Underemployment and the Business Cycle

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Abstract

Recent years have seen a renewed interest in involuntary part-time employment. Despite its sizeable share in measures of resource underutilizaton in the labor market, our understanding of this phenomenon has remained limited. In this paper I analyze both household-level and aggregate data to characterize involuntary part-time employment in the US, and document its business cycle properties. I develop a tractable model of involuntary part-time employment, featuring search and matching frictions and partial substitutability between full-time and part-time workers in the production function, that successfully captures the dynamics of

"[The] unemployment rate today probably does not fully capture the extent of slack in the labor market."

— **Janet Yellen**, *Providence Chamber of Commerce, May 2015*

1 Introduction

In recent years researchers and policymakers have shown a renewed interest in involuntary part-time employment as a crucial element to assess labor market health. The fact that individuals have part-time jobs even though they would be willing to work more

certain economic conditions, without necessarily changing effective headcounts and thus avoiding the potential costs associated to firing workers. Given the benefits and costs associated with this reallocation and the characteristics of the workers who are reallocated, this adjustment is more than a mere reduction in hours to existing workers, and thus part-time employment emerges as an alternative adjustment mechanism, different from the traditional intensive and extensive margins.

The second observation is that wages of involuntary part-time workers display a higher volatility and lower persistence than those of their full-time counterparts, thus indicating a higher degree of flexibility. This will turn out to be a key element in explaining the countercyclicality of involuntary part-time employment.

Based on this evidence, I build a business cycle model of involuntary part-time employment, featuring search and matching frictions, where the decision of whether a worker is full-timer or part-timer is entirely made by the firm. It is an augmented search and matching model of the labor market, which features full-time and part-time employment, and a production function that combines both types of workers. The model thus depicts individuals in three labor-market states: employment as full-timer, employment as part-timer and search unemployment. Individuals search and are hired as full-time employees. However, in a given period the firm may decide to reallocate part of the workforce towards part-time contracts in response to an aggregate shock that negatively affects its profits. When reallocated as part-timers, workers see their working hours reduced and stop receiving fringe benefits. If laid off, they receive unemployment benefits and face a probability less than one of finding a new job.

This model is able to deliver the countercyclicality of involuntary part-time employment found in the data. The key mechanism to obtain this result is the relatively higher flexibility of part-time wages, a feature from the data, that makes it more profitable for the firm to reallocate workers from full-time to part-time contracts during recessions. In addition, the model successfully captures the empirical dynamic comovements between output, unemployment and involuntary part-time employment.

Based on the model, I do policy analysis to evaluate the effect of changes in fringe benefits on involuntary part-time employment. The model predicts that an increase in mandatory fringe benefits to full-time workers, such that their share in average full-time wages goes up by 1 percentage point, leads to an increase of the steady state involuntary part-time ratio by 16 percent, from 4 percent to 4.65 percent. The increase in fringe benefits not only has a direct effect on the incentives of the firm to reallocate workers from full-time to part-time positions, but also has an

worker-specific skills and job-related skills (i.e. productivity endowment) account for much of the part-time wage disadvantage. There are also papers analyzing the investment in human capital by part-time workers. Becker (1964) postulates that part-time workers have lower incentives to invest in their human capital, while Maximiano (2012) finds that workers' training probability increases with the number of contractual work hours.

to full-time jobs, and to easily upgrade the number of hours worked once the demand conditions improve.

Other studies for the US, such as Cajner et al. (2014) and Valletta and Van Der List (2015), than reallocating her.

The paper most related to mine is Warren (2015). He also conceives involuntary part-time employment as a decision made exclusively by the firm. However, di□erently from my representative firm model with heterogeneous workforce, he constructs a model in which heterogeneous firms choose to allocate identical workers either into full- or part-time positions. With his model he is able to match the patterns of vacancies and new hires across the growth distribution of firms. In addition, he produces results for the cross-section of firms that employ part-time workers; however, given the lack of data availability on part-time employment at the firm level, the author cannot test these predictions. He also reports business cycle statistics obtained from the model that are able to capture the countercyclicality of involuntary part-time employment.

