a worker–survey pair in the pooled labor force survey. The analysis sample includes only individuals in the labor force.

Fact 4: There are significant gaps in income, consumption, and assets across work status. As shown in Figure 4, the gap in median monthly income between formal and informal workers is 100,000 CFA francs (FCFA): workers with formal contracts have median earnings of 150,000 FCFA per month, while informal workers have a median income of 50,000 FCFA per month. The gap in monthly consumption per capita is less pronounced, but the difference between median consumption per capita for the two groups is still large in absolute terms (27,033 FCFA per month). The gap in consumption per capita and assets between informal workers and unemployed individuals is rather minimal, despite the latter group's not earning any 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 5: 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 5), while transfers sent by households are much lower on average. In terms of workers' coping strategies after they lose jobs, panel B of the same figure

Figure 4: Distribution of income, consumption, and assets by work status



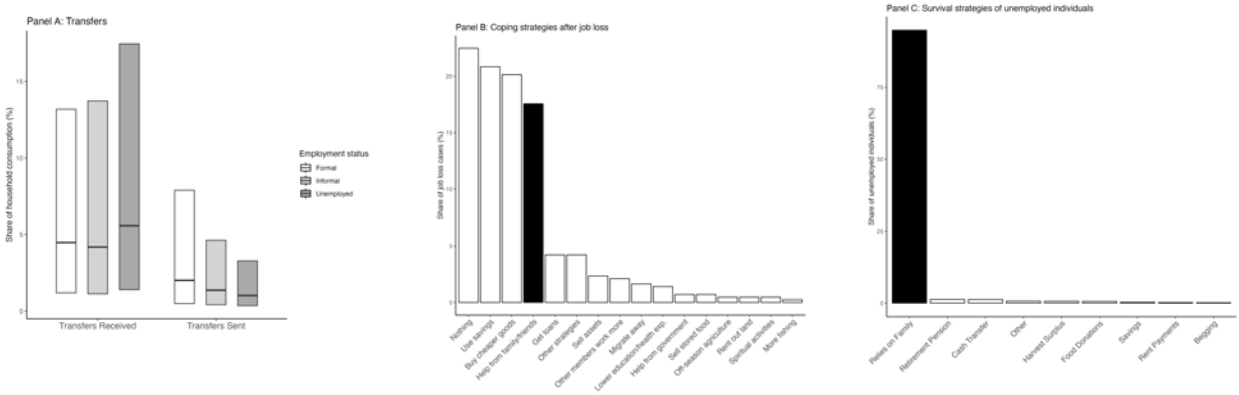
Notes: This figure shows the median, 25 percentile and 75 percentile of monthly consumption per capita and monthly income (on the left) and assets per capita (on the right) for formal workers, informal workers, and unemployed individuals. Formal workers are wage earners with formal, written work contracts. 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 for informal workers and those in dark gray 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.

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 other alternatives typically used/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 the fact that a large share of workers does not have 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 reliance on wage earners could also be the reason why, as highlighted in Fact 4, the consumption differences between employed and unemployed individuals are not very stark.

These stylized facts point to the important scale of informal transfers and the heavy reliance on informal networks by workers who have experienced job loss and by those with a longer duration of unemployment. These facts highlight the important role that formal workers play in the coping strategies and the welfare of other individuals in the labor force, despite formal workers making up only a small share of the labor force. Thus, while it

might be sensible to consider UI as only benefiting formal workers and to question the policy relevance of such schemes in a context with high informality, the welfare impact of UI could extend to a larger base of the workforce.

Figure 5: 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 for informal workers, and those in dark gray 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.

3 Conceptual Framework

In this section, we analyze the welfare implications of unemployment insurance by extending the (Chetty, 2006) model to incorporate an informal sector. Our baseline economy (Model I) assumes that UI is funded by distortionary payroll taxes and that there is UI fraud (or false claims) due to unobservable informal work at formal firms. We ccompare this first welfare analysis to a Baily–Chetty benchmark without an informal sector and with zero false claims (Model II). Lastly, we consider an "alternate funding" economy in which, in the presence of informality and false claims, the UI policy is financed by a consumption tax akin to a VAT (Model III).

3.1 Model I: UI Funded by Payroll Taxes with Informality and False Claims

We consider a static model in which workers can be formally employed (f), informally employed (i), or unemployed (u). The workers' utility function, $u(\cdot)$, is assumed to be concave and increases in disposable income, consisting of their wages (w), assets (A), and government transfers.

Workers search for jobs in both the formal and informal job markets. Workers incur a utility cost of $\psi^f(s^f)$ and $\psi^i(s^i)$ for their search in the formal and informal sectors, respectively. The probabilities of finding a job in the formal and informal sectors are, respectively, s^f and s^i, with the expected resulting welfare of a worker denoted W.

We assume that production is linear, and so wages are constant and unaffected by UI policies.[7] The formal and informal wages are represented by w^f and w^i, respectively.

Formal workers contribute to the UI system through a payroll tax τ^L for collected taxes per formal worker $T \equiv \tau^L w^f$. Unemployed workers and a share λ of informal workers receive unemployment benefits equal to a share b of formal income. Informal workers endogenously choose the probability $\lambda \in [0,1]$ of claiming and receiving unemployment benefits and incur a utility cost $\phi(\lambda)$, corresponding to the cost of fraud. Thus, λ is the *false claims rate*, also referred to as the UI fraud rate. Lower values of λ indicate stricter enforcement of UI eligibility criteria.

We focus on a policy in which UI benefits replace a fraction b of consumption in the formal sector. This formulation allows us to determine the appropriate percentage replacement rate for the UI system. Workers consider the UI replacement rate b as a given constant in their optimization problem. Therefore, they solve the following problem:

$$\max_{s^f,s^i,\lambda} W(s^f,s^i,\lambda) = \max_{s^f,s^i,\lambda} s^f V^f + s^i[\lambda V^{i,\lambda} + (1-\lambda)V^{i,1-\lambda} - \phi(\lambda)] + (1-s^f-s^i)V^u - \psi^f(s^f) - \psi^i(s^i) \tag{1}$$

$$\begin{aligned}
V^f &= u(A + w^f - T) && \text{(Value of formal work)}\\
V^{i,\lambda} &= u(A + w^i + bw^f) && \text{(Value of informal work with UI)}\\
V^{i,1-\lambda} &= u(A + w^i) && \text{(Value of informal work without UI)}\\
V^u &= u(A + bw^f) && \text{(Value of unemployment)}
\end{aligned}$$

The search policy functions $s^f(b)$ and $s^i(b)$ depend on the UI replacement rate b, with the

[7] More specifically, there is a linear, labor-only formal production technology $y(s^f) = z^f s^f$, and so $z^f = w^f$. Likewise, there is a labor-only informal production technology $y(s^i) = z^i s^i$, and so $z^i = w^i$.

first decreasing and the second increasing in the benefit level. Consequently, unemployment insurance gives rise to moral hazard. Furthermore, $\lambda(b)$ depends on the replacement rate, as a higher payoff entices more people into UI fraud.

The social planner takes into account the moral hazard arising from households' search behavior and the resulting fiscal externalities. We assume that the social planner chooses the level of benefits b that maximizes welfare W subject to the government's balanced budget constraint. This constraint requires that the taxes collected from the formal sector fund the benefits provided to both unemployed and informal workers. Formally, the planner's problem can be expressed as follows:

$$\max_b W(s^f(b), s^i(b), \lambda(b)), \tag{2}$$

subject to taxes that balance the government budget constraint,

$$s^f(b)T = \left(1 - s^f(b) - (1-\lambda(b))s^i(b)\right) bw^f.$$

3.1.1 Moral Hazard and Liquidity Effects

To simplify the notation, we introduce the definitions of formal, informal claiming, informal not claiming, and unemployed consumption as follows: $C^f = A + w^f - T$, $C^{i,c} = A + w^i + bw^f$, $C^{i,nc} = A + w^i$, and $C^u = A + bw^f$. By applying the envelope theorem to the workers' search choice and noncompliance choice, we derive the following expression for marginal welfare (see Appendix A1 for the derivation):

$$\begin{aligned}\frac{dW}{db} = &\underbrace{w^f\left[\lambda s^i u'(C^{i,c}) + (1 - s^i - s^f)u'(C^u) - (1 - (1-\lambda)s^i - s^f)u'(C^f)\right]}_{\text{liquidity effect}} + \\ &\underbrace{w^f u'(C^f)\left[\varepsilon_{s^f,b} + s^i(1-\lambda)(\varepsilon_{s^i,b} - \varepsilon_{s^f,b}) - \varepsilon_{\lambda,b}\lambda s^i\right]}_{\text{moral hazard effect}},\end{aligned} \tag{3}$$

where $\varepsilon_{s^f,b}$, $\varepsilon_{s^i,b}$, and $\varepsilon_{\lambda,b}$ represent the elasticities of formal employment, informal employment, and false claims with respect to benefits, respectively.

Unemployment insurance has two opposing effects on total welfare. On the one hand, the social benefits redistribute consumption from wealthier to poorer agents, thereby improving welfare through a liquidity and consumption smoothing channel. On the other hand, the tax levied to finance the UI program reduces the attractiveness of formal employment, leading formal workers to transition to informal jobs or unemployment, and incentivizes more UI fraud, dampening the welfare gains from insurance.

Before a quantitative analysis is conducted, it is unclear whether the liquidity or the moral hazard channel plays a more prominent role in the welfare effect of UI benefits on job search, particularly in a context with high informality. In terms of the liquidity channel, our model highlights an additional effect relative to the baseline Baily–Chetty formula that arises from providing consumption for informal workers, represented by the terms in $s^i u'(C^{i,c})$. The interaction between liquidity and the false claim rate is summarized by the expression:

$$\lambda s^i (u'(C^{i,c}) - u'(C^f)). \tag{4}$$

That is, there are welfare gains from even insuring informal workers with false claims as long as informal workers' consumption is much lower than formal workers' consumption.

Regarding the moral hazard channel, we observe the following comparative statics. First, as the level of benefits increases, the individual's desire for formal work decreases, leading to a decreasing function $s^f(b)$. Additionally, it is reasonable to assume that higher benefit levels correspond to a higher likelihood of unemployment, resulting in a decreasing function $s^f(b) + s^i(b)$. To account for the substitutability between formality and informality, we incorporate an additive cost of search $\psi^f(s^f(b)) + \psi^i(s^i(b))$ for both formal and informal work. This captures the hybrid nature of informality, which exhibits characteristics of both formal employment (such as income and labor effort) and unemployment (as individuals eligible for UI benefits can pretend to be unemployed and claim those benefits).[8] The dependence of the moral hazard effect on the false claim rate is given by the following expression:

$$u'(C^f) s^i [\lambda(\varepsilon_{s^f,b} - \varepsilon_{s^i,b}) - \varepsilon_{\lambda,b}\lambda]. \tag{5}$$

Moral hazard suggests that the elasticity of the formal share of employment is negative while that of the informal share with respect to the benefits is positive. The final term $\varepsilon_{\lambda,b}\lambda$ reflects the endogenous false claim rate. When benefits increase, workers make more false claims. Thus, when computing welfare changes, we need both the level of false claims and its elasticity with respect to benefits to pin down the total policy cost and, consequently, the moral hazard effect of the policy.

