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THE WELFARE EFFECTS OF INVOLUNTARY PART-TIME WORK

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Abstract

Employed individuals in the U.S. are increasingly more likely to work part-time involuntarily than to be unemployed. Spells of involuntary part-time work are different from unemployment spells: a full-time worker who takes on a part-time job suffers an earnings loss while remaining employed, and is unlikely to receive income compensation from publicly-provided insurance programs. We analyze these differences through the lens of an incomplete-market, job-search model featuring unemployment risk alongside an additional risk of involuntary part-time employment. A calibration of the model consistent with U.S. institutions and labor-market dynamics shows that involuntary part-time work generates lower welfare losses relative to unemployment. This finding relies critically on the much higher probability to return to full-time employment from part-time work. We interpret it as a premium in access to full-time work faced by involuntary part-time workers, and use our model to tabulate its value in consumption-equivalent units.

Keywords: Involuntary part-time work; Unemployment; Welfare

JEL codes: E21; E32; J21.

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1 Introduction

Labor market participants are subject to the risks of unemployment and involuntary part-time work.[1] While the welfare costs of unemployment, and the benefits of introducing public insurance programs against it, have been the subject of a vast literature, little is known about how involuntary part-time employment affects workers' welfare. The evolution of the United States' (U.S.) labor market over the past decade has generated great interest in this topic among policy-makers and scholars. In her 2014 address to the annual Jackson Hole Conference, Federal Reserve Chair Janet Yellen listed involuntary part-time work among the top labor market "surprises" worth worrying about (Yellen [2014]). Concomitant research by economists at the Federal Reserve suggests that the unusually elevated levels of involuntary part-time employment observed over the past years are partly explained by structural changes in the U.S. labor market (see Valletta and Bengali [2013]; Canon et al. [2014]; Cajner et al. [2014]; Valletta et al. [2015]).[2] Recently, Borowczyk-Martins and Lalé [2016c] document that the probability to work part-time involuntarily faced by employed individuals has increased during the past four decades, in absolute terms and even more so relative to the probability of becoming unemployed. In face of these facts, a natural question to ask is: how bad are spells of involuntary part-time work compared to unemployment spells?

To answer that question, we first produce new empirical evidence on how the features of the main U.S. income insurance programs affect individuals in involuntary part-time work. We find that the income losses experienced by full-time workers who become part-time employed involuntarily are seldom covered by partial Unemployment Insurance (UI) and Short-Time Compensation (STC) schemes, and that other income programs, such as the Earned Income Tax Credit (EITC), do not cover a large fraction of involuntary part-time workers.[3] Since there are sizable income differences between full-time and involuntary part-time employment (viz. part-time workers earn on average less than half of full-time workers' income), the welfare implications of spells of involuntary part-time work are potentially large.

Next, we take a first step towards assessing those implications. We use a quantitative framework to compute the short-run welfare losses experienced by workers in spells of involuntary part-time work and unemployment. We focus on the key channels by which these risks affect workers' welfare: (i) the expected income loss taking into account the availability (or not) of public income insurance against it, (ii) exposure to different job destruction and reallocation risks and (iii) the ability to allocate time between work, search and leisure. To speak to these various dimensions, we study the decision problem of a worker with well-defined preferences over consumption and leisure, who exerts search effort to generate job offers, and saves in the presence of incomplete markets and borrowing constraints. We anchor this framework to standard preference parameters and to the dynamics and policies of the U.S.

[1] In U.S. statistics individuals are considered to be employed part-time if they work less than 35 hours per week. They are classified as involuntary part-time workers for two reasons: if they cannot find a full-time job or if they work part-time because of slack demand conditions in their current job.

[2] In Valletta et al. [2015], structural changes refer to long-run changes in the demographic characteristics of workers, technology used in the workplace and the structure of labor costs. The Affordable Care Act, which dictates that employers in large firms must provide health insurance to their full-time employees, is an additional factor that could contribute to long-run changes in the U.S. labor market. Even and Macpherson [2015] attribute part of the increase in involuntary part-time work to the enactment of the Affordable Care Act.

[3] We construct a dataset containing estimates of eligibility for the earned income tax credit, which allow to compute the potential coverage of the policy (see Appendix A). This dataset and an instruction file are provided on our webpages.

labor market, and use a structural equation of the model to infer the parameters that determine job search outcomes. Two properties of the calibrated model give us confidence in its ability to produce meaningful quantitative inferences. First, it captures the notion of part-time employment and unemployment as involuntary labor market states. Second, it dictates that accumulated assets are depleted during spells of involuntary part-time work and unemployment, and the predicted consumption losses experienced during unemployment spells are consistent with existing empirical evidence.

We use the model as a laboratory to study displacement shocks to involuntary part-time work and unemployment. First, we find that, from an individual's perspective, spells of involuntary part-time work entail lower welfare losses than unemployment. Individuals would need to be compensated in 5% (resp. 19%) of their consumption during the first quarter of a spell of involuntary part-time employment to be equally well-off in insured (resp. uninsured) unemployment. Second, we use the model to obtain a structural decomposition of the welfare difference between spells of involuntary part-time employment and unemployment into three components: differences in labor earnings, a differential access to full-time work (which occurs only through search effort when unemployed) and the constraint in hours allocated to market activities (which is only active in involuntary part-time work). We show that the second component, the high transition rate at which part-time workers return to full-time employment, accounts for a large share of the welfare gap between involuntary part-time work and unemployment. That is, in a counterfactual world where part-time workers can only use the search technology available to the unemployed, they would need a very high level of search effort in order to mimic their actual transition rate. We refer to this differential as the premium in access to full-time work faced by involuntary part-time workers, and estimate that it is worth 4 to 5% of consumption during the first quarter of a part-time employment spell.

As highlighted in the opening paragraph, involuntary part-time work is becoming an important risk in the U.S. labor market when measured in terms of transition probabilities. Our main contribution is to go beyond this descriptive evidence by combining different data sources (on labor market dynamics, income differences and U.S. labor market institutions) and a dynamic, optimizing framework to assess the implications of this risk for consumption, leisure and welfare. Consistent with the data sources that inform our characterization of involuntary part-time work (worker-level data covering individuals over short labor market spells), we focus on its short-run welfare implications and abstract from its broader macroeconomic consequences. We see our study as groundwork for a general-equilibrium analysis of involuntary part-time employment under incomplete insurance markets and frictions in the labor market (in the spirit, for instance, of Krusell et al. [2010]'s study of the effects of unemployment insurance). A crucial element of that analysis, we think, is the development of a theory explaining why full-time employment relationships can be temporarily suspended in the face of negative shocks, and thereby lead to involuntary part-time work. In our view, that theory could draw on recent work on rehiring and recalls by Fernández-Blanco [2013] and Fujita and Moscarini [2015].

The rising incidence of involuntary part-time work already features in current discussions on the assessment of labor market slack (see Yellen [2014]; Hornstein et al. [2014]; Blanchflower and Levin [2015]). It is likely that related public insurance programs, such as short-time compensation schemes, will also feature more prominently in future policy debates. The parallel we draw between involuntary part-time employment and unemployment, and the evidence we gather on the differences in the provision of public insurance against those risks, offers some insights for these debates. Specifically, our work draws attention to several differences between involuntary part-time work and unemployment, which should be taken into account in the joint design of public insurance against these two labor market risks. At this stage, it is unclear whether public insurance targeted at involuntary part-time work would necessarily lead to social welfare gains. To answer that question a number of key issues would need to be taken into account. First, there may be a significant degree of moral hazard regarding the number of hours worked and the voluntary/involuntary nature of a reduction in the schedules of working hours. Second, there are fundamental interactions between the risks of involuntary part-time work and unemployment, and the existence of public insurance against the latter. For example, in the U.S., where unemployment insurance is experience-rated, involuntary part-time work may provide a way for employers to smooth out an adverse shock while escaping unemployment taxes (see Burdett and Wright [1989], and recently Braun and Brügemann [2014] for related discussions).

The remainder of the paper is organized in the following way. In Section 2 we offer a succinct characterization of involuntary part-time employment by summarizing facts recently documented in the literature and in this paper. Section 3 presents the quantitative framework, while Section 4 describes how we parametrize it in line with the relevant features of the U.S. labor market. The experiments to assess the welfare effects of involuntary part-time are performed in Section 5. Section 6 concludes. The paper also includes an appendix. In Section A of the appendix we review the relevant public insurance programs and show new evidence on how they impact involuntary part-time workers. Finally, Section B provides further auxiliary evidence to our parametrization.

2 Facts

In this section we piece together several newly documented facts on involuntary part-time employment in the U.S labor market. The aim is to provide a stylized characterization of this labor market risk from the worker's perspective and highlight its increasing importance for the experience of U.S. labor market participants. The majority of the empirical facts summarized here have been documented in Borowczyk-Martins and Lalé [2016a,b,c]. We refer to these papers by the acronyms BML16a, BML16b and BML16c, respectively. The facts that pertain to U.S. labor market institutions (Facts 2.1, 2.2 and 2.3 below) are documented in the present paper.

Before presenting the facts, it is useful to comment on the concepts of part-time and involuntary part-time employment used in U.S. statistics (both of which are presented in footnote 1). The Bureau of Labor Statistics considers an individual to be working part-time if she usually works less than 35 weekly hours.[4] Furthermore, if that individual is part-time employed because she cannot find a full-time job or due to slack demand conditions in her current job, she is said to be in involuntary part-time employment. The latter definition emphasizes that involuntary part-time employment is closely related to the notion of unemployment, in that both entail a constraint on workers' desired labor supply – individuals are available to work and would like to work more hours –, and establishes a distinction relative to voluntary forms of part-time employment.[5]

[4]Notice that the definition is based on usual working hours, not actual hours worked. Before the 1994 redesign of Current Population Survey (CPS), that definition cannot be completely implemented in the monthly files of the survey because usual hours are not recorded for those who report more than 35 actual hours of work. See Section 2.2 of BML16c.