Finally, within the literature studying short-time work (STW) programs as the ones developed in Europe, particularly in Germany, a paper that is close to mine in terms of its setup is Balleer et al. (2013). These authors construct a search and matching model with endogenous separations to study the e□ect of STW on unemployment dynamics. Their main finding is that STW programs act as automatic stabilizers, saving jobs during recessions. The modeling strategy in this paper is based on defining two endogenous cuto□s associated to the decisions of firing a worker or of participating in the STW program. I adopt the idea of finding optimal cuto□s but implement it in a model with involuntary part-time employment that resembles more the US reality, where the development of STW programs is very limited, than the European reality.

Empirical Facts

.1 Business Cycles

Table 1 presents empirical facts regarding underemployment in the U.S., with particular focus on involuntary part-time employment. Using data from the BLS, I compute business-cycle statistics for involuntary part-time employment, full-time employment, the involuntary part-time ratio[2], and underutilization measured as U6.

The results show that involuntary part-time employment is very volatile, nearly as volatile as unemployment, and strongly countercyclical. The opposite is true for full-time employment. Both series display a high degree of persistence. The broad measure of underutilization is also very

[2] The involuntary part-time ratio is defined as the ratio between involuntary part-time employment and full-time employment.

developed by

Table 3: Transition Probabilities In and Out of Involuntary

Table 4: Wages at Business Cycle Frequencies

	Relative Std. Dev.	Autocorrelation
Aggregate wage	0.412	0.843
CPS – *all workers*	0.369	0.933
CPS – *FT workers*	0.479	0.912
CPS – *IPT workers*	1.101	0.845

Notes: The statistics correspond to the period 1995q1-2015q12. The aggregate wage corresponds to hourly compensation in the private non-farm business sector from the Labor Productivity and Costs program of the Bureau of Labor Statistics. Hourly wages from the CPS, for each of the groups considered, are composition-bias corrected averages for workers in the private non-farm business sector, between 25 and 60 years old, excluding supervisory workers. All series of economic distress.

Figure (10) shows that a very large fraction of involuntary part-time wages in 2006 were above the minimum wage. Only 5 percent of the individuals reported having an hourly wage equal or less than the minimum hourly wage. The median difference in 2006 was of about $5, which is significant taking into account that the state with the highest minimum wage had an hourly minimum wage of $7.63. This evidence is consistent with the survey results from Van Horn and Zukin (2015), who find that more than 60 percent of the involuntary part-time workers who were surveyed are paid above the minimum wage.

When I compare the distribution of the gap in 2006 to the one in 2009, its is clear that the distribution shifts to the left, implying that wages for involuntary part-timers declined in the context of the Great Recession. In 2009, there is a larger mass of individuals earning a wage at or below the minimum wage than the one in 2006. This is evidence that firms had scope to reduce wages, and that minimum wages were not imposing a bound on firms.

In this context, it is worth noting that more than 80 percent of involuntary part-time workers are paid by the hour, while the majority of full-time workers are salaried workers. There is also empirical evidence that salaries might be stickier than hourly wages (Barattieri et al., 2010). This would be suggestive of a lower degree of rigidity in part-time wages relative to full-time wages.

4 Model

4.1 Decentralized Economy

The model I present in this section is a real business cycle model that features search and matching frictions in the labor market, which impede transitions of individuals from search unemployment to employment. The distinctive feature of my model is that workers can have either full-time or part-time status, and production combines both types of workers. The model thus depicts individuals in three labor-market states: employment as full-timer, employment as part-timer and search unemployment. I abstract from labor force participation decisions on the part of households. They are assumed to supply work inelastically in the sense that all its unemployed members are sent to search for jobs each period.

In this paper I focus on part-time employment for economic reasons, i.e. workers who would like to work as full-timers but that actually work as part-timers due to slack business conditions.[9]

The BLS definition of involuntary part-time employment also comprises individuals who work part-time because

Individuals search and are hired as full-time employees. However, in a given period the firm may decide to reallocate part of the workforce towards part-time contracts in response to a shock that negatively affects its profits.