3.1.2 Funding Limits with Low Formality

To understand the importance of fiscal effects for the welfare effects of UI, we derive another expression for the marginal welfare change with a change in benefits:

[8] Indeed, when w^i/w^f is sufficiently low, individuals are motivated to search more for formal jobs, while when w^i/w^f is sufficiently high, they are incentivized to search more for high-paying informal work to avoid paying taxes.

$$\frac{dW}{db} = \underbrace{-s^f u'(C^f)\frac{dT}{db}}_{\text{negative fiscal effect}} + [\lambda s^i u'(C^{i,c}) + (1 - s^i - s^f)u'(C^u)]w^f, \tag{6}$$

Here, we note from the first term on the right-hand side of equation (6) that the need to raise payroll taxes to finance the benefits $\frac{dT}{db}$ creates distortions that negatively impact welfare. The magnitude of these distortions depends on the impact of additional UI on the required tax, $\frac{dT}{db}$.

$$\frac{dT}{db} = \frac{w^f}{s^f}\left[\underbrace{1 - s^f - s^i(1-\lambda)}_{\text{mechanical effect}} - \underbrace{\varepsilon_{s^f,b} - s^i(1-\lambda)(\varepsilon_{s^i,b} - \varepsilon_{s^f,b}) + \varepsilon_{\lambda,b}\lambda}_{\text{behavioral effect}}\right], \tag{7}$$

where the first term represents the direct/mechanical effect of an increased cost of the social program and the second term reflects the indirect/behavioral effect resulting from workers transitioning from formal employment to other states in response to the tax. From this equation, we see that the negative effect of raising payroll taxes to fund benefits decreases with the size of the formal sector. Its impact on welfare is proportional to $s^f \frac{dT}{db} \propto w^f(1-s^f)$ and thus is decreasing in the share of formal workers, all else equal, suggesting that the formal share of the labor market is a key determinant of the optimal UI scheme.

Before moving to the empirical analysis, we examine two specific cases. First, we consider a scenario in which the government possesses perfect information regarding the worker's employment status. This transforms the model into one equivalent to that of Chetty (2006), establishing an upper bound on the effects of UI. Second, we consider a case in which the UI scheme is financed through a broad-based tax, such as a VAT. This reduces the moral hazard effect and simplifies the implementation of the policy.

3.2 Model II: UI Funded by Payroll Taxes without Informality or False Claims

In this section, we focus on an economy without an informal sector and false claims. In this setting, the government has the ability to accurately determine the employment status of individuals, distinguishing between those who are employed and those who are unemployed. Consequently, UI is funded by all employed workers, and benefits are exclusively provided to the unemployed. The model in this scenario represents a special case of the one presented in Section 3.1. By examining this Baily–Chetty benchmark, we establish an upper bound on the potential welfare gains achievable through social insurance without informality.

In this section, there is no differentiation between informal and formal workers, and thus,

C^e is defined as $C^e = A + w - T$. We also introduce a composite search effort function $\psi^e(s)$, and s now corresponds to both formal and informal employment. Workers solve the problem:

$$\max_s \; W(s) = \max_s \; s \underbrace{u(A + w - T)}_{\text{value of employment}} + (1 - s) \underbrace{u(A + w + b)}_{\text{value of unempl.}} - \underbrace{\psi^e(s)}_{\text{search cost}}, \tag{8}$$

where $W(s)$ represents the overall welfare associated with a given search policy function s, which is dependent on the replacement rate.

As before, the social planner selects the benefit level b that maximizes welfare W according to the objective:

$$\max_b W(s(b)), \tag{9}$$

subject to the balanced budget constraint:

$$s(b)T = bw[1 - s(b)].$$

We can then repeat the derivation presented in Section 3.1.1 to obtain the welfare gain from an infinitesimal expansion of UI:

$$\frac{dW}{db} = \underbrace{w(1 - s)\left[u'(C^u) - u'(C^e)\right]}_{\text{liquidity effect}} + \underbrace{wu'(C^e)\varepsilon_{s,b}}_{\text{moral hazard effect}}.$$

As before, the liquidity effect remains proportional to the gap in marginal utility between employed and unemployed workers. However, the moral hazard effect omits any role for false claims. Notably, the diversion of workers into non-UI-covered informal jobs is absent from the moral hazard effect in this simple setting.

3.3 Model III: UI Funded by a Consumption Tax with Informality and False Claims

Our final model economy is identical to Model I, except we allow for the UI scheme to be financed through a consumption tax or VAT rate t—for collected taxes on consumption tC—thereby mitigating the prevalence of moral hazard. In this scenario, workers solve the

following problem:

$$\begin{aligned}\max_{s^f,s^i,\lambda} W(s^f,s^i,\lambda) = \quad & \max_{s^f,s^i,\lambda} s^f \underbrace{u\left((1-t)C^f\right)}_{\text{value of formal work}} \\ & + s^i\Big[\underbrace{\lambda u\left((1-t)C^{i,c}\right) + (1-\lambda)u\left((1-t)C^{i,nc}\right)}_{\text{value of informal work}} - \underbrace{\phi(\lambda)}_{\text{cost of UI fraud}}\Big] \\ & + \left(1-s^i-s^f\right) \underbrace{u\left((1-t)C^u\right)}_{\text{value of unemployment}} - \underbrace{\psi^f(s^f)-\psi^i(s^i)}_{\text{cost of search}},\end{aligned} \tag{10}$$

where we redefine $C^f = A + w^f$ such that it no longer includes the payroll tax.

The social planner chooses the level of benefits b that maximizes welfare W as follows:

$$\max_b W(s^f(b), s^i(b), \lambda(b)) \tag{11}$$

subject to the budget constraint that ensures the resources collected from the consumption tax are sufficient to cover the additional consumption of the beneficiaries of the UI system:

$$s^f(b)C^f t + s^i(b)\Big[\lambda(b)tC^{i,c} + (1-\lambda(b))tC^{i,nc}\Big] + (1-s^f(b)-s^i(b))tC^u = bw^f\big(1-s^f(b)-(1-\lambda(b))s^i(b)\big). \tag{12}$$

In Appendix A4, we report the full derivation of the welfare effects of a UI policy financed by a consumption tax. In brief, the impact of a marginal increase in the level of benefits on the tax can be understood in three ways. First, there is a direct effect resulting from the additional expenses associated with increased benefits, which in turn raises the required tax revenue. Second, as the consumption of certain individuals rises, the consumption tax revenue generated from their consumption also increases. Third, the movement of some formal workers to the informal sector and unemployment reduces the taxable base, necessitating an increase in the consumption tax rate.

With these insights, we can quantify the overall welfare changes resulting from adjustments in the UI benefit level, following a methodology similar to the ones presented in Sections 3.1 and 3.2.

4 Data and Calibration

To calibrate the key parameters identified 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.[9] 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.[10]

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. 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, 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 1378 individuals across 345 households. To ensure the sample's representativeness, we apply weights to the data using information from the population census.

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 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 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 urban areas, and (ii) the timing of our study (May 2022) was different from that of the ENES, which was done in 2017–2019. These variations are further explored and assessed for an impact on the robustness of our results in Section 6.1.

The survey includes a range of modules covering various aspects such as demographic information, employment information, job search, consumption expenditure, savings and borrowing, risk aversion, and general opinion and attitudes toward UI. 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 input

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

[10] See the discussion of agricultural workers and the reasons for their exclusion in the analysis in Section 6.4.

Table 1: Comparison of Summary Statistics—Custom Survey vs. Labor Force Surveys

	Custom Survey			Labor Force Surveys		
	Mean	**SD**	**Obs.**	**Mean**	**SD**	**Obs.**
	(1)	(2)	(3)	(4)	(5)	(6)
General Characteristics						
Is male (0/1)	0.48	0.50	1314	0.44	0.50	132230
Is household head (0/1)	0.24	0.43	1314	0.21	0.41	132230
Lives in urban area (0/1)	1.00	0.00	1378	0.49	0.50	73646
Education						
No education (0/1)	0.17	0.38	1199	0.62	0.49	132230
Highest level of education is primary (0/1)	0.23	0.42	1199	0.13	0.34	132230
Highest level of education is secondary (0/1)	0.40	0.49	1199	0.22	0.42	132230
Highest level of education is tertiary (0/1)	0.19	0.40	1199	0.03	0.16	132230
Age						
Age is less than 25 yrs (0/1)	0.30	0.46	1373	0.35	0.48	132230
Age is 25–34 yrs (0/1)	0.25	0.43	1373	0.21	0.41	132230
Age is 35–44 yrs (0/1)	0.16	0.37	1373	0.16	0.37	132230
Age is 45–54 yrs (0/1)	0.13	0.33	1373	0.12	0.32	132230
Age is 55+ yrs (0/1)	0.17	0.38	1373	0.16	0.37	132230
Employment						
Paid employment (0/1)	0.47	0.50	1309	0.40	0.49	132230
Unpaid employment (0/1)	0.09	0.29	1309	0.07	0.25	132220
No employment (0/1)	0.45	0.50	1309	0.53	0.50	132220
Labor Force Only						
Formal employment (0/1)	0.17	0.37	900	0.07	0.26	69596
Informal employment (0/1)	0.51	0.50	900	0.65	0.48	69596
Unemployed (0/1)	0.32	0.46	900	0.27	0.45	69596
Salary						
Reported salary (in 000s FCFA)	117.35	118.64	1309	75.00	118.07	18514
Receives nonwage benefits (0/1)	0.20	0.40	616	0.22	0.42	16712
Job Search						
Has searched for a job in last 7 days	0.13	0.34	693	0.01	0.10	69661
Reason for no search is voluntary (0/1)	0.52	0.50	601	0.46	0.50	56451
Reason for no search is involuntary (0/1)	0.48	0.50	601	0.54	0.50	56451

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 respondents in the different rounds of the quarterly national labor force surveys Enquête Nationale sur l'Emploi au Senegal (ENES) 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 nonmissing values for each variable. The mean and the standard deviation are both unweighted. The sample is restricted to respondents aged 15 years or above. See Appendix B3 for definitions of key terms related to employment, the labor force, and job search.

for our estimates. Our analysis reveals that the labor force in our study area is made up of 16.95% formally employed individuals, 51.29% informally employed individuals, and 31.76% unemployed individuals actively seeking employment.

Table C3 summarizes the responses on salary and household consumption expenditures. In line with the definitions used by ANSD, we define the active population as all individuals aged 15 years old 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.[11] With these data in hand, we construct information on individual consumption by employment status, another crucial input for our model. The estimated average consumption values are 74,349 FCFA for formally employed workers, 55,169 FCFA for informally employed workers, and 34,567 FCFA for unemployed individuals.

Our survey data indicate that a significant proportion of individuals in our context exhibit relatively high risk aversion, resulting in an average risk aversion coefficient (σ) of 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 the economy. In Section 6.1, we check the robustness of our results to our setting the CRRA to 2 instead of the survey value.