[5]In the CPS monthly interviews, voluntary part-time employment includes inter alia "Childcare problems",

The connection between involuntary part-time employment and unemployment, and its distinction relative to voluntary part-time employment, have strong empirical support. Facts 1.1 and 1.2. suggest that permanent and transitory characteristics of involuntary part-time workers are more similar to those of the unemployed than of voluntary part-time workers. Fact 1.3 highlights that unemployment and involuntary part-time employment are also similar in that both entail a loss of income relative to full-time employment.

Fact 1.1: *Individuals in part-time employment are very similar to those in unemployment in terms of the distribution of demographic attributes such as sex, age, education and marital status (they are more likely to be prime-age, low-educated and not married), and dissimilar to those in voluntary part-time employment.* Source: BML16b, Table 1.

Fact 1.2: *Spells of voluntary employment (part-time and full-time) are considerably longer than spells of unemployment and involuntary part-time employment, which are remarkably transitory (the average worker in those states faces a high probability of moving to a different state next period).* Source: BML16c, Table 3.

Fact 1.3: *On average, moving from full-time employment to involuntary part-time employment entails a labor income loss due to a reduction in paid hours and to a part-time wage penalty.* Source: Appendix B.2 of the present paper and BML16a, Table 7.

A key distinction between the two labor market risks under consideration is the existence or not of effective public income insurance against the income loss associated with those hazards. While unemployed workers benefit from, and are effectively covered by, unemployment insurance, involuntary part-time workers are covered in a more restrictive set of circumstances, and in practice benefit little from existing public insurance programs for which they are potentially eligible.

Fact 2.1: *In the context of the U.S. labor market, state-level partial UI and STC cover the income loss associated to spells of involuntary part-time work respectively when the part-time worker's claim satisfies state-specific eligibility requirements and when firms' work-sharing plans are approved by the UI agency.* Source: Appendix A.

Fact 2.2: *In practice, the amount paid in partial UI benefits is very small and the number of U.S. states using STC is quite limited (17). In the few states where STC is used, the fraction of workers who actually benefit from STC is extremely small.* Source: Appendix A.

Fact 2.3: *While in principle involuntary part-time workers may benefit from partial income insurance by the EITC, in practice, very few workers do.* Source: Appendix A.

Until the Great Recession, the academic literature has paid little attention to the dynamics of involuntary part-time employment, especially in comparison to unemployment.[6] The recent wave of research on this topic suggests that the salient response during the Great Recession reflects a trend

"Health/medical obligations", "Family/personal obligations" etc.

[6]To our knowledge, the main exceptions to this somewhat sweeping summary of the literature are the early papers by Stratton [1996], Barrett and Doiron [2001] and Hirsch [2005]: their analyses provide some information about transitions into and out of part-time employment. Stratton [1996] uses March CPS data to compare average one-year-apart transition probabilities from unemployment, non-participation and voluntary part-time employment. Barrett and Doiron [2001] compare wages among voluntary and involuntary part-time workers in Canada. In the study of the part-time wage penalty by Hirsch [2005], some regressions include a variable for transitions to and from full-time work.

increase in the incidence of part-time employment, i.e. that it is associated with more persistent changes in the U.S. labor market.

Fact 3.1: *The number of workers on involuntary part-time employment has been stable in the U.S. labor market, both as a fraction of labor market participants (2.7%) and as a fraction of part-time workers (15.7%).* Source: BML16c, Section 5.1 and Figure 3.

Fact 3.2: *Despite this stability, the probability faced by full-time and voluntary part-time workers of undergoing spells of involuntary part-time employment has increased from 1976 until 2015.* Source: BML16c, Figure 4.

Fact 3.3: *The rapid growth in involuntary part-time employment in the Great Recession and its persistence in the recession's aftermath is predominantly accounted for by increases in the transition probability of workers in full-time and voluntary part-time to be relocated to involuntary part-time employment.* Source: BML16c, Figure 4 and Table 4.

Summary. The facts collected in this section support the following characterization of involuntary part-time employment:

1. It is a transitory labor market state that shares many features with unemployment: workers are constrained in their desired labor supply, full-time employed workers suffer an income loss upon reallocation to this state, and the average worker who undergoes such spells is strongly attached to the labor market;

2. The loss of income associated with spells of involuntary part-time employment is seldom covered by a specific public insurance program, and complementary income insurance programs in practice offer little support for workers who undergo those spells;

3. It affects a considerable fraction of labor market participants, increasingly so over the past four decades, and especially so in the Great Recession and its aftermath.

3 Model

To interpret key aspects of the facts summarized in the previous section, we employ a framework that has two pillars: the incomplete-market model and the job-search model. The former is commonly used to assess the consumption-smoothing effects of spells of unemployment (see e.g. Hansen and İmrohoroğlu [1992] and Abdulkadiroğlu et al. [2002]). The addition of job search to that model is similar to the one proposed by Acemoglu and Shimer [2000]. In the framework that results, we are interested only in the individual decision problem of the agent, and hence we keep all prices (wages, interest rates, etc.) exogenous and fixed.

3.1 Environment

A worker makes transitions across full-time employment, part-time employment and unemployment.

Preferences. The worker is risk-averse and infinitely-lived. Her momentary utility function depends on consumption and leisure. She maximizes:

$$\mathbb{E}_0 \sum_{t=0}^{+\infty} \beta^t \frac{\left(c_t \left(\bar{h} - h_t\right)^{\eta}\right)^{1-\sigma} - 1}{1-\sigma}. \tag{1}$$

$\mathbb{E}_0$ denotes the expectation operator conditional on information at time 0, β the subjective discount factor, σ the coefficient of relative risk aversion, η the relative value of leisure and $\bar{h}$ the time endowment. The worker chooses consumption c and the amount of time allocated to market activities h (therefore leisure time is the remainder $\bar{h} - h$).

Hours, wages and search. The worker is either employed or unemployed. There are two types of jobs: part-time (P) and full-time (F), both of which consist of an exogenous bundle of wages and hours of work (w_i, h_i), with $i \in \{P, F\}$ indicating the job type. Notice that we do not assume that part-time work is involuntary. Rather, the involuntary nature of part-time work will be implied by our choice of parameter values.

The worker can search both on and off the job. h hours of search effort generate a work opportunity with probability λh. She selects hours of search effort in the interval $\left[0, \bar{h}\right]$, when unemployed, and in the interval $\left[0, \bar{h} - h_i\right]$, when employed, with $i \in \{P, F\}$.[7] A fraction ϕ_P of work opportunities are part-time jobs, and the worker can decide to turn down any job offer.

Exogenous reallocation. In employment (F, P), the worker is subjected to exogenous job destruction and reallocation shocks governed by the stochastic transition matrix:

$$\Pi = \begin{bmatrix} \pi_{F,F} & \pi_{F,P} & \pi_{F,U} \\ \pi_{P,F} & \pi_{P,P} & \pi_{P,U} \end{bmatrix}. \tag{2}$$

The probabilities $\pi_{i,j}$ give a lower bound on the transitions between states i and j, since in addition there are endogenous transitions across employment states coming from search and quit decisions.[8]

Insurance. There are two sources of insurance against idiosyncratic labor market risks. First, there is private insurance through a risk-free asset a which the worker can save but cannot borrow. The maximization of (1) is thus subject to intertemporal budget constraints:

$$c_t + a_{t+1} \leq (1+r)\, a_t + x_t^d, \quad a_t \geq 0, \tag{3}$$

with a denoting the asset, x^d disposable earnings and r the interest rate.[9]

[7] We allow the worker to search both during part-time and full-time work, although in the parametrized version of the model the returns to search in full-time employment are offset by the costs of so doing. Thus, the assumption of on-the-job search in full-time employment is innocuous, but the alternative (ruling out job search during full-time work) would generate an unnecessary difference between part-time and full-time employment.

[8] In particular, notice that the matrix Π in equation (2) is *not* the matrix describing the labor market trajectory of the worker. That is, there is a Markov transition matrix to compute her trajectory across labor market states and asset holdings.

[9] Given a value for the interest rate, we will calibrate the subjective discount factor so that the worker remains close to the borrowing limit. Notice that, even if we were interested in the equilibrium of the model, it is unclear whether the interest rate should be endogenized (using, e.g., an aggregate production function with labor and physical capital). Indeed, without any additional ingredients (e.g. agents with low discount factors, financial shocks, etc.) in equilibrium the interest rate would approach the worker's subjective discount rate and make her accumulate a large stock of financial wealth. This

Second, there is public insurance against the risk of becoming unemployed: when the job is destroyed by the shocks $\pi_{P,U}$ or $\pi_{F,U}$, the worker can collect unemployment benefits θ_1. These benefits expire with probability ϕ_U and they can be regained only through a spell of employment. If benefits are exhausted, she receives social assistance benefits $\theta_0 < \theta_1$. Finally, the worker cannot quit to receive unemployment benefits. In particular, when a full-time position is transformed into a part-time one (which occurs with probability $\pi_{F,P}$), the worker can only choose between working part-time or moving to social assistance.[10]

3.2 Recursive Formulation

The decision problem of the worker can be formulated in recursive form. Hereafter, W_i denotes the value of being employed in a job $i \in \{P,F\}$; U_1 is the value of being unemployed and collecting unemployment benefits; U_0 is the value of being unemployed and collecting social assistance benefits.