4.1.1 Labor Market

The labor market is characterized by matching frictions. Unemployed workers search for full-time jobs at no cost and firms pay a cost to post vacancies. Matching between unemployed individuals and vacancies occurs randomly according to an aggregate matching function:

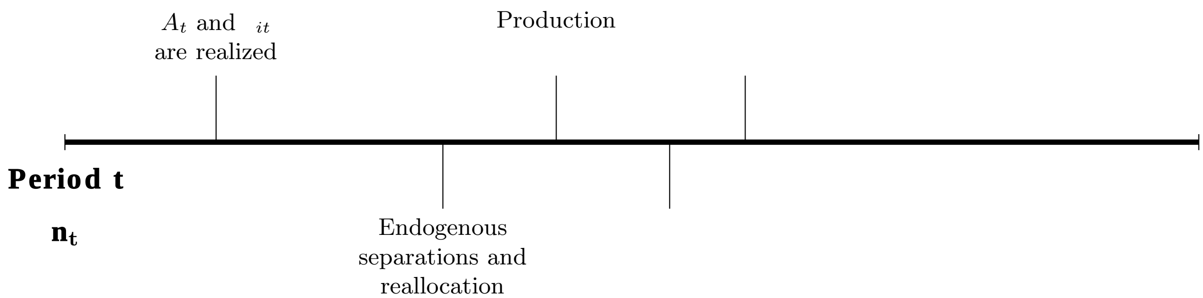
$$m(v_t, s_t) = \mu s_t^{\xi} v_t^{1-\xi}, \tag{1}$$

where s_t is the measure of workers searching for a job and v_t is the aggregate number of vacancies during period t. The parameter ξ denotes the elasticity of job matches with respect to search unemployment, and μ is the matching efficiency parameter. Finally, the labor market tightness, θ_t is defined as the vacancy-unemployment ratio, v_t/s_t. The probability that an unemployed individual is matched to an open vacancy at date t is denoted $p_t = m_t/s_t$. Similarly, the probability that any open vacancy is matched with a searching worker at date t is $q_t = m_t/s_t$. Households and firms take these probabilities as given. New hires, $m(v_t, s_t)$, begin working with a one-period delay.

Even though individuals search for full-time positions and are hired as full-time employees, when the jobs become operative in the following period the firm may choose to turn some full-time contracts into part-time contracts. This re allocation decision depends on the realization of the job-specific idiosyncratic productivity, z_{it}, that is drawn from a time-invariant distribution with c.d.f. $F(z)$, which has positive support and density $f(z)$. If the realization of the idiosyncratic productivity falls below $\tilde{z}_t$, then the job is destroyed and worker and firm separate. This leads to a job destruction rate $F(\tilde{z}_t)$. Alternatively, if the realization of the idiosyncratic productivity is higher than $\tilde{\tilde{z}}_t$, the individual remains as a full-time worker, i.e. under the conditions she was originally hired. Finally, if the realization of the idiosyncratic productivity falls between the two endogenously determined critical thresholds $\tilde{z}_t$ and $\tilde{\tilde{z}}_t$, it would be optimal for the firm to turn the full-time job into a part-time job. The resulting full-time/part-time reallocation rate is $F\left(\tilde{\tilde{z}}_t\right) - F(\tilde{z}_t)$. The optimal cutoffs are represented in Figure 11. Besides the previously described

they cannot find a full-time job. However, this component is much smaller, representing about a third of total involuntary part-timers, and less responsive to business cycle fluctuations than part-time employment due to slack business conditions. Therefore, I focus on the latter.

Figure 1: Timing of Events



time (normalized to 1) to full-time jobs, while part-time jobs involve only $\bar{h} < 1$ hours. Each job i produces $A_t z_{it}$ units of output if it is full-time and $A_t z_{it} \bar{h}$ units of output if it is part-time, where A_t denotes aggregate productivity and z_{it} denotes job-specific idiosyncratic productivity.