Lastly, in order to measure the potential moral hazard effects of UI expansions, we asked respondents hypothetical questions. For a given replacement rate of $X\%$ on a base salary of Z FCFA, 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] FCFA 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 ($\varepsilon_{s^f,b}$), informal employment ($\varepsilon_{s^i,b}$), and false claims ($\varepsilon_{\lambda,b}$) with respect to benefits. We compute elasticities using arc percent changes. Our survey elasticities suggest a low degree of moral hazard. Our elasticity of overall employment with respect to benefits implies that a 10

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

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.

Table 2: Model Parameters

Panel A: Baseline model parameters

Parameter	Description	Value	Notes
σ	CRRA parameter	3.519	Consistent with Halek and Eisenhauer (2001)[12]
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	273,152.50	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
λ	Share of UI false claims	0.316	Share of informal workers who work for formal firms

Panel B: Robustness checks parameters

Parameter	Description	Value	Notes
s^x	Crowd-out parameter	0.246	Share of workers who would receive informal transfers as unemployed
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

Notes: This table shows each parameter of the model specified in Section 3, the meaning of the parameter, its value used in our calculations, the method or source used to derive those values, and clarifying notes on meaning or sources.

4.1 Calibration and Welfare Assessment for Small UI Expansions

Beginning *from the current Senegalese economy*, we compute the welfare gains from an infinitesimal expansion of unemployment insurance. The current Senegalese economy corresponds to a setting with zero unemployment insurance, $(T, t, b) = (0, 0, 0)$. We then use our survey to measure the remaining variables $(s^f, s^i, \lambda, C^f, C^u, C^{i,nc}, C^{i,c})$ and corresponding elasticities.[13] In particular, we proxy the false claim rate λ with the share of informal workers who work for formal firms. Table 2 provides a comprehensive overview of the parameters, including their definitions, values, estimation methods, and sources. Panel A displays the parameters needed for the analysis of the baseline scenarios of Models I, II, and III. Panel

[13]Since $b = 0$, we have $C^{i,nc} = C^{i,c}$, and we observe the consumption of the informal workers in our data.

B presents the additional parameters required to perform robustness checks on our models. See Appendix B for detailed, step-by-step explanations of how each of these parameters is estimated.

We measure the gains from small UI expansions following Chetty (2006). We compute consumption-equivalent welfare gains x from a given policy change as $x = \frac{dW}{w^f db}\frac{1}{s^u u'(C^u)}$, evaluated at the current values of Senegalese policy variables $(T, t, b) = (0, 0, 0)$. By normalizing the welfare gains by the marginal utility of the unemployed $s^u u'(C^u)$ and dividing the wage by the FCFA value of marginal benefits $w^f db$, our definition of consumption-equivalent welfare means that a 1-FCFA balanced-budget increase in the weekly benefit level would raise each individual's utility by the same amount as an x-FCFA cent increase in the monthly consumption of the unemployed.[14] In other words, x is the dollar consumption gain of an unemployed worker per dollar of benefits, that is, the dollar-on-dollar gain from UI.

4.2 Calibration and Welfare Assessment for Large UI Expansions

Our formulas provide a way of assessing the welfare gains from infinitesimally small policy deviations. For larger UI expansions, we must forecast changes in search effort/false claims and calibrate the associated costs of changing search effort/false claims. In contrast to those under an infinitesimal UI expansion, the moral hazard effects are nonzero when UI expansions are large. This section summarizes our approach to computing these counterfactual values, details of which are presented in Appendix A2.

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

$$\psi^f(s^f) = a_f \frac{\left(s^f\right)^{1+\frac{1}{\epsilon_f}}}{1+\frac{1}{\epsilon_f}}, \qquad \psi^i(s^i) = a_i \frac{\left(s^i\right)^{1+\frac{1}{\epsilon_i}}}{1+\frac{1}{\epsilon_i}} \qquad \phi(\lambda) = a_\lambda \frac{\lambda^{1+\frac{1}{\epsilon_\lambda}}}{1+\frac{1}{\epsilon_\lambda}}.$$

Second, we estimate these parameters to match the current Senegalese economy with $(b, \lambda, T) = (0, 0, 0)$ since there is currently no UI. We calibrate $\{\epsilon_f, \epsilon_i, \epsilon_\lambda\}$ to match the 3 arc elasticities measured in our survey[15]. We calibrate the shifters $\{a_f, a_i\}$ to match the formal employment share, informal employment share when $T = 0$ and $b = 0$. Lastly, 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 and Appendix Appendix A2.

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

[15] The arc elasticity of false claims with respect to benefits is proxied via the informal quit elasticity (Table 2). We calibrate the elasticities assuming there is a payroll tax. Lastly, we use the same elasticities in all model economies.

Table 3: Large UI changes, Estimated parameters

Var.	Description	Value	Moment	Model	Data
ϵ_λ	Power of false claim costs	0.20	Elast. false claims WRT b	0.20	0.20
ϵ_f	Power of formal search costs	0.08	Elast. formal empl. WRT b	-0.02	-0.02
ϵ_i	Power of informal search costs	0.38	Elast. informal empl. WRT b	-0.08	-0.08

Notes: This describes the model moments and targets for the payroll tax economy (Model I) when $T = 0, b = 0, \lambda = 0$. These elasticities are also applied to the other model economies. Appendix Appendix A2 provides additional details on the estimation as well as the values of a_f, a_i, and a_λ.

Third, we convert the discrete welfare change, $W(b)-W(0)$, into a dollar-on-dollar metric similar to our approach in Section 4.1 according to $x = \frac{W(b)-W(0)}{w^f b} \frac{1}{u'(C^u)s^u}$.

5 Numerical Results

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

5.1 Welfare Gains from Small UI Expansions

Table 4 reports the dollar-on-dollar welfare gains from a small expansion of UI, $\frac{dW}{w^f db} \frac{1}{s^u u'(C^u)}$, for each of the three model economies when evaluated at the current values of the Senegalese policy variables.

Table 4 reveals large welfare gains from an infinitesimal expansion of unemployment insurance. The dollar-on-dollar gain is 0.98 in Model I (informality with payroll tax). A value of $\frac{dW}{w^f db} \frac{1}{s^u u'(C^u)} = 0.98$ implies that a dollar increase in benefits yields welfare gains worth \$0.98. Comparable U.S. estimates for unemployment insurance expansions fall in a narrow range around 0.04 (Chetty, 2006). Model II (no informality with payroll tax) yields a dollar-on-dollar gain of 0.83, and Model III (informality with consumption tax) yields a dollar-on-dollar gain of 0.53. Relative to the US, Senegal would see large gains from small UI expansions.

Furthermore, the losses from moral hazard are modest relative to the total welfare gains, showcasing the strong demand for liquidity and consumption smoothing in the economy. For an infinitesimal change in the replacement rate, the impact of moral hazard is the smallest in Model I (-1.58%). Since formal jobs are more rewarding and harder to find, formal workers are less inclined to quit their jobs to collect UI, as represented by their elasticity of employment being the smallest among the three groups of workers ($\varepsilon_{s^f,b} = -0.01717$). Model II provides a useful benchmark for our welfare analysis. This model does not take into account the formality status of employed workers, pooling them together as employed.

On the one hand, this leads to a larger moral hazard effect (-3.44%), as informal workers are more inclined to leave their jobs to collect unemployment insurance and they make up the majority of employment. On the other hand, we see that, even in the absence of moral hazard, Model I yields larger welfare gains than Model II (1.00 vs 0.86). This result stems from Model I's being a more targeted policy that collects resources from only the wealthiest workers and redistributes them to some informal workers. Model III presents the largest moral hazard effect (-12.87%) for an infinitesimal expansion of UI, as the tax burden required to raise the required funds is spread across all agents. Since informal workers make up the majority of the labor force, their larger elasticity ($\varepsilon_{s^i,b} = -0.08461$) drives the moral hazard effect.

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 I (Informality with payroll tax)	0.98	1.00	-1.58 %
Model II (No informality with payroll tax)	0.83	0.86	-3.44 %
Model III (Informality with consumption tax)	0.53	0.60	-12.87 %

Notes: The table shows the dollar-on-dollar gains under the three models from Section 3 for an infinitesimal 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. In column (3), we compute the percentage difference between columns (1) and (2) to find the impact of moral hazard on the total welfare effect.

Note that this scenario considers an infinitesimal change in the replacement rate so the tax burden in all three models is negligible compared to consumption. In Section 5.2 below, we analyze the welfare gains from a large UI expansion, akin to an introduction of a UI system in a country without one, in which case the choice of how to finance the policy has important implications.

5.2 Welfare Gains from Large UI Expansions

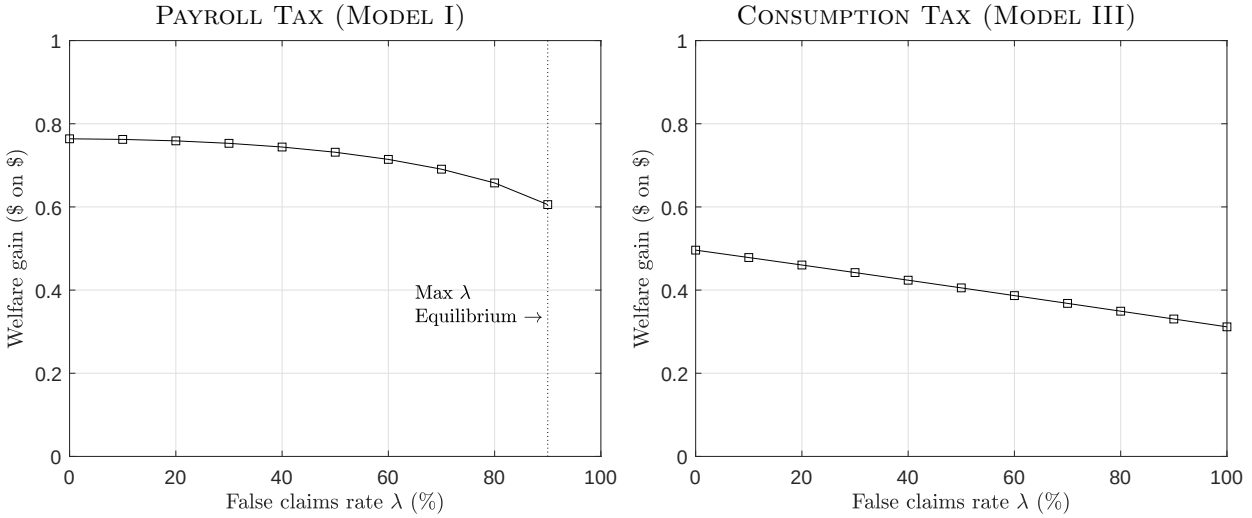
Our next exercise computes the welfare gains from larger UI expansions. We estimate the mean welfare gains from the introduction of a UI system that replaces 2% of formal workers' wage. We call this a large UI expansion since the replaced income constitutes 15.8% of the consumption of the unemployed and Senegal does not currently have a UI system.

We measure the dollar-on-dollar gains from labor tax–funded and consumption tax–funded UI expansions, and we demonstrate how those gains vary with the *final* false claims

rate, λ.[16] 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 6. We plot the unemployed 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).