Beginning with the value functions in employment, these solve:

$$\begin{aligned} W_i(a) &= \max_{a',h} \left\{ \frac{\left(c\left(\bar{h}-h_i-h\right)^{\eta}\right)^{1-\sigma}-1}{1-\sigma} + \beta\left(\lambda h\left(\phi_P \max\left\{\overline{W}_i\left(a'\right), W_P\left(a'\right)\right\}\right.\right.\right. \\ &\left.\left.\left. + (1-\phi_P)\max\left\{\overline{W}_i\left(a'\right), W_F\left(a'\right)\right\}\right) + (1-\lambda h)\overline{W}_i\left(a'\right)\right)\right\} \end{aligned} \tag{4}$$

subject to

$$\begin{aligned} c + a' &\leq (1+r)a + w_i \\ a' &\geq 0 \\ h &\in \left[0, \bar{h}-h_i\right] \end{aligned}$$

where $\overline{W}_i(a) \equiv \pi_{i,F}\max\{W_F(a), U_0(a)\} + \pi_{i,P}\max\{W_P(a), U_0(a)\} + \pi_{i,U}U_1(a)$ is the value of being employed in a job $i \in \{P,F\}$ by the end of the model period.

In unemployment, we index the value functions by $j \in \{0,1\}$ to write the Bellman equations as:

$$\begin{aligned} U_j(a) &= \max_{a',h} \left\{ \frac{\left(c\left(\bar{h}-h\right)^{\eta}\right)^{1-\sigma}-1}{1-\sigma} + \beta\left(\lambda h\left(\phi_P \max\left\{\overline{U}_j\left(a'\right), W_P\left(a'\right)\right\}\right.\right.\right. \\ &\left.\left.\left. + (1-\phi_P)\max\left\{\overline{U}_j\left(a'\right), W_F\left(a'\right)\right\}\right) + (1-\lambda h)\overline{U}_j\left(a'\right)\right)\right\} \end{aligned} \tag{5}$$

would shut down the main insurance issues we focus on.

[10] This assumption explains why the worker sometimes undertakes part-time work: our parameter values imply that uninsured unemployment is never preferred to part-time work. In addition, the lifetime utility of a worker is always higher in full-time than in part-time employment, which justifies interpreting the latter as involuntary.

subject to

$$
\begin{aligned}
c + a' &\leq (1+r)a + \theta_j \\
a' &\geq 0 \\
h &\in \left[0, \bar{h}\right]
\end{aligned}
$$

with $\overline{U}_1(a) \equiv (1-\phi_U) U_1(a) + \phi_U U_0(a)$ and $\overline{U}_0(a) \equiv U_0(a)$ giving the end-of-period value functions of the worker during unemployment.

The above set of Bellman equations delivers three types of decisions. First, there are decision rules for asset holdings $\widetilde{a}^P(a)$, $\widetilde{a}^F(a)$ associated with equations (4), and $\widetilde{a}_0^U(a)$, $\widetilde{a}_1^U(a)$ associated with equations (5) (notice that both (4) and (5) describe two equations). Second, there are decision rules for search effort $\widetilde{h}^P(a)$, $\widetilde{h}^F(a)$ associated with equations (4), and $\widetilde{h}_0^U(a)$, $\widetilde{h}_1^U(a)$ associated with equations (5). Finally, there are work decisions associated with the comparison of value functions in employment and unemployment. That is,

$$
\varepsilon_{i,j}(a) = \mathbb{1}\left\{W_i(a) > U_j(a)\right\} \tag{6}
$$

for all $i \in \{P, F\}$ and $j \in \{0, 1\}$, and

$$
\varepsilon_{F,P}(a) = \mathbb{1}\left\{W_F(a) > W_P(a)\right\} \tag{7}
$$

($\mathbb{1}\{.\}$ is the indicator function). Notice that in (6) and (7), uncertainty about labor market status if the worker decides not to accept the job opportunity is resolved. That is, we assume that job destruction and exhaustion of benefits occur before the end of the model period. This is consistent with the formulation of equations (4) and (5) since, from the perspective of the beginning of the period, the worker is uncertain about her outside option if she receives a job offer by the end of the period.

4 Parametrization

To select values for the model parameters we draw on standard parameters in the literature, auxiliary information on U.S. institutions and on our own calculations based on data from the Current Population Survey. For reasons that we explain below, we calibrate the parameters β, λ, ϕ_P jointly to match three targets. The other parameters are set externally. Table 1 summarizes our parameter choices. Throughout the analysis we interpret a period as one month.

4.1 Parameters Set Externally

Utility function. We choose $\sigma = 2.0$, which is within the range of empirically plausible estimates of the coefficient of relative risk aversion (see Heathcote et al. [2009]).[11] For the relative value of leisure, η, we explored a range of values from low to high and found that the results are robust

[11] The results are qualitatively similar when we change the coefficient of risk aversion; see, for instance, Appendix C in BML16b where we report results based on $\sigma = 1.0$ and $\sigma = 3.0$.

Table 1. Parameter values (one model period is one month)

Parameter		**Value**	**Source**
Set externally:			
Relative risk-aversion	σ	2.0	Literature
Relative value of leisure	η	0.5	Literature
Interest rate	r	0.003	3.5 percent annual interest rate
Time endowment	$\bar{h}$	1.0	Normalization
Part-time hours of work	h_P	0.245	Workweek length of 24 hours*
Full-time hours of work	h_F	0.429	Workweek length of 42 hours*
Part-time earnings	w_P	0.485	Part-time wage penalty of 15 percent*
Full-time earnings	w_F	1.00	Normalization
Social assistance benefits	θ_0	0.05	OECD [2007]
Unemployment benefits	θ_1	0.45	OECD [2007]
Probability of exhausting benefits	ϕ_U	0.167	Benefit period of 26 weeks
Reallocation shocks:			Estimated transition probabilities*
	$\pi_{P,F}$	0.258	$I \to F$ at the same employer
	$\pi_{F,P}$	0.009	$F \to I$
	$\pi_{F,U}$	0.014	$F \to U$
	$\pi_{P,U}$	0.111	$I \to U$
Set internally:			
Subjective discount factor	β	0.9902	Median wealth to annual ratio of 0.5
Returns to search effort	λ	0.454	Transition probability $U \to E$*
Fraction of part-time jobs	ϕ_P	0.179	Transition probability $U \to I$*

Notes: * - Based on CPS data. E: Employment. F: Full-time employment. I: Involuntary part-time employment. U: Unemployment. See Appendix B for a complete description.

to changing this parameter. We use an intermediate value of $\eta = 0.50$ as a benchmark and discuss results for $\eta = 0.25$ and $\eta = 0.75$ in Subsections 4.3 and 5.3.

Interest rate. The interest rate is set to 3.5 percent on an annual basis. This is in line with long-run averages of the real return on U.S. 10-year treasury note and is a standard value used in models of precautionary savings (see e.g. Gourinchas and Parker [2002]).

Earnings and hours of work. The model allows for two normalizations: the time endowment $\bar{h}$ and full-time earnings w_F. We set both parameter values to 1.0. We use CPS data on hours and earnings to pin down values for h_F, h_P and w_P. For hours, we find that in full-time (involuntary part-time) employment individuals report 42 hours (24 hours) per week (Panel a. of Table B3, in Appendix B.2).[12] Assuming that an individual has $7 \times 14 = 98$ hours of substitutable time per week, we set $h_F = 0.429$ and $h_P = 0.245$.

To pin down a value for w_P, we estimate a part-time wage penalty, the reduction in hourly wages attributable to part-time work.[13] Using data come from the Outgoing Rotation Groups of the CPS, we

[12]The results are very similar when we set values for h_F and h_P such that $h_P = h_F \times 1/2$.

[13]We do not attach any causal interpretation to our estimates, since though standard our specification raises valid

find that the part-time wage penalty is generally around 15% (Panel b. of Table B3 in Appendix B.2). We set $w_P = 0.485$ such that $w_P/h_P = 0.85 w_F/h_F$.

Unemployment insurance. We use figures for the U.S. labor market reported in OECD [2007] to parametrize unemployment insurance and social assistance benefits. The average replacement ratios for these benefits are 45 and 5 percent, respectively, which dictates $\theta_1 = 0.45$ and $\theta_0 = 0.05$. ϕ is set to 0.167 to make the worker exhaust unemployment benefits after 26 weeks, in line with U.S. policies in normal times.

Transition probabilities. To pin down values for the matrix Π, we use labor market data for non-married individuals without children. These individuals are typically not eligible for EITC (cf. Appendix A), which makes them a relevant empirical counterpart to the worker in our theoretical framework. Specifically, we use data before the period of the Great Recession as follows: (i) $\pi_{F,P}$ is set to the transition probability from full-time employment to involuntary part-time work, (ii) $\pi_{P,F}$ is set to the transition probability from involuntary part-time work to full-time employment *at the same employer* and (iii) $\pi_{F,U}$ (resp. $\pi_{P,U}$) is set to the transition probability from full-time employment (resp. involuntary part-time work) to unemployment. We provide details regarding the measurement of transition probabilities in Appendix B.1. Since Π is a stochastic matrix, we obtain:

$$\Pi = \begin{bmatrix} 0.978 & 0.009 & 0.014 \\ 0.258 & 0.631 & 0.111 \end{bmatrix} \tag{8}$$

4.2 Parameters Set Internally

To pin down values for the remaining parameters, namely β, λ, ϕ_P, our starting point is the following equation (where a is omitted to simplify the notation):

$$\frac{\eta c^{1-\sigma}}{\left(\overline{h}-h\right)^{1-\eta(1-\sigma)}} = \beta\lambda\left[\phi_P \max\left\{W_P - \overline{U}_j, 0\right\} + (1-\phi_P)\max\left\{W_F - \overline{U}_j, 0\right\}\right]. \tag{9}$$

In this equation, W_i is the value of employment in $i \in \{P, F\}$, and $\overline{U}_j$ is the value of being unemployed with unemployment income θ_j, with $j \in \{0, 1\}$, by the end of the model period. The right-hand side gives the expected returns to search effort in unemployment; the left-hand side of the equation is the marginal utility of the worker with respect to hours, h. The interior solution for search effort must satisfy this first-order condition. In particular, equation (9) highlights that β, λ, ϕ_P jointly determine the returns to search effort for a given set of values of the parameters selected in the previous section.[14]

Guided by this structural equation, we use three moments of the time-invariant distribution of the model to calibrate β, λ and ϕ_P. Notice that, due to the ergodic properties of Markov processes, we can interpret this distribution as the fraction of time that the worker spends in the different states of the model (labor market states and asset holdings).