Total output is the aggregation of full-time and part-time output by means of a Constant Elasticity of Substitution (CES) aggregator:

$$Y_t = \left[\alpha \left(Y_t^F\right)^{\varepsilon} + (1-\alpha)\left(Y_t^P\right)^{\varepsilon}\right]^{1/\varepsilon}$$

subject to a sequence of flow budget constraints

$$c_t + b_t = (1 - \tau^n) W_t + [1 - n_t + n_t F(\tilde{z}_t)] \chi + R_t b_{t-1} + d_t. \tag{12}$$

The subjective discount factor is β, and the function $u(\cdot)$ is a standard strictly-increasing and strictly-concave utility function over consumption. There is no labor force participation decision in this problem. Since the reallocation and firing decision are only made by the firm, the workers have no control over their employment status and take as given the reallocation and firing thresholds, $\tilde{\tilde{z}}_t$ and $\tilde{z}_t$.

The total pre-tax wage income is W_t, defined as in equation (6

In Section 3 I present evidence that part-time wages are more flexible than full-time wages. In order to capture this with the model, I assume that full-time wages are sticky by introducing a partially smoothed wage of the following form:

$$w_t^F = \omega w_t^{F,NB} + (1 - \omega)\, w_{ss}^{F,NB}, \tag{14}$$

where $w_t^{F,NB}$ is the full-time Nash-bargaining wage negotiated in period-t, $w_{ss}^{F,NB}$ is the full-time Nash-bargaining wage in the deterministic steady state, and $\omega \in (0,1)$ measures the degree of stickiness. The smaller is ω, the stickier are full-time wages.

Part-time workers are just paid the Nash-bargaining wage negotiated in period-t, i.e.

$$w_t^P = w_t^{P,NB}. \tag{15}$$

The derivation of the Nash bargaining w) wage is negotiated might have a low realization of her idiosyncratic productive and might be fired.

4.1.5 Government

Unemployment benefits are provided by the government. The government runs a balanced budget and finances the unemployment insurance system by collecting labor income taxes and issuing real state-contingent debt. The period-t government budget constraint is thus

$$[1 - n_t + n_t F(\tilde{z}_t)]\chi + R_t b_{t-1} = \tau^n W_t + b_t, \tag{18}$$

where W_t is defined as in equation (6).

4.1.6 Equilibrium

The equilibrium in this economy is made up of endogenous processes $\left\{c_t, v_t, n_{t+1}, \tilde{z}_t, \tilde{\tilde{z}}_t, w_t^F, w_t^P, R_t, b_t\right\}_{t=0}^{\infty}$ that, given the stochastic processes $\{z_t, A_t\}_{t=0}^{\infty}$ and the initial stock of workers n_0, satisfy:

1. The household's consumption-saving optimality condition (13).
2. The firm's optimality conditions (8), (9) and (10).
3. The wage equations (16) and (17).

$\tilde{\tilde{z}}$ equa ~ $\hat{z}_t$

First of all, moving to the standard model requires discarding part-time employment, which occurs as long as $\tilde{\tilde{z}}_t = \tilde{z}_t = \hat{z}_t$. When the firing and reallocation thresholds are the same, total output is just given by

$$Y_t = \alpha^{1-\varepsilon} A_t n_t \int_{\hat{z}_t}^{\infty} z f(z) dz, \tag{20}$$

which implies that the contribution of the marginal worker to output is $\alpha^{1-\varepsilon} A_t z_t$.