Figure 6: Unemployed Worker's Dollar Consumption Gain per Dollar of Benefits



Notes: The figure shows the change in the unemployed worker's dollar consumption gains per dollar of benefits after an increase in the replacement rate b by 2%, with 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 informal workers who can access the UI benefits have higher consumption than do formal workers after the payroll tax is applied.

In the left panel, the policy provides large welfare gains since liquidity effects are very large (see Table 4). However, as explained in Section 3.1.1, 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, the severe rate of false claims distorts the incentives of formal workers, thereby attenuating the welfare gains derived from the provision of liquidity to other workers. Once λ reaches 90%, there is no combination of employment shares and tax rates that satisfies both the budget constraint and the incentives of formal workers, making the policy infeasible.

Turning to the right panel of Figure 6, 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. A higher λ yields greater UI benefits for those with lower marginal utility of consumption: informal claimants.

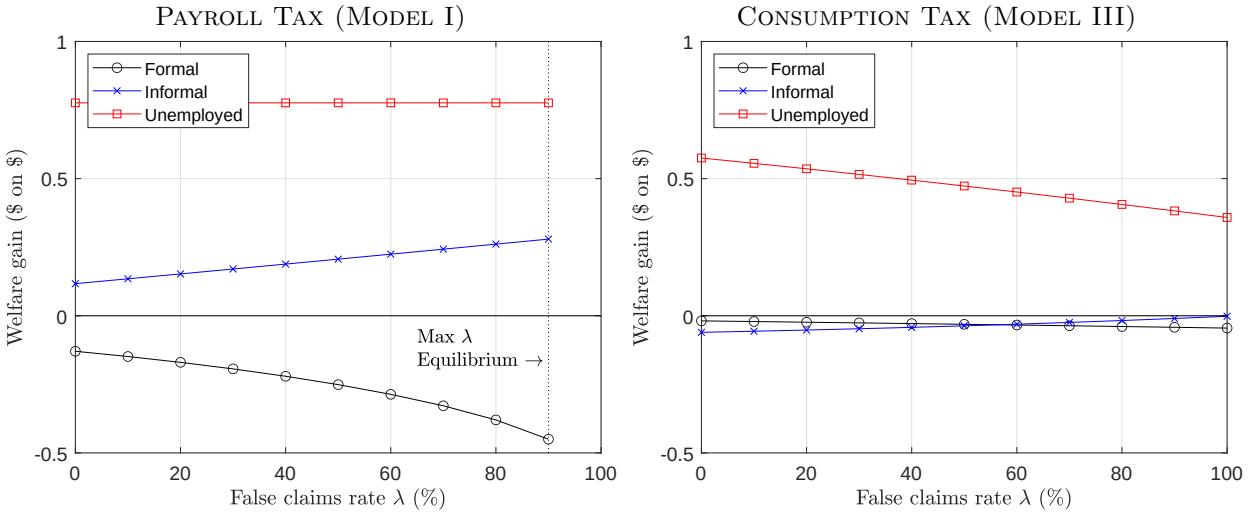
[16] While we provide an initial guess for λ in the small UI exercise, we face considerable uncertainty over its value; hence, we vary λ in each experiment.

As a result, the welfare gains fall as λ increases. However, the policy remains feasible even at high false claim rates.

5.3 Effect of False Claims

To better understand the effects driving behavior under different initial levels of λ, we can see in Figure 7 which types of agents, divided by their labor force status, benefit or lose from changes in the false claim rate. To do so, we compute the changes in utility for the average formal, informal, and unemployed agent.

Figure 7: Unemployed Worker's Dollar Consumption Gain per Dollar of Benefits Decomposed by Labor Force Status



Notes: The figure shows the change in the unemployed worker's dollar consumption gains per dollar of benefits after an increase in the replacement rate b by 2% decomposed by labor force status with 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. Formal workers, represented in black, are wage earners with formal, written work contracts. Informal workers, represented in blue, are wage earners with no written contract. Unemployed individuals, represented in orange, are individuals aged 15 or above with no job who are actively looking for a job or are not looking for involuntary reasons.

In the scenario with payroll tax financing, the losses incurred by formal workers remain minimal at low levels of false claims, as the moral hazard effects are initially negligible. However, as the rate of false claims (λ) increases, formal workers face escalating tax obligations to finance the extension of UI benefits to a growing pool of informal agents, resulting in progressively larger declines in welfare. Conversely, the gains for informal agents rise with λ, as UI benefits are dispensed to a broader segment of this group. Meanwhile, the gains for the unemployed remain unaffected by changes in λ, as this group is not subject to alterations in taxation or benefit provisions.

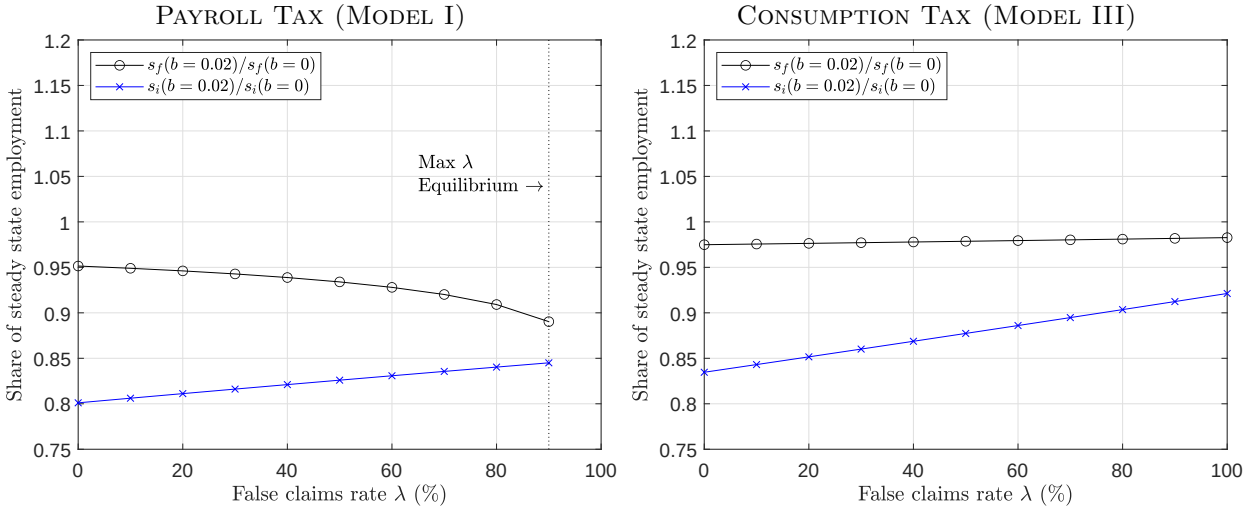
In the case of consumption tax financing, the losses experienced by formal workers are amplified by greater false claims, albeit at a slower pace than in the payroll tax scenario.

This is because the additional financial burden is distributed across all labor force groups. At low levels of false claim rates, the welfare gains for informal workers are negative, as they bear the consumption tax without receiving corresponding benefits. However, as λ rises, the welfare for informal workers becomes subject to dual forces: While benefits extend to a larger proportion of this group, the increment in taxes necessary to finance the policy curtails the net benefits received. Meanwhile, the gains for the unemployed diminish with λ, as the tax rate increases to support UI benefits for informal workers claiming unemployment, thereby reducing the net benefits gained after taxation.

5.4 Moral Hazard Effects

We next explore the moral hazard effects of the large UI expansion. Figure 8 illustrates the changes in formal and informal employment following the introduction of UI.

Figure 8: Formal and Informal Employment After Policy as Ratio of Steady-State Values



Notes: The figure shows the formal and informal employment shares after an increase in the replacement rate b by 2% with changes in the share of informal workers who manage to access UI (λ) as a ratio of the values of s_f and s_i in steady state. 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.

In the left panel, which analyzes the payroll tax economy (Model I), we see that raising b lowers the shares of formal and informal workers by 4.8% and 19.9%, respectively, when $\lambda = 0$. An increase in the false claims rate has opposite 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 decreases. Past the false claim rate of 90%, the policy becomes infeasible because there is no tax amount

T 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 enactment of the policy by approximately 11.0% and 15.5%, respectively.

In the right panel, we instead analyze the consumption tax economy (Model III). 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 2.5% and 16.5%, respectively. Since the tax is widespread and paid by all agents, unemployment becomes a less desirable state than in Model I, which reduces moral hazard effects. Furthermore, as informal work is closer in consumption to unemployment, the moral hazard effects are stronger, and search effort decreases more for informal jobs than for formal jobs. When the rate of false claims increases, the liquidity gains in the unemployed state diminish because of the additional tax, which thus reduces moral hazard. In addition, some informal workers receive unemployment benefits, further lessening the drop in informal employment. When λ reaches 100%, the shares of formal and informal employment decline by approximately 1.7% and 7.9%, respectively.

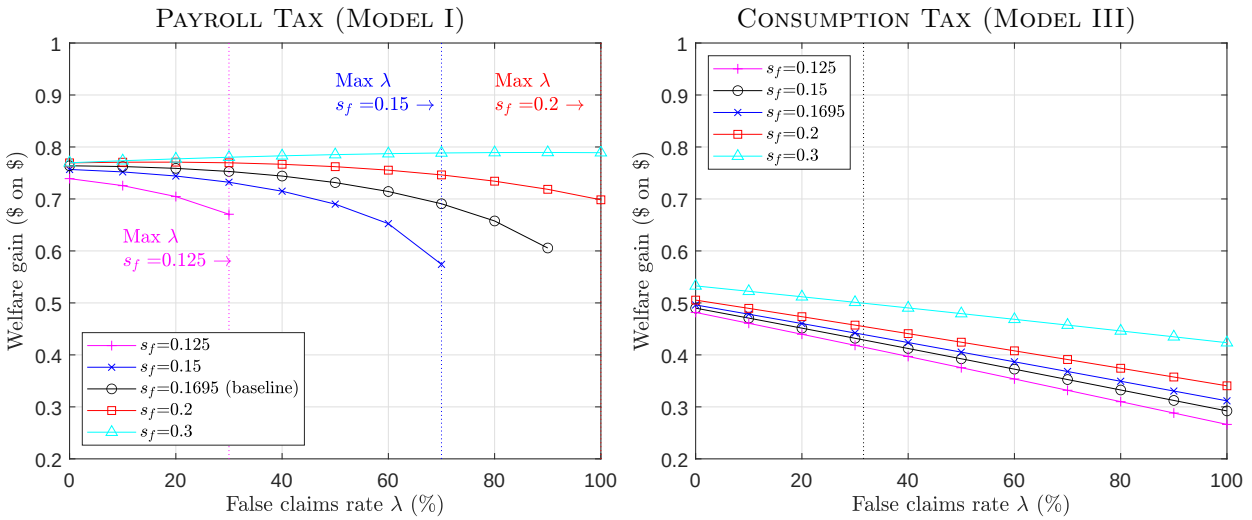
5.5 Effects of the Formal Labor Force Share

In this section, we expand our analysis by studying the degree of labor market informality—that is, the tax base of payroll taxes—and illustrate how changes in the informal share affect welfare gains. As discussed in Section 2, the share of formal workers varies with the notion of formality, in particular, whether it is defined at the firm or at the worker level. In addition, our dataset covers urban areas, which tend to have higher formalization than rural areas. Figure 9 repeats our numerical exercise for a range of formal worker shares. We change the share of formal workers by reallocating workers between informal and formal status while keeping the total employment rate constant.[17]

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 considerable payroll tax (proportional to $\frac{1}{s^f}$) is required to finance the UI benefits. The high payroll tax induces a large 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. For instance, with a share of formal workers of 12.5%, the payroll tax–funded scheme becomes infeasible at a false claims rate above 30%. When the formal employment share rises above 20%, we observe a concave trajectory of welfare gains with increases in the

[17] We do so by altering the relative costs of search, a_f and a_i, so that total employment remains the same and we achieve the desired split of emloyment between formal and informal sectors.