Discount factor. We calibrate β such that the median ratio of wealth compared to annual

concerns of endogeneity bias.

[14] Of course, in principle all the parameters of the model can affect search efforts since the lifetime values W_i and U_j are solved jointly with the policy functions, which include search efforts. We emphasize equation (9) to explain why, after choosing values for the remaining parameters, it is relevant to calibrate β, λ, ϕ_P jointly.

income is 0.50. That is, over time the worker accumulates assets and sometimes runs down her financial wealth. We require that her median asset levels are worth one half of her annual income.[15]

Job availability parameters. We calibrate λ and ϕ_P to match an average (monthly) transition rate from unemployment to employment of 32.5%, and an average transition rate from uninsured unemployment to part-time work of 6.25%. The first target is the job-finding rate computed in our data, i.e. the monthly transition probability to employment for the unemployed, non-married individuals without children. To be precise, transition probabilities from unemployment to full-time and part-time employment are 18.5% and 14.0%, respectively, which adds up to the target of 32.5%.[16] The other target, also computed from our data, is the observed transition probability from unemployment to involuntary part-time work ($U \to I$) before the recession. We use it as a target for transitions out of uninsured unemployment because, in our framework, this makes the worker resemble the unemployed who would take on a part-time job because they cannot find a full-time position.

Our calibration procedure yields: $\beta = 0.9902$, $\lambda = 0.4537$, $\phi_P = 0.1792$. In the sections below, when we report results based on $\eta = 0.25$ or $\eta = 0.75$, the parameters β, λ, ϕ_P are re-calibrated using the same procedure.[17]

4.3 Features of the Model

Several features of the calibrated model give us confidence that we can to use it to draw quantitative inferences. First, part-time work in the model is involuntary, in that the value of full-time employment, W_F, is higher than the value of part-time employment, W_P, for the range of assets held by the worker over time. This outcome results from a combination of the disutility of work, lower earnings in part-time employment and the fact the worker is too impatient to accumulate enough assets to prefer part-time over full-time work. Second, the model predicts that the worker runs down her assets during spells of part-time employment. In models with precautionary savings, dissaving is typically associated with unemployment. Our framework also has this property, which is illustrated in Figure 1, and justifies the comparison we draw between part-time work and unemployment.

The third, and perhaps more important reason why this framework is suitable for our purposes, is that it captures the risk of unemployment well. Indeed, Table 2 below shows that the drops in consumption experienced on losing a full-time job are similar to those observed in the data. For instance, when using $\eta = 0.50$ for the relative value of leisure, the predicted drop in insured unemployment is 8%, and the corresponding number in uninsured unemployment is 24%. Both numbers are remarkably close to those reported by Gruber [1997]: he reports a 6-8% decrease in the first case and a 22% decrease in the second scenario. Notice that we obtain these figures by looking at the behavior of the worker when her wealth at the time of job loss amounts to one quarter of annual earnings. We motivate this choice by studying empirically the amount of household wealth which is held in liquid

[15] The ratio of wealth to annual income we select is slightly higher than in standard calibrations of incomplete market models. This is motivated by the fact that our model precludes borrowing.

[16] See Appendix B.1. There is a slight discrepancy with Table B1 in the appendix because our calibration targets are both computed using data before the Great Recession. Table B1, on the other hand, reports transition probabilities averaged over a period that includes the Great Recession.

[17] When $\eta = 0.25$, we obtain: $\beta = 0.9907$, $\lambda = 0.3942$, $\phi_P = 0.1837$. When $\eta = 0.75$, we obtain : $\beta = 0.9896$, $\lambda = 0.5110$, $\phi_P = 0.1775$. In Appendix C of BML16b we report the outcomes of the calibration for $\eta \in \{0.25, 0.50, 75\}$ combined with $\sigma \in \{1.0, 2.0, 3.0\}$.

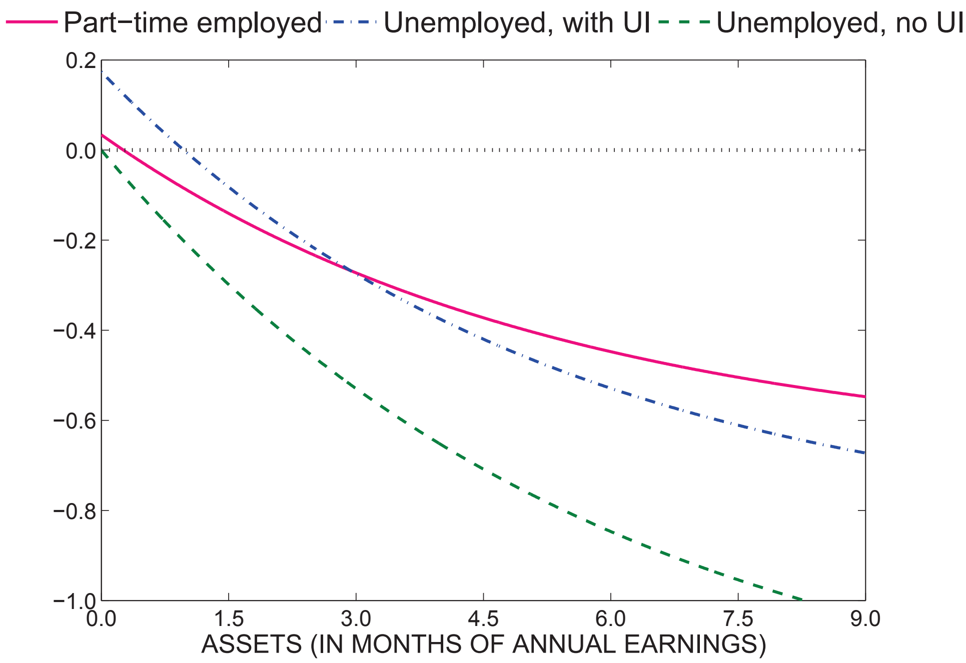

Figure 1. Net savings decisions of the worker

Notes: The solid line is the policy function for net savings in part-time employment, $\widetilde{a}^{P}(a)-a$. The dashed-dotted (resp. dashed) line is the policy function for net savings decisions in insured (resp. uninsured) unemployment $\widetilde{a}_1^{U}(a)-a$ (resp. $\widetilde{a}_0^{U}(a)-a$).

assets, i.e. assets that can be liquidated on short notice and at a small transaction cost. In Appendix B.3 we report that, in data from the Panel Study of Income Dynamics, liquid assets typically amount to one quarter of annual earnings.[18] This is the value that we use for our baseline results in the next section. In Subsection 5.3, we study how these results change when we vary the amount of wealth held by the worker at the time of job loss.

Table 2. Consumption drop following (full-time) job loss

	$\eta=0.25$	$\eta=0.50$	$\eta=0.75$
Part-time employment	-5.42	-5.57	-5.79
Insured unemployment	-13.55	-8.25	-5.11
Uninsured unemployment	-29.64	-24.15	-21.42

Notes: An entry in the table is the change (reported in percent) in consumption after losing employment in a full-time position, when wealth at the time of displacement amounts to one quarter of annual earnings.

5 Numerical Experiments

This section contains our quantitative results: we calculate the short-run welfare impact suffered by full-time workers in spells of involuntary part-time work and unemployment. We decompose

[18]We follow the literature on precautionary savings (e.g., Carroll and Samwick [1998]) to establish this fact. The result is not new and it is not surprising either: it is well known that household wealth is mostly held in illiquid assets (see Kaplan and Violante [2014]).

differences between them into several components using a methodology laid out in the first subsection.

5.1 Methodology

Let $\mathscr{U}_{1,t}$ (resp. $\mathscr{U}_{4,t}$) be a statistic measuring the welfare effect of involuntary part-time work (resp. unemployment) t periods after displacement from full-time employment; we will explain momentarily how these statistics are calculated. We are interested in understanding the source of differences between the two labor market risks. To this end, we consider a set of intermediary changes that make involuntary part-time work resemble unemployment incrementally. We thus decompose the difference according to the equation below:

$$\underbrace{\mathscr{U}_{1,t}-\mathscr{U}_{4,t}}_{\triangle\ \text{total}} = \underbrace{\mathscr{U}_{1,t}-\mathscr{U}_{2,t}}_{\triangle\ \text{labor earnings}} + \underbrace{\mathscr{U}_{2,t}-\mathscr{U}_{3,t}}_{\triangle\ \text{access to full-time}} + \underbrace{\mathscr{U}_{3,t}-\mathscr{U}_{4,t}}_{\triangle\ \text{hours constraint}} . \tag{10}$$

That is, we attribute the total difference between spells of involuntary part-time work and unemployment to: a gap in labor earnings, a differential access to full-time work (which occurs only through search effort when unemployed), and a constraint in hours allocated to market activities.

The experiment protocol is the following. Instead of just one worker, now we envision cohorts of workers whose preferences and behavior are identical to that of the worker described so far. We study four cohorts of full-time workers, which we put respectively in the following states in the first period of observation:[19] [20]

1. part-time employment (the control group);
2. part-time employment earning benefits θ_j (with j fixed to either 0 or 1 to indicate if the comparison is to uninsured or insured unemployment);
3. part-time employment earning benefits θ_j and whose working hours h_P are used to search for a full-time job (viz. we replace $\pi_{P,F}$ by $\lambda\,(1-\phi_P)\,h_P$);
4. unemployment.

All cohorts are followed for several periods and we keep track of their outcomes. Then, we use the model-generated data to compute the treatment effect of displacement from state 1 to state 2, state 3 and finally state 4.[21] The outcome variable is cross-sectional utility, which we express in terms of percentage change in consumption.