The two critical thresholds for reallocation and firing defined by equations (9) and (10) are the same as long as the following condition holds:

$$\alpha^{1-\varepsilon} A_t \hat{z}_t - w_t^F(\hat{z}_t) - \zeta + \left(1 - \rho^F\right) \frac{g'(v_t)}{q_t} = -\phi.$$

Given the full-time wage in equation (14), and assuming complete flexibility (i.e. $\omega = 1$), this ew6272.3-1.99626]TJ-41e-41e(i)2(o)5(n)-defies the reallocation thresholdunder which and reallocation cuto□s:

$\tilde{z}_t$ = 1

benefits, i.e. higher ζ

wages. If this is the case, then $\partial|\eta_{z,A}|/\partial\omega$ is unambiguously negative. In other words, the magnitude of the elasticity of the reallocation cutoff with respect to aggregate productivity is larger when full-time wages are more sticky. This implies that, when full-time wages are stickier, a higher reallocation towards part-time would take place than in the case of complete flexibility of wages.

This result is indicative of the relevance of wage stickiness in shaping the reallocation decision. However, in my model there are other elements in place – e.g. structural differences between full-timers and part-timers – that might be affecting the benefits and costs of reallocating workers within the firm when facing a negative shock. This will be take of full-time and part-time workers and set $\varepsilon = 0.75$. This assumption is relaxed later to capture the effect of different degrees of substitutability on involuntary part-time; the results of these experiments are reported in Section 6.2.3. Hours worked by part-timers, $\overline{h}$, are computed as the ratio between 25 and 42, which are the average hours worked by part-time and full-time workers, respectively, in the CPS.

Shifting attention to the labor market, the matching function is assumed to be Cobb-Douglas, $m(v_t, u_t) = \mu s_t^{\xi} v_t^{1-\xi}$, with $\xi = 0.4$, as typically assumed in the literature.

The exogenous separation rate for part-time workers, ρ^P, is not directly observed in the data. An analysis of the flows form CPS indicates that part-time workers are almost six times more likely to separate from their jobs than their full-time counterparts.[18] But it is not possible to disentangle what is the share of exogenous separations of each group in total exogenous separations. Due to this lack of direct evidence, I just assume that $\rho^P = 1.2 \times \rho^F$, and then analyze the sensibility of the results to this assumption.

I set the part-timers' bargaining power, η^P, at an intermediate value of 0.5, and then choose the full-timers' bargaining power so that the average compensation – including wages and benefits – of part-timers is 60 percent of the average compensation of full-timers[19]; the resulting value is $\eta^F = 0.75$. The fringe benefits paid to full-time workers, set at $\zeta = 0.1507$, are calibrated to be 20 percent of full-time wages, in line with the Employer Costs for Employee Compensation statistics reported by the BLS.[20] Similarly, the unemployment benefits are chosen to be $\chi = 4$ in order to match a replacement rate of 40 percent, which is consistent with the average replacement rate for the period 1997-2016 published in the UI Replacement Rate Reports made available by the Employment and Training Administration within the US Department of Labor.

The labor income tax rate is calibrated based on the empirical measure developed by Arseneau and Chugh (2012). According to their calculations, the mean labor income tax rate over the period 1947Q1-2009Q4 is about 20 percent. Therefore, τ^n is set at 0.20.

The parameters α, ρ^F, μ, γ_v, and ϕ are chosen so as to match five steady state targets. First,

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The average transition rates from part-time and full-time employment to unemployment in the period 1994-2014 were 6.6. percent and 1.2 percent, respectively. However, it could be the case that most of the separations of part-timers captured in the CPS flows are due to endogenous separations rather than exogenous quits, and thus the numbers reported previously might be overestimating the exogenous separations of involuntary part-timers.

The Employer Costs for Employee Compensation statistics reported by the BLS show that the ratio of part-time over full-time compensation averaged 50 percent during the period 2004-2016. However, this statistics correspond to total part-timers, both voluntary and involuntary, and not only to involuntary part-timers, which is what I am capturing with my model. Nevertheless, these number is indicative of the magnitude.