Figure 9: Unemployed Worker's Dollar Consumption Gain per Dollar of Benefits Under Different Levels of λ and Formal Employment



Notes: The figure shows the effects of a change in the unemployed 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.

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, three 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 are now a lower share of the employed, the marginal impact of an increase in false claims (λ) on both the liquidity and moral hazard effects is attenuated, given that fewer informal workers are eligible to claim UI benefits. Therefore, the slope of welfare as a function of λ is flatter when the formal share is higher. To conclude, payroll taxes can predictably provide large welfare gains irrespective of the rate of false claims when the economy is highly formal but can even hurt welfare when the economy is highly informal.

Moving to the right panel of Figure 9, we study the implications of different formal worker shares when the policy 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 in the payroll tax economy when the proportion of informal workers decreases. In addition, a rise in the rate of false claims reallocates fewer resources

from unemployed to informal workers, thus mitigating the impact of an increase in the false claims rate, λ, on welfare. Therefore, payroll taxes can guarantee welfare improvements even at very low shares of formal employment by guaranteeing a broad base.

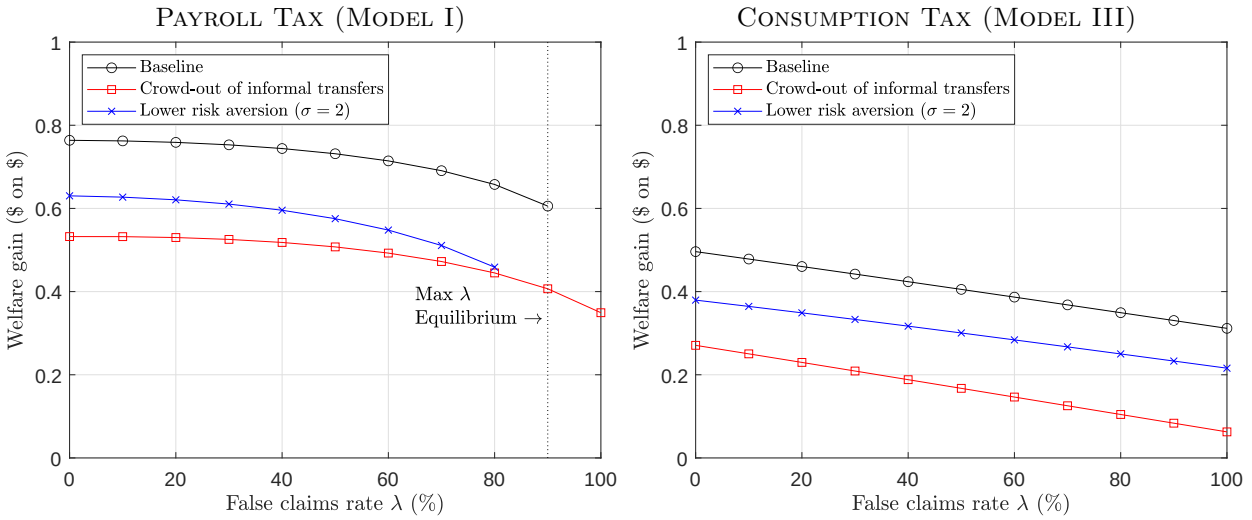
In the next section, we examine the significance of informal transfers, investigate the sensitivity of our results to different values of risk aversion, and discuss potential concerns related to the noninclusion of agricultural workers in our analysis and the implications of a dynamic model.

6 Robustness and Extensions

6.1 Risk Aversion and Crowding-Out of Informal Transfers

In Figure 10, we present the dollar-on-dollar welfare gains from a benefit equal to 2% following variations in the false claim rate λ under different scenarios.

Figure 10: Robustness Analysis



Notes: The figure shows the effects of a change in the unemployed worker's dollar consumption gain per dollar of benefits with changes in the share of informal workers who manage to access UI (λ) in different scenarios. In both plots, the black line represents the baseline value reported in Figure 6; the blue line represents the scenario in which all agents have a coefficient of risk aversion equal to 2; the orange line represents the scenario in which 24.6% of eligible individuals receive no utility gains from UI because of crowding-out of informal transfers. 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.

For the first scenario, we examine the coefficient of relative risk aversion. The estimated coefficient from our survey surpasses the magnitudes typically utilized in standard macroeconomic models but aligns with findings from studies suggesting higher risk aversion in low-income countries (Yesuf and Bluffstone, 2009). Note, however, that survey measures of risk aversion come with limitations (Treibich, 2015). Therefore, we investigate the im-

plications of reducing the coefficient to a standard value of $\sigma = 2$ within our analysis. As depicted in Figure 10, a lower coefficient of risk aversion dampens the demand for insurance during unemployment, resulting in diminished welfare gains from UI. Notably, the impact of a lower coefficient of risk aversion on the consumption tax–funded policy is less pronounced than that on the payroll tax–funded one. This discrepancy arises because the former finances the policy through taxes levied on both informal workers and the unemployed, thereby mitigating the utility loss attributable to the tax. Furthermore, when agents are less risk averse, the payroll tax policy becomes infeasible for lower levels of UI, with $\lambda = 80\%$ as the lowest value for which an equilibrium exists.

For the second scenario, we explore the potential effects of a UI policy on the informal safety net that some individuals rely on during unemployment. Specifically, we surveyed respondents regarding their ability to access informal borrowing from sources such as informal lenders or individuals within their network in the event of job loss. Our survey results indicate that approximately 24.6% of individuals have access to informal borrowing options during periods of unemployment. In Figure 10, we investigate the implications of assuming *complete crowding-out* of informal transfers by the UI policy. We assume that a share $s^x = 0.246$ of unemployed individuals claim benefits but have one-for-one offsetting reductions in informal transfers (see Table 2). Crowding-out of informal insurance reduces the attainable welfare gains under both the payroll tax– and consumption tax–financed UI schemes.

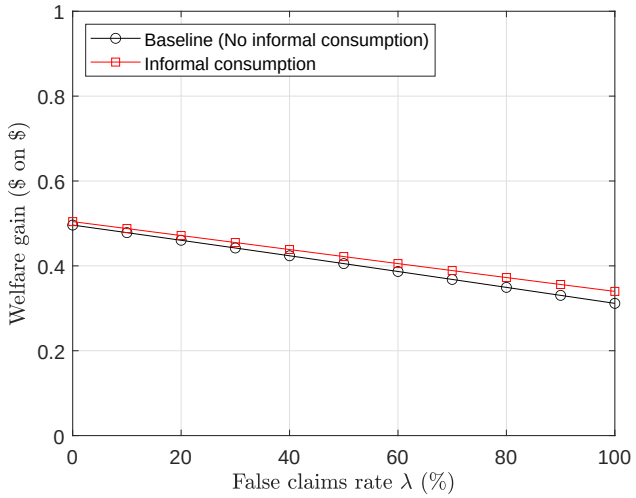
6.2 Consumption Taxes and Informal Consumption

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, a portion of the consumption of all agents would not be subject to a consumption tax. In our survey, we differentiate individual consumption into four categories: utilities, housing, food, and other expenditures. To test the effects of informal consumption on the welfare gains in the consumption tax–financed model, we assume that food consumption happens entirely in the informal market.

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 we assume that food consumption is "informal" and thus cannot be taxed. Our data show that formal workers spend 51.8% of their consumption on food, informal workers 47.2%, and jobless individuals 53.9% (see Table 2). We normalize the relative price of food and nonfood goods to 1 without loss of generality. The government budget constraint becomes

$$t\left[s^f\left(1-\gamma^f\right)C^f+\lambda s^i\left(1-\gamma^i\right)C^{i,c}+(1-\lambda)\,s^i\left(1-\gamma^i\right)C^{i,nc}+\left(1-s^f-s^i\right)\left(1-\gamma^u\right)C^u\right]=\left(1-s^f-(1-\lambda)\,s^i\right)bw^f.$$

Figure 11: Unemployed Worker's Dollar Consumption Gain per Dollar of Benefits with Informal Consumption



Notes: The figure shows the effects of a change in the unemployed worker's dollar consumption gain per dollar of benefits with changes in the share of informal workers who manage to access UI (λ) when the policy is financed through a consumption tax. The gray line represents the baseline value reported in the right plot of Figure 6; the blue line represents the scenario in which food consumption occurs in the informal market and thus is exempt from taxation.

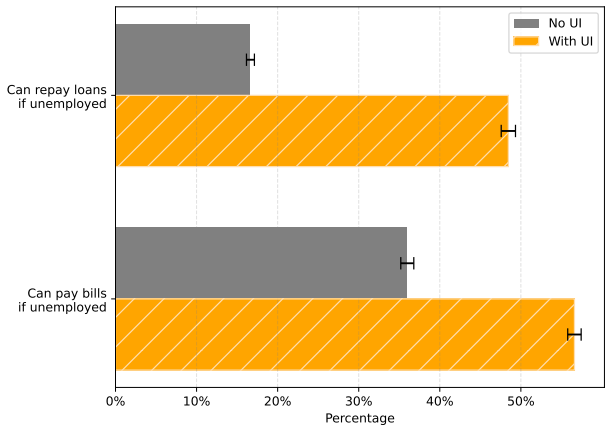
Numerical results for the dollar-on-dollar welfare gains are presented in Figure 11. The figure illustrates that the welfare gains are more substantial in the model that incorporates informal consumption, as consumption taxes become more progressive (Bachas et al., 2023). When we account for tax evasion through informal consumption, the welfare gains from the consumption tax–funded UI rise by 0.82–2.82 cents across false claims rates. This model incorporates that unemployed workers consume more in the informal sector than employed workers. Consequently, the consumption tax rises in progressivity as its burden, in percentage terms, falls on formal and informal workers disproportionately more than on the unemployed. The majority of the welfare gains in this consumption tax–financed model are driven by the liquidity benefits to unemployed individuals, resulting in significant welfare improvements. Additionally, these relative gains increase with the rate of false claims since the tax burden on the unemployed is smaller than in the scenarios without informal consumption.

6.3 More benefits from UI: Private Credit Markets and Default

In addition to the channels highlighted in our structural analysis, our survey allows us to provide unique tests of recent hypotheses regarding the way UI affects the macroeconomy. In particular, recent work by Braxton et al. (2020) and Bornstein and Indarte (2022) argues that private credit markets and public insurance are complementary. An expansion of the safety net does not crowd out private borrowing. It does precisely the opposite: a wider safety net reduces default rates, and private credit markets expand. While a complete analysis of this topic is beyond the scope of the paper, we provide suggestive evidence that expanding the safety net in Senegal would reduce defaults. We asked our survey respondents two hypothetical questions to assess whether they would be able to meet their financial obligations in different scenarios. The specific questions asked can be found in Appendix B6.