[19] In the calculations of 2, 3 and 4, we re-compute optimal decisions and lifetime values after changing the parameters of the model. Therefore, the agents always take into account changes to the economic environment, which they interpret as permanent changes. We obtain qualitatively similar results if we keep the policy functions unchanged from the baseline calibration and introduce an unexpected, one-off change in earnings, hours and transitions from part-time employment to full-time employment.

[20] After changing the value of $\pi_{P,F}$ in 3, we re-scale $\pi_{P,P}$ using $\pi_{P,P}=1.0-\pi_{P,F}-\pi_{P,U}$, so that the value of $\pi_{P,U}$ remains unchanged throughout the experiments.

[21] Notice that the treatment effects depend on wealth at the time of displacement. In line with the discussion in Subsection 4.3 (and data from Appendix B.3), we use cohorts of workers whose asset holdings on losing their full-time job amount to one quarter of annual earnings.

Measurement. The experiments rely on the comparison of cross-sectional utility across several cohorts of workers. These workers have identical preferences and they are homogeneous in assets at the time of the displacement shock. We follow them over a short period of time (our focus is on the first quarters after displacement), and since there is only one full-time job, the model generates little dispersion in labor market trajectory and asset holdings within each cohort. Therefore we treat each cohort in any period as a representative worker. This allows us to present the results of the experiments using a small set of numbers, rather than reporting the treatment effects for all possible trajectories following the displacement shock.

Consider for instance the comparison of cohorts in states 1 and 2, t periods after the shock. We measure cross-sectional utility, $\mathscr{U}_{k,t}$, in each cohort $k \in \{1,2\}$. Let $C_{k,t}$ and $H_{k,t}$ denote consumption and leisure, respectively, of the representative worker ($\mathscr{U}_{k,t} = \mathscr{U}\left(C_{k,t}, H_{k,t}\right)$). The treatment effect $\vartheta^t_{1,2}$ we report satisfies:

$$\mathscr{U}\left(\left(1+\vartheta^t_{1,2}\right)C_{1,t}, H_{1,t}\right) = \mathscr{U}\left(C_{2,t}, H_{2,t}\right). \tag{11}$$

For the class of utility function considered, this gives:

$$1+\vartheta^t_{1,2} = \left[\frac{\mathscr{U}_{2,t}+\frac{1}{1-\sigma}}{\mathscr{U}_{1,t}+\frac{1}{1-\sigma}}\right]^{\frac{1}{1-\sigma}}. \tag{12}$$

Next, consider the cohorts in states 1, 2 and 3. Since $\vartheta^t_{2,3}$ satisfies an equation similar to (12), we can show that:

$$\left(1+\vartheta^t_{1,2}\right)\left(1+\vartheta^t_{2,3}\right) = 1+\vartheta^t_{1,3}. \tag{13}$$

Therefore, $\vartheta^t_{1,3} \approx \vartheta^t_{1,2} + \vartheta^t_{2,3}$ is valid as a first-order approximation of this equation. Using this result, we can write:

$$\vartheta^t_{1,4} \approx \sum_{k=1}^{3} \vartheta^t_{k,k+1}. \tag{14}$$

This last equation provides a simple way to operationalize the decomposition presented in equation (10). In practice, the approximation is highly accurate, which can be gauged by comparing column 4 to the sum of columns 1 to 3 in Tables 3, 4 and 5 below.

5.2 Main Results

The main results are displayed in Table 3. An entry in each panel of the table is the treatment effect of reducing labor earnings in part-time employment (column 1), changing the role of hours h_P from work to search (column 2), removing the constraint on hours worked (column 3), and finally the cumulated sum of these effects (column 4). The effects are reported as averages over each quarter (up to the 3rd quarter) following the displacement shock. The subsequent tables in this section are organized in the same way.

Consider first the number displayed in column 4 of the first row in panel 1. If workers were

Table 3. Welfare costs of involuntary part-time work vs. unemployment

1. Comparison with: Insured unemployment

	△ labor earnings (1)	△ access to full-time (2)	△ hours constraint (3)	△ total (4)
1st quarter	-1.797	-4.088	0.741	-5.145
2nd quarter	-0.783	-0.271	0.142	-0.912
3rd quarter	-0.517	-0.129	0.055	-0.591

2. Comparison with: Uninsured unemployment

	△ labor earnings (1)	△ access to full-time (2)	△ hours constraint (3)	△ total (4)
1st quarter	-13.967	-5.489	0.228	-19.228
2nd quarter	-1.270	-0.630	0.272	-1.629
3rd quarter	-0.804	-0.298	0.153	-0.948

Notes: An entry in the table is the change (reported in percent) in quarterly consumption. The upper (resp. lower) panel of the table compares part-time employment with insured (resp. uninsured) unemployment, when wealth at the time of displacement amounts to one quarter of annual earnings.

reallocated to insured unemployment instead of part-time work, their consumption during the first quarter would need to be raised by 5% to compensate them. The number is larger in uninsured unemployment (panel 2), as their consumption would need to be increased by 19%. Both numbers are plausible given the observed drop in consumption during unemployment (cf. Subsection 4.3). These effects vanish as we move to the second and third quarters after displacement. This is due to the fast dynamics of the U.S. labor market, which informs our calibration. After one quarter, the majority of workers from the control group have returned to full-time work, and a large fraction of workers from the treated group have also returned to full-time employment.

Next, when analyzing columns 1, 2 and 3, we note that 'access to full-time employment' (column 2) plays an important role in all instances. To understand this finding, note that $\lambda\,(1-\phi_P)\,h_P = 0.454\times(1.0-0.179)\times 0.245 = 0.091$ is the (exogenous) transition probability to full-time work that the worker would face during part-time employment if her hours h_P were used for the purpose of search instead of work. This ought to be compared with the probability $\pi_{P,F} = 0.258$, which is almost three times larger. We interpret the discrepancy between $\pi_{P,F}$ and the transition rate to full-time work implied by h_P as the premium in access to full-time work faced by involuntary part-time workers. As shown in Table 3, it has important welfare implications: removing the premium associated to $\pi_{P,F}$ amounts to a loss of 4-5% in consumption during the first quarter of a spell of involuntary part-time employment.

Our interpretation is that $\pi_{P,F}$ captures an alternative reallocation channel compared to job search, and which is consistent with the observation that the majority of transitions between part-time and full-time work occur at the same employer (see Appendix B.1). In other words, if involuntary part-time workers used the same search technology to return to full-time work as the unemployed, they would move less quickly (and/or they would need to exert higher search effort to maintain a high transition rate) and suffer larger decreases in consumption.

Finally, the results displayed in columns 1 and 3 are somewhat more mechanical. The negative effects of reducing earnings in part-time employment to equate them to benefits θ_j are larger when we consider uninsured unemployment. The effects of removing the constraint on hours supplied to the labor market are positive, not negligible during the first quarter and they vanish quickly.[22]

5.3 Discussion

To gauge the sensitivity of our main results, we report the same computations for different parametrizations of the relative utility of leisure parameter, η, or after changing the assets held by individuals at the time of displacement from full-time employment. We refer the reader to BML16b for additional sensitivity checks.

Utility of leisure. Table 4 replicates the results in Table 3 using a lower (left-hand side panels) and higher (right-hand side panels) value for the relative utility of leisure, η. With a lower value of leisure ($\eta = 0.25$) the gap in workers' welfare between involuntary part-time work and unemployment decreases, both for insured and uninsured unemployment (respectively from -5.145 to -3.958, and from -19.228 to -16.611). Inspection of the columns in each panel shows that all three components concur to make unemployment relatively less costly than in the baseline scenario. With $\eta = 0.75$, the effect is the opposite (the value of the utility compensation increases), with the exception of 'access to full-time employment', which contributes to a tiny decrease, rather than an increase, in the gap between labor market states. Quantitatively, the main change with respect to the baseline results comes from the labor earnings component (column 1). Our main finding, viz. the greater quantitative importance of 'access to full-time employment' in accounting for the welfare difference between involuntary part-time and insured unemployment, is still true in either of the two alternative parametrizations.

Asset holdings. Table 5 displays results from performing the same calculations but when individuals have lower and higher initial asset levels relative to the baseline scenario, namely 1 and 6 months of annual earnings. The main observed changes are the following. First, the relative value of the utility compensation changes little with the level of initial wealth in the comparison with insured unemployment. Second, initial assets affect differently the direction of change of the various components. While the labor earnings component (column 1) becomes more important when assets are lower, 'access to full-time employment' and 'hours constraint' increase in importance with asset levels. Third, as before, 'access to full-time employment' is the most important contributor to the short-run welfare difference between involuntary part-time work and insured unemployment.

[22] In the comparison to unemployment, we ignore the fact that, according to labor market statistics, individuals must provide a minimum search effort to be classified as unemployed workers. Therefore it is possible that the experiments overstate the effects of relaxing the constraint on hours allocated to the labor market.

Table 4. Sensitivity analysis: The role of the utility of leisure

1. Comparison with: Insured unemployment

	a. $\eta = 0.25$				**b.** $\eta = 0.75$			
	△ labor earnings (1a)	△ access to full-time (2a)	△ hours constraint (3a)	△ total (4a)	△ labor earnings (1b)	△ access to full-time (2b)	△ hours constraint (3b)	△ total (4b)
Q1	-1.178	-3.652	0.872	-3.958	-2.345	-4.006	0.599	-5.752
Q2	-0.600	-0.194	0.076	-0.718	-0.945	-0.290	0.193	-1.042
Q3	-0.426	-0.123	0.039	-0.510	-0.586	-0.138	0.074	-0.649

2. Comparison with: Uninsured unemployment

	a. $\eta = 0.25$				**b.** $\eta = 0.75$			
	△ labor earnings (1a)	△ access to full-time (2a)	△ hours constraint (3a)	△ total (4a)	△ labor earnings (1b)	△ access to full-time (2b)	△ hours constraint (3b)	△ total (4b)
Q1	-11.424	-5.454	0.267	-16.611	-16.077	-5.047	-0.045	-21.169
Q2	-0.993	-0.511	0.175	-1.329	-1.551	-0.633	0.394	-1.790
Q3	-0.673	-0.282	0.111	-0.843	-0.905	-0.283	0.177	-1.011

Notes: An entry in the table is the change (reported in percent) in quarterly consumption. The upper (resp. lower) panel of the table compares part-time employment with insured (resp. uninsured) unemployment, when wealth at the time of displacement amounts to one quarter of annual earnings. Columns Xa (resp. Xb) report results based on a low (resp. high) utility of leisure.