[2] The average ratio of health e 57(a)4.43279(r)0.5475(N)-6.204(r)0rs, ate

the quarterly total job-separation rate in steady state is set at 0.1, a standard value in search and

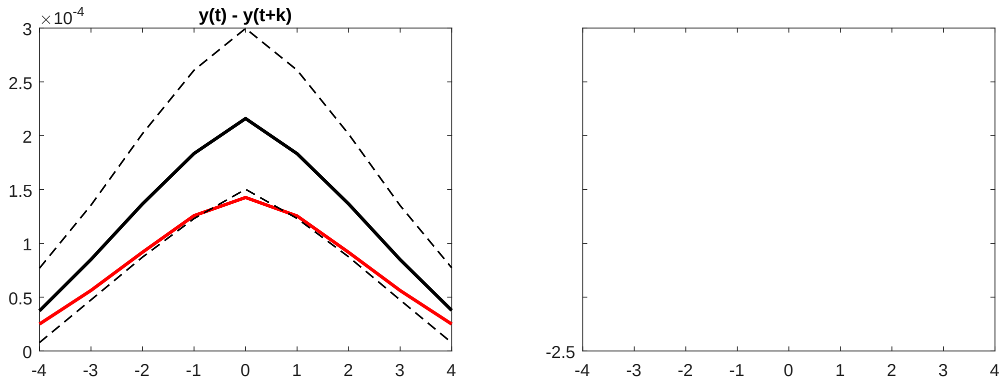
Table 6: Business Cycle Statistics

	IPT	FT	PT Ratio	Unempl.	U6	Avg. Wage
				Data		
Std. Dev.	0.102	0.014	0.115	0.113	0.102	0.007
Relative Std. Dev.	9.204	0.922	9.241	10.168	9.241	0.412
Autocorrelation	0.869	0.922	0.884	0.939	0.939	0.843
Correlation w/ Output	-0.890	0.837	-0.898	-0.918	-0.919	0.080
				Model		
Std. Dev.	0.080	0.012	0.091	0.062	0.063	0.005
Relative Std. Dev.	6.680	1.004	7.589	5.198	5.318	0.403
Autocorrelation	0.704	0.883	0.738	0.888	0.882	0.740
Correlation w/ Output	-0.899	0.999	-0.924	-0.985	-0.999	0.925

Notes: Author's own calculations based on data from BLS for the period 1994Q1-2016Q2. Model results are obtained from simulating the model with a stochastic TFP shock. All variables are reported in logs as deviations from an HP trend with smoothing parameter 1600.

this exercise I consider longer series, starting in 1955.[21] The red solid lines in Figure 2 represent the auto-covariances among these variables predicted by the model, and the black ones are those obtained from the data. The dotted lines correspond to 95 percent confidence intervals for the

Figure 2: Business Cycle Comovements in the Data and in the Model



As detailed in Section 5, both the firing and reallocation cutoffs are inversely related to aggregate productivity. Less productive matches are destroyed when production is less profitable due to worse aggregate conditions, leading to an increase in the firing threshold. Given the parameterization of α, which rules the effect of A_t on the marginal productivity of full-time and part-time

Figure 3: Impulse Response Functions to a 1 S.D. Negative Aggregate Productivity Shock

while the opposite is true when full-time wages are more flexible. These results are in line with the literature that has emerged since Shimer (2005) that has incorporated wage stickiness to search and matching models of the labor market as a way to deliver higher volatility of labor market variables.

In the baseline scenario I assumed that the exogenous separation rate of part-time work

Figure 4: Impulse Response Functions to a 1 S.D. Negative TFP Shock, for different degrees of wage stickiness

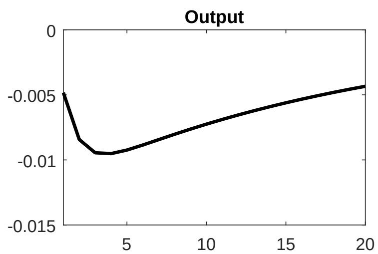
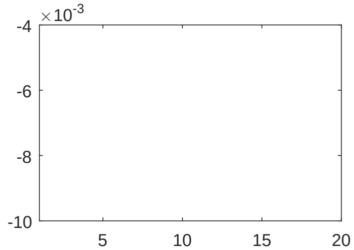