To estimate the effects of a more easily implementable policy, we consider the subset of respondents who were asked about a potential UI amount of between approximately 5% and 25% of the average salary in Senegal (across formal and informal workers) or 5000 FCFA and 30000 FCFA. Table C4 reports the summary statistics of the results. Furthermore, we compare them to the baseline results with no UI in Figure 12. We find that job losers' ability to make payments on loans and bills improves with an expansion of the safety net, in agreement with the existing literature. This suggests that, rather than crowding out private insurance opportunities, the safety net allows private credit markets to expand.

Figure 12: Impact of UI on Loan Repayment and Financial Obligations



Notes: The figure shows the percentage of affirmative answers to the questions presented above. The first two bars represent the percentage of respondents who would be able to repay their loans in the event of unemployment without UI (solid bar) and with UI in a range of 5000 FCFA to 30000 FCFA, that is, between approximately 5% and 25% of the average salary (striped bar). The last two bars represent the percentage of respondents who would be able to pay their bills in the event of unemployment without UI (solid bar) and with UI in a range of 5000 FCFA to 30000 FCFA, between approximately 5% and 25% of the average salary (striped bar). The error bands represent the 99% confidence interval for the mean response.

6.4 Additional Discussion

Before concluding, we address 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 agriculture in our analysis. We address this in two ways. First, in Figure 9, 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, the agricultural workers in our context receive targeted support from the government through ISPs, which have been in 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 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). For our theory, Chetty (2006) shows that in a dynamic setting, a standard Baily–Chetty formula, similar to ours, still applies.[18] 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 are effectively hand-to-mouth with extremely low asset stocks (see Figure 4),[19] and (ii) our survey evidence implies similar short-run and long-run quit elasticities (see Table B1 of our Appendix). We believe a richer dynamic setting 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 rise.

However, another dynamic elasticity that a static model does not account for is the propensity of the UI scheme to induce job formalization. We asked the following question in

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

[19] 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.

our survey:

> *Suppose the government seeks to implement a social protection policy over the next two months that would consist of offering, to every worker with formal employment, the equivalent of one month's salary once in case of job loss. In this case, would you ask your employee to formalize your employment status (if you are an employee) or would you be willing to formalize the employment status of your undeclared employees, including yourself (if you are an employer or self-employed)?*

We ask this question with UI replacing one month of salary for the previously formally employed. A total of 69.2% of informal respondents answered "Yes" to this question. This result suggests that a UI scheme could push informal workers to require their employer to formalize. Absent other barriers to formalization, this could boost the share of formal workers. This additional dynamic benefit of UI is studied by Cirelli et al. (2021), who find that replacement of a month's salary can increase the share of formal workers by at least 3.7% points.

Alternative policies: There are several other policy instruments such as cash transfers, means-tested income support, and more progressive income taxes that may complement – but not substitute – UI. Cash transfers, means-tested income support and progressive income taxes span different risks at different frequencies compared to UI. UI insures short-term job loss risk as opposed to cash transfers, which are often designed to alleviate more persistent income shocks. Means-tested income support and more progressive income taxes occur annually and rely on tax forms, while UI operates at a lower frequency. We believe that the presence of these other forms of insurance would not alter our main insights regarding the relative targeted-ness and feasibility of payroll- and consumption-tax funded UI programs.

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. However, the moral hazard effects are relatively modest, 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 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 50–80 cents. This dollar-on-dollar welfare gain from UI exceeds comparable estimates for the U.S. by a factor of 10–20.

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 actually unemployed claimants and informal workers posing as unemployed 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 unfeasible at high false claim rates.

In economies with a significant informal sector, financing a UI policy with a broad tax emerges as a viable compromise. This approach mitigates the moral hazard effect associated with payroll financing and is robust against the potential unfeasibility of UI that may arise with a high payroll tax on a small formal base. Furthermore, given the redistribution of welfare between unemployed and informal workers facilitated by the consumption tax implementation, the welfare gains are less diminished when we consider a risk aversion coefficient more aligned with the estimates in the standard literature.

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

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FOR ONLINE PUBLICATION

Appendix A – Model Solutions

A1 Model I: Small Changes in b

Environment. We briefly repeat the environment (see the text for variable definitions). The model economy is described by the household problem,

$$W\left(s^f, s^i, \lambda\right) = \max_{s^f, s^i, \lambda} s^f V^f + s^i \left[\lambda V^{i,\lambda} + (1-\lambda) V^{i,1-\lambda} - \phi(\lambda)\right] + \left(1 - s^f - s^i\right) V^u - \psi^f\left(s^f\right) - \psi^i\left(s^i\right), \qquad (A1)$$

subject to

$$s^i + s^f \leq 1, \qquad s^i \geq 0, \qquad s^f \geq 0, \qquad 0 \leq \lambda \leq 1$$

where $V^f = u\left(A + w^f - T\right)$, $V^{i,\lambda} = u\left(A + w^i + bw^f\right)$, $V^{i,1-\lambda} = u\left(A + w^i\right)$, $V^u = u\left(A + bw^f\right)$, and the government budget constraint,

$$s^f T = \left(1 - s^f - (1-\lambda) s^i\right) bw^f.$$

We assume there is a linear, labor-only formal production technology $y(s^f) = z^f s^f$, and so $z^f = w^f$. Likewise, there is a labor-only informal production technology $y(s^i) = z^i s^i$, and so $z^i = w^i$.
Last, for ease of exposition, we define $C^f = A + w^f - T$, $C^{i,c} = A + w^i + bw^f$,$C^{i,nc} = A + w^i$, and $C^u = A + bw^f$.

Government problem. The government's objective is to choose b to maximize $W\left(s^f, s^i, \lambda\right)$, subject to the balanced budget constraint. Applying the envelope theorem, the first-order condition for b is

$$\frac{dW}{db} = s^f u'\left(C^f\right)(-1)\frac{dT}{db} + s^i \lambda u'\left(C^{i,c}\right) w^f + \left(1 - s^f - s^i\right) u'\left(C^u\right) w^f,$$

and the derivative of the tax rate is

$$\frac{dT}{db} = \frac{1}{s^f}\left[\left(1 - s^f - (1-\lambda) s^i\right) w^f - \left(\frac{ds^f}{db} + (1-\lambda)\frac{ds^i}{db} - \frac{d\lambda}{db} s^i\right) bw^f - \frac{ds^f}{db} T\right].$$

Now, define $\varepsilon_{s^f,b} = \frac{ds^f}{db}\frac{b}{s^f}$, $\varepsilon_{s^i,b} = \frac{ds^i}{db}\frac{b}{s^i}$, $\varepsilon_{\lambda,b} = \frac{d\lambda}{db}\frac{b}{\lambda}$ and use $T = \frac{1}{s^f}\left(1 - s^f - (1-\lambda) s^i\right) bw^f$ to see

$$\frac{dT}{db} = \frac{w^f}{s^f}\left[1 - s^f - (1-\lambda)\, s^i - \varepsilon_{s^f,b} - (1-\lambda)\, s^i \left(\varepsilon_{s^i,b} - \varepsilon_{s^f,b}\right) + \varepsilon_{\lambda,b}\lambda s^i\right].$$

Sufficient statistic for welfare. Combining $\frac{dW}{db}$ and $\frac{dT}{db}$ yields our sufficient statistic expression for changes in welfare stemming from small changes in b:

$$\begin{aligned}\frac{dW}{db} =& w^f\left[s^i\lambda u'\left(C^{i,c}\right) - u'\left(C^f\right)\left(1 - s^f - (1-\lambda)\, s^i\right) + \left(1 - s^f - s^i\right) u'\left(C^u\right)\right] \qquad (A2)\\ & u'\left(C^f\right) w^f\left(\varepsilon_{s^f,b} + (1-\lambda)\, s^i\left(\varepsilon_{s^i,b} - \varepsilon_{s^f,b}\right) - \varepsilon_{\lambda,b}\lambda s^i\right).\end{aligned}$$

The liquidity gains are denoted by

$$\frac{dW}{db}^L = w^f\Big(s^i\lambda u'\left(C^{i,c}\right) - u'\left(C^f\right)\left(1 - s^f - (1-\lambda)\, s^i\right) + \left(1 - s^f - s^i\right) u'\left(C^u\right)\Big).$$

Cash-on-cash welfare metric. To make our metric comparable to others in the existing literature, we convert the gains into a "cash-on-cash metric" as follows:

$$\frac{dW}{db}\frac{1}{w^f}\frac{1}{(1 - s^i - s^f)}\frac{1}{u'(C^u)} \approx \frac{\text{change in welfare in dollars}}{\text{change in benefits in dollars}}.$$

We note that dbw^f is the change in benefits in dollars, $(1 - s^i - s^f)$ converts the metric to a per-unemployed person basis, and $\frac{dW}{u'(C^u)}$ is the change in welfare in consumption units.

A2 Model I: Large Changes in b

Calibration of search costs (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},$C^{i,nc}_{data}$ 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. We treat the data as the $T = 0$, $b = 0$ equilibrium. We assume isoelastic functions for formal search, informal search, and false claims costs:

$$\psi^f(s^f) = a_f\frac{\left(s^f\right)^{1+\frac{1}{\epsilon_f}}}{1+\frac{1}{\epsilon_f}}, \qquad \psi^i(s^i) = a_i\frac{\left(s^i\right)^{1+\frac{1}{\epsilon_i}}}{1+\frac{1}{\epsilon_i}} \qquad \phi(\lambda) = a_\lambda\frac{\lambda^{1+\frac{1}{\epsilon_\lambda}}}{1+\frac{1}{\epsilon_\lambda}}.$$

For any positive cost of false claims $a_\lambda > 0$, when $b = 0, T = 0$ (as we treat our data), the household's optimal false claims rate is $\lambda = 0$, and so our choice of a_λ is arbitrary in the initial $b = 0, T = 0$ equilibrium, and it has no effect on our measured elasticities.

Table A1: Large UI changes, Estimated parameters

Var.	Description	Value	Moment	Model	Data
ϵ_λ	Power of false claim costs	0.20	Elast. false claims WRT b	0.20	0.20
ϵ_f	Power of formal search costs	0.08	Elast. formal empl. WRT b	-0.02	-0.02
ϵ_i	Power of informal search costs	0.38	Elast. informal empl. WRT b	-0.08	-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	2.37e-02	Formal employment	0.17	0.17
a_i	Scaling of informal employment search costs	6.02e-12	Informal employment	0.51	0.51

Notes: This describes the model moments and targets for the payroll tax economy when $T = 0, b = 0, \lambda = 0$. Appendix Appendix A2 provides additional details on the estimation.