Table 5. Sensitivity analysis: The role of asset holdings at the time of displacement

1. Comparison with: Insured unemployment

	a. a =1 month of earnings				**b.** a = 6 months of earnings			
	△ labor earnings (1a)	△ access to full-time (2a)	△ hours constraint (3a)	△ total (4a)	△ labor earnings (1b)	△ access to full-time (2b)	△ hours constraint (3b)	△ total (4b)
Q1	-2.084	-3.826	0.720	-5.190	-1.476	-4.399	0.790	-5.088
Q2	-1.034	-0.257	0.083	-1.207	-0.506	-0.282	0.205	-0.584
Q3	-0.775	-0.193	0.066	-0.902	-0.264	-0.066	0.046	-0.284

2. Comparison with: Uninsured unemployment

	a. a =1 month of earnings				**b.** a = 6 months of earnings			
	△ labor earnings (1a)	△ access to full-time (2a)	△ hours constraint (3a)	△ total (4a)	△ labor earnings (1b)	△ access to full-time (2b)	△ hours constraint (3b)	△ total (4b)
Q1	-22.105	-4.181	-0.074	-26.359	-3.289	-6.780	0.385	-9.684
Q2	-2.182	-0.999	0.448	-2.733	-0.745	-0.415	0.164	-0.998
Q3	-1.393	-0.599	0.315	-1.678	-0.206	0.026	-0.018	-0.195

Notes: An entry in the table is the change (reported in percent) in quarterly consumption. The upper (resp. lower) panel of the table compares part-time employment with insured (resp. uninsured) unemployment, when wealth at the time of displacement amounts to one quarter of annual earnings. Columns Xa (resp. Xb) report results based on initial assets amounting to 1 month (resp. 6 months) of annual earnings.

6 Conclusion

In this paper, we analyze the short-run welfare implications of spells of involuntary part-time work. The contribution is twofold. First, we provide empirical evidence on the availability and extent of public insurance against this labor market risk. We combine this evidence with other facts on involuntary part-time work to obtain a stylized characterization of this risk. Second, we use this characterization to inform an incomplete-market, job-search model wherein spells of involuntary part-time work coexist with unemployment spells.

We find that spells of involuntary part-time work entail lower welfare losses compared to unemployment spells, and that this difference is largely accounted for by the higher probability of returning to full-time work enjoyed by part-time workers. Hence, to compare the two labor market risks it is not enough to make a static comparison between the effective loss of income experienced by full-time workers on moving to involuntary part-time work and unemployment. Spells of involuntary part-time work are shorter than unemployment spells, and many workers return to full-time employment with their previous employer.

To obtain a complete macroeconomic understanding of this phenomenon, future work should investigate the employers' perspective on the substitution between involuntary part-time work and unemployment, both theoretically and empirically. That knowledge is key to inform the assessment of current income insurance programs in the U.S. labor market, especially in an environment where involuntary part-time employment is becoming more common.

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A U.S. Institutions and Policies

In this appendix, we review the public insurance programs in the U.S. that are relevant for our topic. There are three programs that may provide some degree of income insurance to workers in involuntary part-time employment. Below we report results from our own empirical analysis and academic research on the scope, eligibility and take-up of these programs.[23] We evaluate that these programs are unlikely to cover the majority of workers undergoing spells of involuntary part-time work.

A.1 Partial Unemployment Insurance

All U.S. states offer some form of partial unemployment insurance (UI) benefits. This program is part of the state's UI system and aims to provide income insurance to individuals who are either part-time employed but looking for a full-time job, or individuals in short-time work. The basic eligibility requirements are the same as those for (full-time) unemployment insurance: workers must search and be available for full-time work, have accumulated enough employment in the past and be unemployed (partially or fully) at the time of the claim due to no fault of their own. Additional requirements vary by state. In most states eligible individuals must work less than a full-time workweek and earn below their weekly benefit amount (WBA) plus some disregard amount. The WBA is the amount of weekly unemployment benefits the individual is entitled to if he is fully unemployed. The partially unemployed worker's benefits are calculated differently in each state, but usually correspond to the difference between the WBA and the labor income earned in excess of the disregard level.[24]

While the description above may suggest that partial UI is an effective income insurance mechanism for individuals who undergo spells of involuntary part-time work, in practice this does not seem to be the case. To assess the coverage of this program, we collect state-level data on the amount of benefits effectively paid in partial and full unemployment insurance published by the Employment and Training Administration of the U.S. Department of Labor (DOLETA).[25] By linking this data to time series of stocks of unemployed and involuntary part-time workers, we obtain estimates of the UI amounts (in dollars) paid monthly per unemployed and involuntary part-time worker.[26]

The results are reported in Figure A1. The dashed line denotes the UI amount paid per unemployed worker.[27] It averages at 315 dollars over the sample period. The solid line depicts the amount paid per involuntary part-time worker, which is much lower: the average over the period is 18 dollars. It also clear that its cyclical component is considerably less salient compared to the dashed line. These observations suggest that the coverage provided by partial UI is limited and that involuntary part-time workers receive little income from this program.

This finding may seem somewhat surprising. We conjecture that workers who are experiencing short-time work at their employer (the bulk of the stock of involuntary part-time workers) have lit-

[23] Our series span the period from January 1986 onwards. We were unable to find any information about claims for short-time compensation schemes before 1986.

[24] See US-DOL [2015a] for further details.

[25] Available at `http://oui.doleta.gov/unemploy/`. The amount paid in partial unemployment insurance corresponds to the total value of benefits paid to individuals who earn above the state's disregard level.

[26] We estimate the number of involuntary part-time workers in each state and month by combining the monthly files of the CPS with the March CPS following the correction procedure developed in Borowczyk-Martins and Lalé [2016c].

[27] Both series are expressed in constant 2009 prices based on the Personal Consumption Expenditures Price Index.

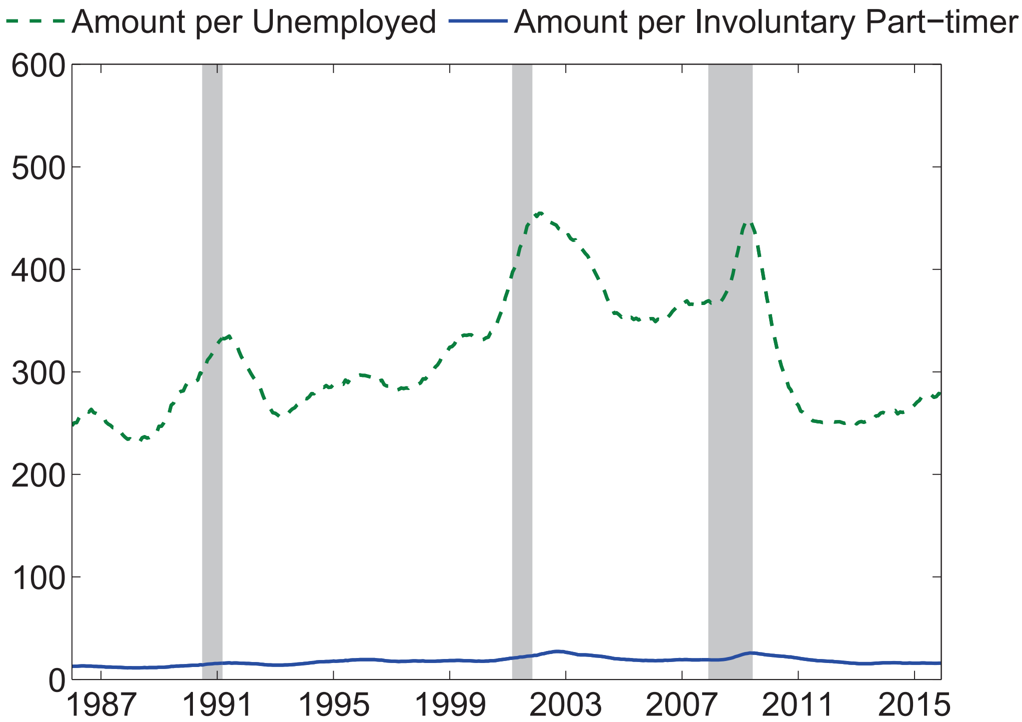

Figure A1. UI amounts paid per involuntary part-time worker and per unemployed

Notes: Authors' calculations based on DOLETA data on amounts paid in UI (in constant 2009 dollars) and CPS data on worker stocks. Seasonally adjusted and MA-filtered data. Gray-shaded areas indicate NBER recession periods.

tle incentives to claim partial UI. In this regard, Le Barbanchon [2016]'s analysis offers interesting insights based on a case-study of the utilization of this insurance mechanism in four states of the U.S. (Idaho, Louisiana, Missouri and New Mexico) during the late 1970s and early 1980s. He provides a detailed account of partial UI rules in those states during that period, as well as descriptive statistics using data from the Continuous Wage and Benefit History (CWBH) project. He finds that eligibility of individuals on short-time work on their current employer is conditional on the presentation of an employer-certified reduction in hours worked. In addition, in his sample the share of total weeks claimed as partial unemployment is small (respectively 17.6, 6.7, 2.5 and 8.5% in Idaho, Louisiana, Missouri and New Mexico) and reduced hours represent a small share of total partial UI claims (15.7% of the total of weeks claimed as partial UI).[28] Although it is not possible to extrapolate Le Barbanchon [2016]'s findings to our sample, we conjecture that short-time workers face several hurdles (at the UI agency or at their employers), which prevents them from effectively claiming partial UI benefits.