Figure 5: Impulse Response Functions to a 1 S.D. Negative TFP Shock, for different exogenous separation rates of part-timers



and

$$\tilde{\tilde{z}} = \frac{(1-\eta)}{(1-\eta)(2\alpha-1)}\zeta. \tag{29}$$

The elasticities of the firing and reallocation cutoffs with respect to the fringe benefits are

$$\eta_{\tilde{z},\zeta} = \frac{1}{\tilde{\tilde{z}}}\left[\frac{\left(1-\rho^{P}\right)\gamma_{v}}{(1-\eta)(1-\alpha)}\right]\left[\frac{1}{q}\eta_{q,\zeta} + \eta\theta\eta_{\theta,\zeta}\right] \tag{30}$$

and

$$\eta_{\tilde{\tilde{z}},\zeta} = 1, \tag{31}$$

where $\eta_{\tilde{z},\zeta}$, $\eta_{\tilde{\tilde{z}},\zeta}$, $\eta_{q,\zeta}$ and $\eta_{\theta,\zeta}$ are the elasticities of the firing and reallocation cutoffs, of the job filling rate, and of the market tightness with respect to ζ.

Besides the expected direct effect of higher fringe benefits on the reallocation cutoff, the above expressions also show that fringe benefits may also affect the firing cutoff through their impact on market tightness. Higher fringe benefits are likely to reduce market tightness because it reduces the incentives of firms to post vacancies. This implies that the elasticity in equation (30) is negative: the expansion of healthcare coverage leads to a reduction in the firing cutoff. The opposite happens with the reallocation cutoff, which increases because each full-time match becomes less profitable. As a consequence, the involuntary part-time ratio increases.

The changes in ζ considered in this section aim to capture, in a very stylized way, the adoption of regulation such as the Employer Shared Responsibility provisions that are part of the Affordable Care Act (ACA). These provisions, which went into effect at the beginning of 2015, require firms with 50 or more employees to provide affordable health insurance to their full-time workers, or otherwise be subject to penalties that are based both on the number of full-time workers and on the number of months in which an affordable coverage was not offered.[22,23] One of the concerns around the new regulation has been that it would give incentives to firms to reduce their employee's hours below the 30-hour threshold to avoid the costs associated with offering them health insurance. In fact, in a survey carried out in 2014 by ADP Research Institute[24], 38 percent of the respondents indicated that they would adjust employee hours in response to the Employer Shared Responsibility provisions and, among them, 51 percent were considering the possibility of reducing hours.

[22] In the context of this law, full-time workers are defined as those who work more than 30 hours per week.

[2] If the firm offers a health insurance plan that is not affordable, it will be subject to penalties determined based on the number of full-time workers who receive a federal subsidy for the purchase of a policy on a health insurance exchange.

[2] ADP Research Institute, "Measuring the Impact of the Affordable Care Act", 2015.

Given the short period of time since the new regulation has been in place, and that its implementation coincides with a period of economic recovery after a major crisis, empirical evidence on the effects of ACA on part-time employment is inconclusive.[25] The results presented in this section shed some light on the effects that such regulation might have on involuntary part-time employment. If all firms in the economy were as the representative firm in my model, in the data we would see an increase in involuntary part-time employment as a consequence of ACA. However, these results should be taken with a grain of salt. In the US economy, 96 percent of firms have less than 50 workers and thus are not affected by the regulation. Therefore, not all firms may have

97.992(p)-6(a)5(i)-5(t)3.0011(a)3.0011(t)3.0011(i)2(m)-2-6(u)4(e)-328.013(e)4.00146(m)-3.00334(p9886(p)-6(l)2(o)3700146(9919(y)

pu6(e)-347.985(g)5wo5t

Table 7: Business Cycle Statistics of Involuntary Part-Time Employment

	HP Filter			Bandpass Filter		
	1955 – 2016	1955 – 1989	1990 – 2016	1955 – 2016	1955 – 1989	1990 – 2016
Std. Dev.	0.092	0.085	0.098	0.079	0.073	0.086
Relative Std. Dev.	6.223	4.997	8.984	5.58	4.369	8.508
Autocorrelation	0.758	0.636	0.854	0.912	0.89	0.94
Correlation w/ Output	-0.819	-0.825	-0.882	-0.874	-0.932	-0.907