Therefore, we set $a_\lambda = 1$ in our baseline experiments and calibration. We then jointly calibrate $\{a_f, a_i, \epsilon_f, \epsilon_i, \epsilon_u\}$ to match five moments: (1) the formal employment share s^f_{data} at $b = 0$, $T = 0$; (2) the informal employment share s^i_{data} at $b = 0$, $T = 0$; (3) the arc elasticity of formal employment with respect to benefits; (4) the arc elasticity of informal employment with respect to benefits; and (5) the arc elasticity of false claims with respect to benefits, which we proxy via the informal quit elasticity (Table 2). Table A1 reports the constants and elasticities.

Calibration of search costs (varying λ). In many of our exercises, we vary the equilibrium false claims rate by varying a_λ. Since we assume $\phi(\lambda) = a_\lambda \frac{\lambda^{1+\frac{1}{\epsilon_\lambda}}}{1+\frac{1}{\epsilon_\lambda}}$, we have $\phi'(\lambda) = a_\lambda \lambda^{\frac{1}{\epsilon_\lambda}}$, $\phi^{-1\prime}(x) = \left(\frac{1}{a_\lambda} x\right)^{\epsilon_\lambda}$. We then invert for the value of a_λ that delivers an optimal choice $\lambda = \overline{\lambda}$ as follows, where b is specified in the counterfactual and w^f_{data} is observed:

$$a_\lambda = \frac{1}{\left(\overline{\lambda}\right)^{\frac{1}{\epsilon_\lambda}}} \left(u\left(C^{i,nc}_{data} + b w^f_{data}\right) - u\left(C^{i,nc}_{data}\right)\right).$$

Solution method. We solve the model by taking first-order conditions for households and then using bisection 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 (5.) are satisfied. A solution must satisfy:

1. First-order condition for λ:

$$\lambda = \phi^{-1\prime}\left(u\left(C^i + b w^f\right) - u\left(C^i\right)\right).$$

2. First-order condition for s^f:

$$s^f = \psi^{f-1\prime}\left(u\left(C^f - T\right) - u\left(C^u + b w^f\right)\right).$$

3. First-order condition for s^i:

$$s^i = \psi^{i-1\prime}\left(\left[\lambda u\left(C^i + bw^f\right) + (1-\lambda)\,u\left(C^i\right) - \phi\left(\lambda\right)\right] - u\left(C^u + bw^f\right)\right).$$

4. Government budget clearing:

$$s^f T = \left(1 - s^f - (1-\lambda)\,s^i\right) bw^f.$$

5. Feasibility:

$$s^i + s^f \leq 1, \qquad s^i \geq 0, \qquad s^f \geq 0, \qquad 0 \leq \lambda \leq 1$$

Welfare decomposition. Once the model is solved, we provide a welfare decomposition. We note that

$$\begin{aligned} dW = {} & s^{f\prime} u\left(C^f - T'\right) + s^{i'}\left[\lambda' u\left(C^i + b'w^{f'}\right) + (1-\lambda')\,u\left(C^i\right) - \phi\left(\lambda'\right)\right] + \left(1 - s^{f'} - s^{i'}\right) u\left(C^u + b'w^f\right) - \psi^f\left(s^{f'}\right) - \psi^i\left(s^{i'}\right) \\ & - \left[s^f u\left(C^f - T\right) + s^i\left[\lambda u\left(C^i + bw^f\right) + (1-\lambda)\,u\left(C^i\right) - \phi\left(\lambda\right)\right] + \left(1 - s^f - s^i\right) u\left(C^u + bw^f\right) - \psi^f\left(s^f\right) - \psi^i\left(s^i\right)\right] \end{aligned}$$

can be rewritten in terms of the formal, informal, and unemployed components:

$$\begin{aligned} dW = {} & s^{f\prime} u\left(C^f - T'\right) - s^f u\left(C^f - T\right) + \left(s^f - s^{f'}\right) u\left(C^u + b'w^f\right) - \left[\psi^f\left(s^{f'}\right) - \psi^f\left(s^f\right)\right] \left(:= dW \text{ formal}\right) \\ & + s^{i'}\left[\lambda' u\left(C^i + b'w^{f'}\right) + (1-\lambda')\,u\left(C^i\right) - \phi\left(\lambda'\right)\right] - s^i\left[\lambda u\left(C^i + bw^f\right) + (1-\lambda)\,u\left(C^i\right) - \phi\left(\lambda\right)\right] \left(:= dW \text{ informal}\right) \\ & - \left[\psi^i\left(s^{i'}\right) - \psi^i\left(s^i\right)\right] + \left(s^i - s^{i'}\right) u\left(C^u + b'w^f\right) \\ & + \left(1 - s^f - s^i\right)\left[u\left(C^u + b'w^f\right) - u\left(C^u + bw^f\right)\right] \left(:= dW \text{ unemployed}\right). \end{aligned}$$

This decomposition computes the change in "average formal" welfare, taking into account shifts in search behavior.

Full crowding-out. Suppose s^x of the unemployed see their informal transfers fully crowded out by UI (i.e., one dollar of b is offset by a dollar-for-dollar reduction). The household problem then becomes

$$\begin{aligned} & \max_{s^f, s^i, \lambda} s^f u\left(C^f - T\right) + s^i\left[\lambda u\left(C^i + bw^f\right) + (1-\lambda)\,u\left(C^i\right) - \phi\left(\lambda\right)\right] \\ & + \left(1 - s^f - s^i\right)\left[s^x u\left(C^u\right) + (1 - s^x)\,u\left(C^u + bw^f\right)\right] - \psi^f\left(s^f\right) - \psi^i\left(s^i\right). \end{aligned}$$

The share s^x that sees its informal transfers crowded out still claims benefits, and so the government budget constraint is unchanged.

A3 Model II: Small Changes in b

Simplifying equation $(A2)$ and noting $\lambda = 0$, $s^i = 0$, we have

$$\frac{dW}{db} = u'\left(C^f\right) w^f \varepsilon_{s^f,b} + w^f \left(1 - s^f\right) \left[u'\left(C^u\right) - u'\left(C^f\right)\right].$$

When mapping this economy to the data, (1) we replace formal consumption C^f with consumption of all employed workers C^e, (2) we replace the elasticity of formal workers $\varepsilon_{s^f,b}$ with the elasticity of all employed workers $\varepsilon_{s,b}$, and (3) we replace s^f with the overall employment share s:

$$\frac{dW}{db} = u'\left(C^e\right) w^f \varepsilon_{s,b} + w^f \left(1 - s\right) \left[u'\left(C^u\right) - u'\left(C^f\right)\right].$$

The values of C^e, $\varepsilon_{s,b}$, and s are reported in Table 2.

A4 Model III: Small Changes in b

Environment. We now turn to the consumption tax. Given the changes in tax systems, we must redefine $C^f = A + w^f$. The model economy is now described by the household problem,

$$\begin{aligned}\max_{s^f,s^i,\lambda} W\left(s^f, s^i, \lambda\right) = \max_{s^f,s^i,\lambda} \; & s^f u\left(\left(1-t\right)C^f\right) + s^i\left[\lambda u\left(\left(1-t\right)C^{i,c}\right) + \left(1-\lambda\right)u\left(\left(1-t\right)C^{i,nc}\right) - \phi\left(\lambda\right)\right] \\ & + \left(1 - s^f - s^i\right) u\left(\left(1-t\right)C^u\right) - \psi^f\left(s^f\right) - \psi^i\left(s^i\right),\end{aligned}$$

subject to

$$s^i + s^f \leq 1, \qquad s^i \geq 0, \qquad s^f \geq 0, \qquad 0 \leq \lambda \leq 1$$

and the government budget constraint,

$$s^f t C^f + \lambda s^i t C^{i,c} + \left(1-\lambda\right) s^i t C^{i,nc} + \left(1 - s^f - s^i\right) t C^u = \left(1 - s^f - \left(1-\lambda\right) s^i\right) b w^f.$$

We maintain the assumption that there is a linear, labor-only formal production technology $y(s^f) = z^f s^f$, and so $z^f = w^f$. Likewise, there is a labor-only informal production technology $y(s^i) = z^i s^i$, and so $z^i = w^i$.

Government problem. The objective of the government is to choose b to maximize $W\left(s^f, s^i, \lambda\right)$, subject to the balanced budget constraint. The first-order condition for b yields

$$\frac{dW}{db} = s^f u'\left(\left(1-t\right)C^f\right)\left(-\frac{dt}{db}C^f\right) + s^i\lambda u'\left(\left(1-t\right)C^{i,c}\right)\left(-\frac{dt}{db}C^{i,c} + \left(1-t\right)w^f\right)$$
$$+ s^i\left(1-\lambda\right)u'\left(\left(1-t\right)C^{i,nc}\right)\left(-\frac{dt}{db}C^{i,nc}\right) + \left(1-s^f-s^i\right)u'\left(\left(1-t\right)C^u\right)\left(-\frac{dt}{db}C^u + \left(1-t\right)w^f\right).$$

Define the term

$$\Omega \equiv \left[s^f C^f + \lambda s^i C^{i,c} + \left(1-\lambda\right)s^i C^{i,nc} + \left(1-s^f-s^i\right)C^u\right].$$

Beginning from an economy in which $t = 0$, $b = 0$, we can write the change in welfare stemming from small changes in b as follows:

$$\frac{dW}{db} = s^f u'\left(C^f\right)\left(-\frac{dt}{db}C^f\right) + s^i\lambda u'\left(C^{i,c}\right)\left(-\frac{dt}{db}C^{i,c} + w^f\right)$$
$$+ s^i\left(1-\lambda\right)u'\left(C^{i,nc}\right)\left(-\frac{dt}{db}C^{i,nc}\right) + \left(1-s^f-s^i\right)u'\left(C^u\right)\left(-\frac{dt}{db}C^u + w^f\right)$$

$$\frac{dt}{db} = \frac{\left(1-s^f-\left(1-\lambda\right)s^i\right)w^f}{\Omega} - \frac{1}{\Omega}\left(\varepsilon_{s^f,b}\frac{s^f}{s^i} + \left(1-\lambda\right)\varepsilon_{s^i,b} - \varepsilon_{\lambda,b}\lambda\right)s^i w^f$$

$$\Omega = \left[s^f C^f + \lambda s^i C^{i,c} + \left(1-\lambda\right)s^i C^{i,nc} + \left(1-s^f-s^i\right)C^u\right].$$

A5 Model III: Large Changes in b

Solution method. Similarly to Model I, we solve the model by taking first-order conditions for households and then using bisection 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 (5.) are satisfied. A solution must satisfy:

1. First-order conditions for λ:

$$u\left(\left(1-t\right)C^{i,c}\right) - u\left(\left(1-t\right)C^{i,nc}\right) - \phi'\left(\lambda\right) = 0.$$

2. First-order conditions for s^f:

$$u\left(\left(1-t\right)C^f\right) - u\left(\left(1-t\right)C^u\right) - \psi^{f\prime}\left(s^f\right) = 0.$$

3. First-order conditions for s^i:

$$\lambda u\left(\left(1-t\right)C^{i,c}\right)+\left(1-\lambda\right)u\left(\left(1-t\right)C^{i,nc}\right)-\phi\left(\lambda\right)-u\left(\left(1-t\right)C^{u}\right)-\psi^{i\prime}\left(s^i\right)=0.$$

4. Government budget clearing:

$$t\left[s^fC^f+\lambda s^iC^{i,c}+\left(1-\lambda\right)s^iC^{i,nc}+\left(1-s^f-s^i\right)C^u\right]=\left(1-s^f-\left(1-\lambda\right)s^i\right)bw^f.$$

5. Feasibility:

$$s^i+s^f\leq 1,\qquad s^i\geq 0,\qquad s^f\geq 0,\qquad 0\leq\lambda\leq 1$$

Informal consumption. Let $\gamma^f,\gamma^i,\gamma^u$ denote the share of consumption spent on food by formal, informal, and unemployed workers, respectively. We assume these shares are fixed and exogenous, and we assume that food consumption is "informal" and thus cannot be taxed. The government budget constraint then becomes

$$t\left[s^f\left(1-\gamma^f\right)C^f+\lambda s^i\left(1-\gamma^i\right)C^{i,c}+\left(1-\lambda\right)s^i\left(1-\gamma^i\right)C^{i,nc}+\left(1-s^f-s^i\right)\left(1-\gamma^u\right)C^u\right]=\left(1-s^f-\left(1-\lambda\right)s^i\right)bw^f.$$

The utility function of household x becomes $u\left(\left(1-t\right)\left(1-\gamma^x\right)C^x+\gamma^xC^x\right)$. Our solution method proceeds as before.