A.2 Short-Time Compensation Schemes

A number of states in the U.S. run short-time compensation (STC) schemes (also known as work-sharing plans). Under this program workers whose employers obtain approval from the UI agency to implement a work-sharing plan are entitled to UI benefits. The amount of benefits is prorated based

[28] See table 3 and footnote 17 of Le Barbanchon [2016]. As Le Barbanchon explains, the reason why the share of partial UI weeks is so elevated in Idaho is that workers are considered partial claimants if they earn up to 1.5 times their weekly benefit amount.

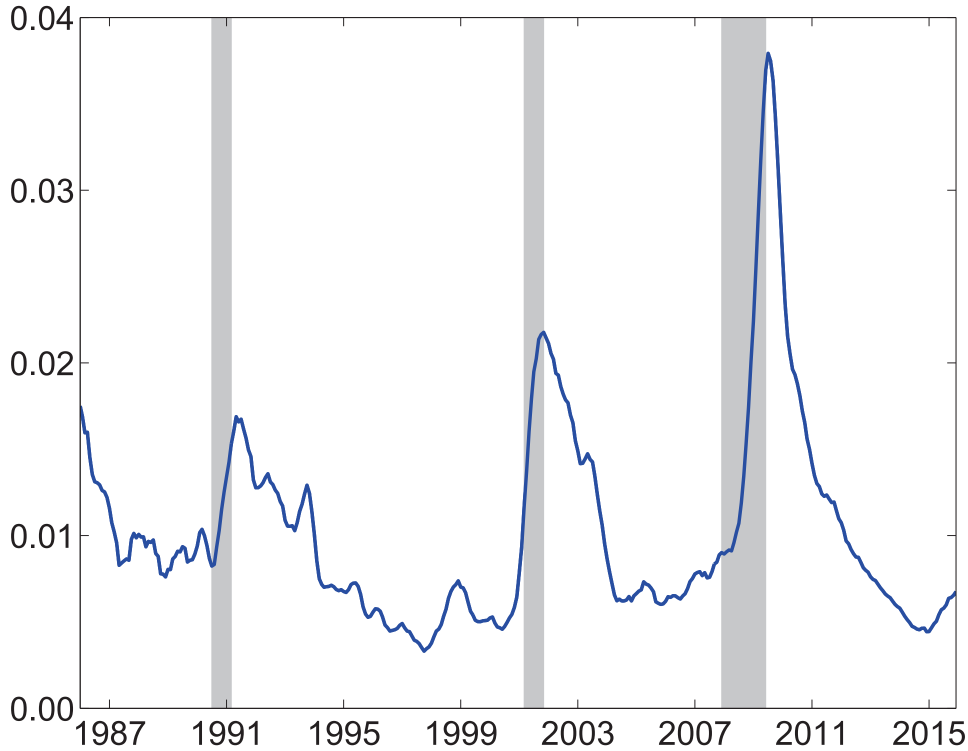

Figure A2. Fraction of STC claims among involuntary part-time workers in selected states

Notes: Authors' calculations based on monthly STC claim data from DOLETA and worker stocks data from the CPS. Seasonally adjusted and MA-filtered data. Gray-shaded areas indicate NBER recession periods.

on the reduction in hours. Thus, while partial UI formulas are based on workers' earnings, STC rules are based on hours worked. STC schemes may be used for workers whose hours have been reduced by between 10% and a maximum determined by state law, which has to be below 60%. The maximum duration for benefit reception is between six and twelve months, and they have a similar effect on employers' tax rates as unemployment benefits paid to laid-off workers.[29]

In practice, the scope of income insurance provided by STC schemes in the U.S. context is quite limited. To see this, we use data from the DOLETA and compare the number of STC claims to the number of involuntary part-time workers in the 17 states that run STC programs.[30] As shown in Figure A2, the fraction of involuntary part-time workers who receive STC is remarkably low, at 0.01 on average over the sample period. Abraham and Houseman [2014] report similarly small take-up rates. They also report that even in states that adopted STC schemes during the Great Recession and its aftermath, take-up rates remain close to zero.

To provide a basis for comparison, we compute the ratio of UI claims to the number of unemployed individuals in states with STC schemes.[31] As is well known, there is substantial heterogeneity in the take-up for UI benefits across states.[32] However, even in states with low take-up rates, the ratio of UI

[29]According to Abraham and Houseman [2014], some states impose surcharges on employers, and even prohibit employers with negative balances in their unemployment insurance accounts from implementing a short-time compensation plan. See US-DOL [2015b] for further details.

[30]The data are available at `http://www.dol.gov/`.

[31]We use weekly claims data available at: `http://www.workforcesecurity.doleta.gov/unemploy/finance.asp`. Data on unemployment at the state level come from the Local Area Unemployment Statistics of the Bureau of Labor Statistics; see `http://www.bls.gov/lau/`.

[32]Take-up rates are also heterogeneous for STC schemes. Abraham and Houseman [2014] report that STC schemes

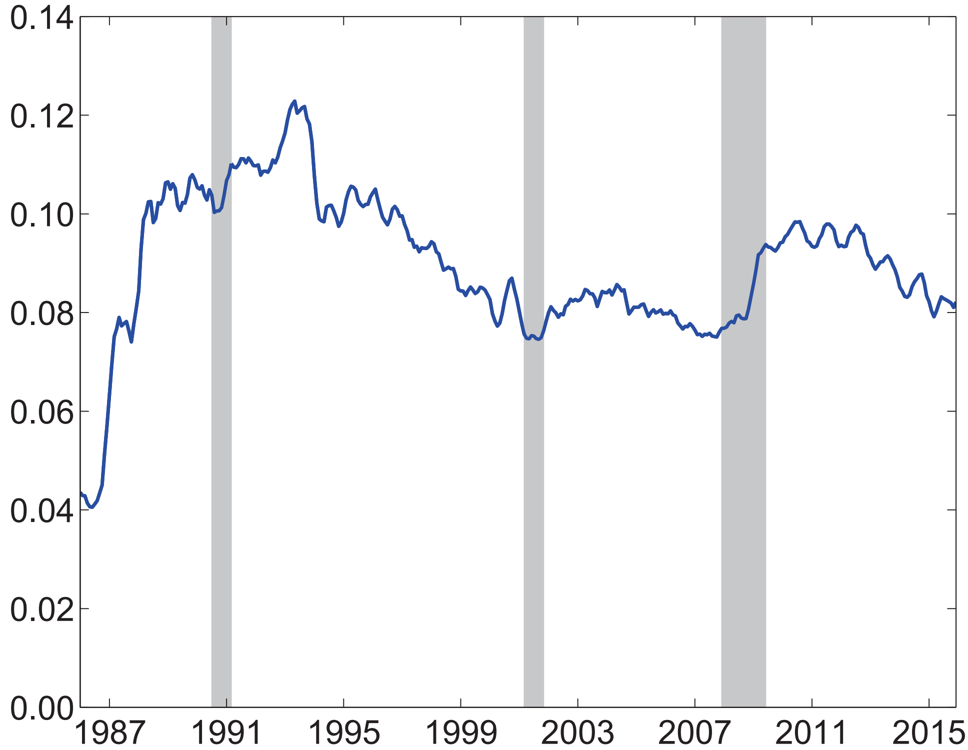

Figure A3. Fraction of involuntary part-time workers potentially eligible for EITC

Notes: Authors' calculations based on EITC parameters from the Congressional Research Service and monthly data from CPS combined with data from the March CPS. Seasonally adjusted and MA-filtered data. Gray-shaded areas indicate NBER recession periods.

claims to the number of unemployed individuals is much higher than the ratios displayed in Figure A2. This is shown in the table below:

Arizona	0.23	Kansas	0.32	Oregon	0.42
Arkansas	0.39	Maryland	0.32	Rhode Island	0.48
California	0.38	Massachusetts	0.50	Texas	0.23
Connecticut	0.48	Minnesota	0.38	Vermont	0.49
Florida	0.23	Missouri	0.33	Washington	0.40
Iowa	0.37	New York	0.39		

On average the ratio of UI claims to the number of unemployed workers in those 17 states is 0.34.

A.3 The Earned Income Tax Credit

Our description of the Earned Income Tax Credit (EITC) is more succinct because it is well known and extensively studied compared to partial UI and STC programs (see Nichols and Rothstein [2015] and references therein). The EITC is an in-work benefit program that provides income support to individuals based on their income and their family's structure and income. Eligibility is determined by the presence of qualifying children in the household, positive labor earnings below a certain threshold (for example, 50,000 dollars per year for a family with two children) and a maximum threshold

are most popular in the state of Rhode Island, where the Department of Labor and Training has widely advertised this program.

of non-labor income (which is lower than the labor income threshold). According to Nichols and Rothstein [2015], single parents with no children are unlikely to receive any or very small amounts, and families without children receive much lower benefits.

To estimate the fraction of involuntary part-time workers who are eligible to the EITC, we combine information from the Congressional Research Service with data from the annual demographic supplement files of the Current Population Survey (March CPS).[33] We compare household income to the maximum phase-out income level of the EITC to compute the share of individuals potentially eligible in groups stratified by family structure and marital status.[34] These estimates are then matched to data from the monthly CPS.

The results are displayed in Figure A3. We find that, on average over the past three decades, the fraction of involuntary part-time workers who are eligible to the EITC is only 0.08 . Due to differences in demographic characteristics, the corresponding number for the whole labor force is slightly higher at 0.11. Both figures are consistent with the actual EITC coverage.

B Auxiliary information

In this appendix, we give details on our parameter choices for transition probabilities (B.1), hours worked and earnings (B3) and asset holdings (B.3).