Appendix B – Parameter Estimation

B1 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] FCFA. The second job offers: (i) a 50% chance of earning a monthly salary of [2*Y] FCFA and (ii) a 50% chance of earning a monthly salary of [X * Y] FCFA. Among the two options available to you, which one would you choose?*

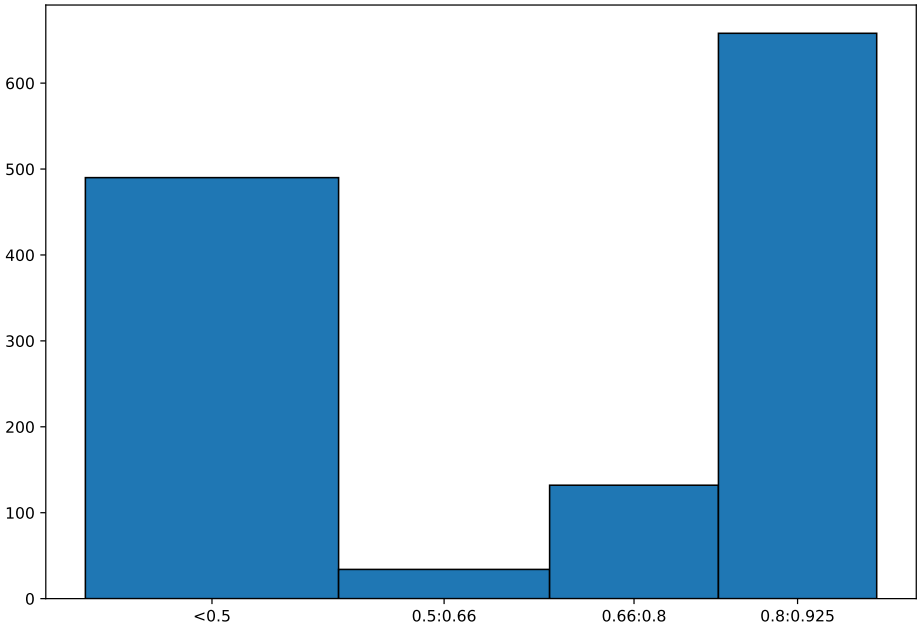
We asked the question twice. The first time, we used $X = 2/3$. The second time, we used $X = 1/2$ if the respondent picked the lottery and $X = 4/5$ if she picked the safe job.

We map the answers on risk aversion back to theory, assuming that individuals have a von Neumann–Morgenstern utility function $u(\cdot)$ 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 λy, the scale factor λ is implicitly defined by:

$$\frac{1}{2}u(2y) + \frac{1}{2}u(\lambda y) = u(y).$$

Depending on the answer given to the hypothetical questions, we can infer which of the following intervals the λ 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 λ after an interval is assigned to each respondent based on her responses.

Figure B1: Bins of Scale Factor λ



Notes: This figure shows the distribution of the intervals in which the values of the scale factor λ of 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 usual representations of risk aversion in the literature. To deal with 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 the value of λ 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.

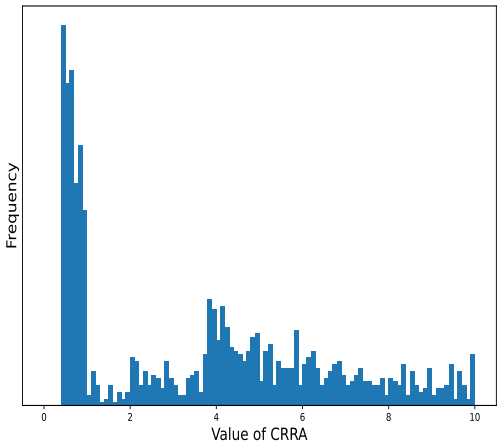
Under an assumption of CRRA, there is a one-to-one positive relationship between λ and the respondent's coefficient of relative risk aversion R, or $\frac{u''(\cdot)}{u'(\cdot)}$, as follows. We use an implicit function solver to find the exact value of the CRRA coefficient, using the formula

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

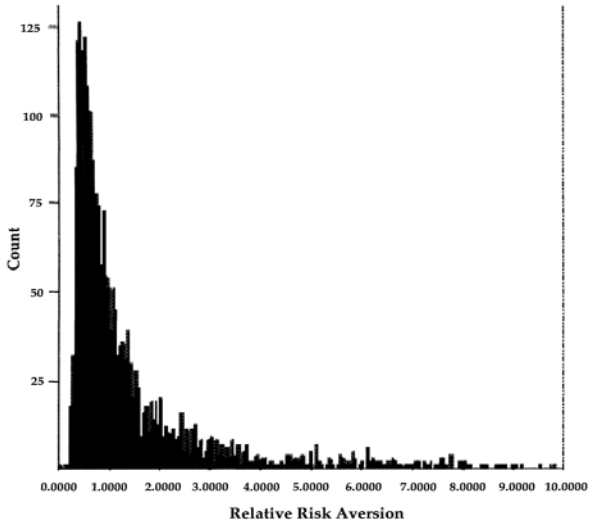
, where A is the CRRA coefficient. Figure B2 displays the resulting distribution of the CRRA coefficient obtained from the above mapping:

Figure B2: Distribution of the Coefficient of Risk Aversion

(a) Survey



(b) Halek and Eisenhauer (2001)



Notes: This figure shows in the left panel the distribution of the CRRA coefficient for the respondents in our sample and in the right panel 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 λ. 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).

B2 Consumption

We use data on respondents' current expenditure level and focus on 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, 60,900.79 FCFA and 34,566.80 FCFA.[20]

Our survey presents four categories of expenditure: utilities, housing, food, and other expenditures. We utilize the share of expenditures on food over the total to estimate the parameters γ^x for all types of agents.

B3 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 be able 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 the extended definition of unemployment that the Senegalese National Agency of Statistics and Demography (ANSD) uses. Given the poor structure of the Senegal labor market, which impedes job search, the ANSD considers as unemployed both people 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 my skills, abilities). (3) He/she does not think he/she can get a job for 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

[20]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 $1487.76 or 818,519.15 FCFA. 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 56,136.77 FCFA, which is consistent with our findings.

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.

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.

B4 Arc-Elasticities

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

$$\varepsilon_{s^f,b} = \frac{\frac{s^{f\prime} - s^f}{\frac{1}{2}\left(s^{f\prime} + s^f\right)}}{\frac{b' - b}{\frac{1}{2}(b' + b)}}.$$

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

$$\varepsilon_{s^i,b} = \frac{\frac{s^{i\prime} - s^i}{\frac{1}{2}(s^{i\prime} + s^i)}}{\frac{b' - b}{\frac{1}{2}(b' + b)}}.$$

To compute the false claims elasticity, we must use a proxy (since there are no benefits yet in Senegal). We therefore use the informal quit elasticity $\frac{dq^i}{db}$ as a proxy for the share of individuals who would make a false claim, $\frac{d\lambda}{db} \approx \frac{dq^i}{db}$. The share of informal workers at formal firms pins down our baseline $\lambda = 0.316$. For the hypothetical benefit change in our survey, $db = b' - b$, we compute $\lambda' = 0.316 + \frac{d\lambda}{db}db$,

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

To compute the quit elasticities, we asked respondents some questions to estimate the changes in their incentives to search for a job in the context of an 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] FCFA 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.[21] 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.

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.

B5 Informal Transfers

To estimate the share of workers who would receive informal transfers in case of unemployment, the s^x parameter that we use for our robustness check in Section 6.1, 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?

[21] For unemployed individuals, their last earned salary is utilized. 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

B6 Meeting of Financial Obligations

To estimate respondents' ability to meet financial obligations that we discuss in Section 6.3, we use the responses to the following two questions from the questionnaire:

If you were to lose your job today and the government offered you [X] FCFA per month for two months, would you be able to pay off the debts you have incurred from formal financial institutions, informal lenders, individuals within your network, or any other sources for this month? If you were to lose your job today and the government offered you [Y] FCFA per month for two months, would you be able to pay your water and electricity bills for this month?

where X and Y are a random amount of FCFA between 0 and 120,000. The first question concerns the ability to repay outstanding loans and the second the ability to pay utilities.

Appendix C – Data and Summary Statistics

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.[22] 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] FCFA per month during this period. Would you leave your current job (even if temporarily) during these [Y] months?*

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

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] FCFA 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 second job with a comparable expected wage but higher variance.

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 ('000s FCFA)	757	529.31	2,646.01	0	40,000
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. FCFA is the Senegalese currency.

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 ('000s FCFA)	1,309	117.35	118.64	1.80	1,350.00
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 ('000s FCFA)					
Food expenditures	392	142.87	74.75	15.00	600.00
Utility expenditures	387	51.76	331.63	0.00	6,500.00
Housing expenditures	298	55.13	61.62	0.00	300.00
Other expenditures	332	56.14	75.93	0.00	450.00
Total expenditures	254	285.28	431.22	35.00	6,632.00
Expected change in expenditures if unemployed	298	79.06	65.84	0	500
Benefits					
Currently receives some aid (0/1)	1,314	0.06	0.24	0	1
Total value of aid ('000s FCFA)	78	123.73	244.69	0	2,000

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

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 pays 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 (000s FCFA)	25	756.80	1,632.51	0	7,000
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 (000s FCFA)	125	104.83	204.23	0	2,000
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 (000s FCFA)	52	89.13	150.73	10	1,000
Saves salary in real estate	81	0.26	0.44	0	1
Amount saved in real estate (000s FCFA)	6	300.00	383.41	50	1,000
Saves salary in mobile wallet	573	0.40	0.49	0	1
Amount saved in mobile wallet (000s FCFA)	193	28.27	23.15	0	100
Saves salary at home	617	0.23	0.42	0	1
Amount saved at home (000s FCFA)	112	37.42	36.47	2	200

Notes: This table shows summary statistics for select variables from our custom survey described in Section 4. FCFA is the Senegalese currency.

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 elasticities					
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.