B.1 Measurement of Transition Probabilities

We estimate transition probabilities using the monthly files of the CPS after its re-design (from 1994 until 2015). For completion, we classify workers in five labor market states: full-time work (F), part-time work, voluntary (V) or not (I), unemployment (U) and non-participation (N). Formally, labor market stocks in period t are stacked in vector

$$\boldsymbol{s}_t = \begin{bmatrix} F & V & I & U & N \end{bmatrix}_t' \tag{15}$$

As is standard, we characterize the dynamics of $\boldsymbol{s}_t$ by means of a first-order discrete-time Markov chain model. Its evolution is governed by: $\boldsymbol{s}_t = \boldsymbol{M}_t \boldsymbol{s}_{t-1}$, where $\boldsymbol{M}_t$ is a matrix the elements of which are transition probabilities $p(i \to j)$ between labor market states i and j. These probabilities satisfy $\sum_j p(i \to j) = 1$ for any i and are the main ingredient of our empirical analysis.

To obtain our estimates, we first link CPS respondents in four consecutive months using household and personal identifiers from the non-rotation groups as well as an age/sex/race filter. Second, we correct transitions between voluntary (V) and involuntary (I) part-time work, as well transitions between non-participation (N) and unemployment (U), both of which appear spuriously common in the raw data. This approach was suggested by Elsby et al. [2015]; see Appendix A.4 in BML16c for

[33] From www.crs.gov, we retrieve information on the maximum phase-out income level in each year for childless adults, for families with one child, families with two children and families with three or more children.

[34] In the March CPS, we use information on total household income and money received from energy subsidies and food stamps. In each group circumscribed by family structure and marital status, we estimate the proportion of households with income below the maximum phase-out income level of the EITC of the corresponding year.

further details. Third, we adjust the time series to control for seasonality. Fourth, we correct the time series of labor market flows for margin error, so as to reconcile them with the time series of labor market stocks. Last, we correct transition probabilities to account for time-aggregation bias (Shimer, 2012). All reported results are based on the adjusted series.

Table B1. Sample averages of monthly transition probabilities

Involuntary part-time employment		Unemployment	
$p(I \to F)$	28.5	$p(U \to F)$	15.3
$p(I \to V)$	16.0	$p(U \to V)$	5.96
$p(I \to U)$	10.0	$p(U \to I)$	6.19
$p(I \to N)$	2.72	$p(U \to N)$	9.06
$\sum_{j \neq I} p(I \to j)$	57.3	$\sum_{j \neq U} p(U \to j)$	36.5

Notes: Authors' calculations based on CPS data on non-married individuals without children for the period 1994m01–2015m12. All entries in the table are reported in percent.

As indicated in the text (Section 4), to maximize consistency between data and the assumptions of our model, we estimate transition probabilities for non-married individuals without children. Table B1 reports sample averages of transition probabilities for these workers in involuntary part-time employment (left panel) and unemployment (right panel). While these averages cover the whole period from 1994 until 2015, we exclude data from the Great Recession and its aftermath to parametrize the matrix Π of the model (equation (8)).

An important fact concerning the source of transitions between involuntary part-time and full-time employment is that they take place overwhelmingly at the same employer. Table B2 illustrates this point with statistics on the share of transitions occurring at the same employer. For instance, we observe that 92% of transitions from full-time employment to involuntary part-time work ($F \to I$) occur without a change in employer. It underscores our findings regarding the premium enjoyed by part-time workers in returning to full-time work.

Table B2. Transitions between full-time and involuntary part-time work

Share of transitions at the same employer			
$F \to I$	92.3	$I \to F$	88.3

Notes: Authors' calculations based on CPS data on non-married individuals without children for the period 1994m01–2015m12. All entries in the table are reported in percent.

B.2 Hours Worked and Earnings

Hours worked. Panel a. of Table B3 reports average and median (usual) hours worked in full-time, in overall part-time and in involuntary part-time jobs. The gap in hours worked is close to 50 percent when we compare full-time jobs with overall part-time jobs, and is reduced when we only consider involuntary part-time jobs. In a previous version of the model, we calibrated h_P and h_F under the assumption that the difference in hours is exactly 50 percent. The results were similar to those obtained under the current calibration, which selects the parameters to reproduce median hours worked in full-time and in involuntary part-time work.

Earnings. A detailed investigation of the wage penalty associated with involuntary part-time work is beyond the scope of the paper. In this subsection, we report results based on our own calculations, and that are very well-aligned with the findings from the literature on the part-time wage penalty (see footnote 35 below).

Table B3. Hours and earnings in overall part-time and involuntary part-time work

a. Hours	Male workers			Female workers		
	Full-time	Part-time		Full-time	Part-time	
		Overall	Involuntary		Overall	Involuntary
Mean	43.7	21.6	24.0	41.4	21.4	23.6
Median	40.0	20.0	25.0	40.0	20.0	25.0

b. Earnings gap	Male workers			Female workers		
Overall part-time	-0.608	-0.288	-0.201	-0.323	-0.179	-0.112
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Involuntary part-time	-0.519	-0.274	-0.185	-0.397	-0.230	-0.134
	(0.006)	(0.006)	(0.005)	(0.004)	(0.004)	(0.004)
Worker-level controls	N	Y	Y	N	Y	Y
Job-level controls	N	N	Y	N	N	Y

Notes: Authors' calculations based on CPS data, pooled outgoing rotation groups for the period 2001m12–2007m11. Panel a: Average and median hours worked in full-time, in overall part-time and in involuntary part-time employment. Panel b: Each entry is from a separate OLS regression of the log hourly earnings against a dummy for overall part-time work (first row) or involuntary part-time work (second row), and further controls at the worker-level (N/Y) and job-level (N/Y). Standard errors in parentheses.

We pool data from the Outgoing Rotation Group of the CPS for the period 2001m12–2007m11 (that is, between the two recessions covered by our dataset). Our variable of interest is (the log of) hourly earnings (including usual amounts of overtime, tips, commissions, and bonuses) expressed in 2012 U.S. dollars, and trimmed at the bottom and top 1 percent of the distribution. We run several OLS regressions to estimate the penalty of overall part-time work and the penalty of involuntary part-time work only. As can be observed in panel b. of Table B3, there is a significant and large earnings penalty in the raw data (first column): -60.8% (-32.3%) in overall part-time, -51.9% (-39.7%) in involuntary part-time for men (women). In line with the existing literature, we also find that individual controls account for a large share of the observed differential, and that including job characteristics further reduces the difference in earnings. After accounting for (observed) individual and job characteristics (third column), the part-time penalty is between -20.1% and -18.5% for men, and between -13.4% and -11.2% for women, very similar to estimates reported in the literature.[35] In the calibrated model, we take the part-time wage penalty to be -15%, a figure well within the range of the estimates presented in Table B3.

B.3 Asset Holdings

We use data from the Panel Study of Income Dynamics (PSID) to compare *liquid* asset holdings to annual earnings.[36] These comparisons help us determine the relevant range of asset holdings used to conduct our numerical experiments.

Data. The data come from the supplemental wealth files to the PSID for the years 1984, 1989, 1994 and for every two years from 1999 to 2007. These files contain information on eight broad wealth categories at the family level. Those include: (i) the value of checking and savings accounts, money market funds, certificates of deposit, savings bonds, Treasury bills and other individual retirement accounts (IRAs; IRAs are asked separately beginning in 1999), (ii) the value of shares of stock in publicly-held corporations, mutual funds or investment trusts, including stocks in IRAs, (iii) the value of other investments in trusts or estates, bond funds, life insurance policies and special collections, (iv) the value of debts other than mortgages, such as credit cards, student loans, medical or legal bills, personal loans, (v) the net value of real estate other than the main home, (vi) the net value of vehicles or other assets "on wheels", (vii) the value of home equity, calculated as home value minus remaining mortgage and (viii) the net value of farm or business assets. We follow the study of precautionary savings by Carroll and Samwick [1998] and sum components (i), (ii) and (iii) to construct a variable measuring liquid assets.

The wealth files can be matched to the core file of the PSID, which provides socio-demographic and income data at the family level. We restrict the sample to observations from the non-poverty subsample of the PSID, with households heads aged 25 to 54 and with at least 12 years of schooling. The objective of these restrictions is to obtain a sample that is representative of a large population while being sufficiently homogeneous to resemble our framework, which features no ex ante heterogeneity.

Analysis. Table B4 reports the mean value of three variables: liquid assets, annual earnings, and the ratio of liquid assets to annual earnings. Notice that the third row shows the mean of this ratio, which is different from taking the ratio of the mean of the first two variables.

The picture conveyed by Table B4 is readily described. When looking at liquid assets, we find that these amount to around a quarter of households' annual earnings. This average value is not too sensitive to the ratios observed at the two ends of the spectrum. As noted in the main text (for instance in footnote 18), the figure is not unexpected in light of what the literature on precautionary savings documents. Table B4 motivates our focus on the trajectory of a worker who holds one quarter of annual earnings in savings to smooth out the shock of being separated from a full-time position.

[35] Similar results are found in specifications that are arguably more immune to endogeneity biases; see Hirsch [2005] who uses the panel structure of the CPS, and Aaronson and French [2004] who use administrative data.

[36] Our view is that less liquid assets do not resemble the asset that the worker accumulates in the model. Arguably, assets that cannot be liquidated without incurring a high transaction costs are less relevant to smooth out a temporary shocks to labor earnings.

Table B4. Asset holdings compared with annual earnings

	(1)	(2)	(3)
Average wealth (liquid assets), in 2000 U.S. dollars	15,920	15,306	13,058
Average annual earnings, in 2000 U.S. dollars	53,303	53,535	53,764
Ratio of wealth to annual earnings	0.29	0.27	0.22

Notes: Authors' calculations based on PSID data on households (non-poverty subsample) with head aged 25 to 55 years old and with at least 12 years of schooling. In column 2 (resp 3), the sample is trimmed at the 1st and 99th (resp. 5th and 95th) percentiles of the variable measuring the ratio of wealth to annual earnings.