Notes: Author's own calculations based on data from BLS for the period 1955Q1-2016Q2. All variables are reported in logs and filtered using an HP filter with smoothing parameter 1600, as well as a bandpass filter with periodicities between 6 and 32 quarters.

behavior of involuntary part-time employment has changed over time. In particular, by comparing the two sub-periods, involuntary part-time employment in recent years has become much more volatile and persistent. This is consistent with Borowczyk-Martins and Lalé (2016b) who find that, during the Great Recession, the cyclical response of involuntary part-time work exceeded by a large factor what was observed in previous recessions.

What could be behind the changes in the cyclical behavior of involuntary part-time employment over time? I consider two possible explanations. The first one is that the Great Recession involved a much larger shock than any of the previous recessions occurred during the post-WWII period. If the response of involuntary part-time employment is disproportionately larger to bigger shocks than to smaller shocks, this could explain the substantial increase in involuntary part-time employment observed during the Great Recession. Under the light of my model, one mechanism through which this could be happening is the existence of nonlinearities in the distribution of idiosyncratic productivity. If the shock is large enough so as to move the reallocation cutoff to an area of the distribution where there is a nonlinear change in the probability mass, it would generate a much larger increase in involuntary part-time employment than the one driven by a small shock.

The second explanation is that structural changes have affected the behavior of involuntary part-time employment over the business cycle. In particular, I consider the role of organizational innovation.[27] Changes in organizational capital have been taking place for more than two decades, since the 1990s. It involves a complex innovation process that encompasses several dimensions

[2] Cajner et al. (2014), Valletta and Van Der List (2015), and Valletta et al. (2016) have also considered other structural factors behind the large increase in involuntary part-time observed during the Great Recession, such as changes in industry composition towards services-oriented sectors, demographic changes, and increases in labor costs through the introduction of new regulation such as the Employer Shared Responsibility provisions in the Affordable Care Act.

of human resources management.[28] This phenomenon was fueled by low IT prices and sustained economic growth, which led businesses to invest in IT equipment and software, as well as by cheaper and increasing electronic connectivity (Department of Commerce, 2000).

Organizational innovation and the adoption of workforce management technologies make it easier for firms to reallocate workers from full-time to part-time positions by increasing their degree of substitutability. It makes it easier and less costly to allocate workers in shifts, and reduces the difficulties associated to coordinating the availability, preferences and skills of heterogeneous workforces.

In my model, the degree of substitutability between full-time and part-time workers is captured by the parameter ε in the production function. To capture the process of organizational innovation occurred since the 1990s, I consider an increase in ε. Figure 6 shows the impulse responses to an aggregate productivity shock for different degrees of substitutability between full-time and involuntary part-time workers. When the substitutability is higher then the reallocation from full-time to part-time is easier and more profitable, which leads to a larger increase of the part-time

Cajner, T., Mawhirter, D., Nekarda, C., and Ratner, D. (2014). Why is Involuntary Part-Time Work Elevated? FEDS Notes, Board of Governors of the Federal Reserve System.

Canon, M. E., Kudlyak, M., Luo, G., and Reed, M. (2014). Flows To and From Working Part Time for Economic Reasons and the Labor Market Aggregates During and After the 2007-09 Recession. *Economic Quarterly*, 100(2):87–111.

Chodorow-Reich, G. and Karabarbounis, L. (2016). The Cyclicality of the Opportunity Cost of Employment. *Journal of Political Economy*, forthcoming.

Davis, S. J., Faberman, R. J., and Haltiwanger, J. (2006). The Flow Approach to Labor Markets: New Data Sources and Micro-Macro Links. *Journal of Economic Perspectives*, 20(3):3–26.

Department of Commerce (2000). Digital Economy 2000. mimeo, O□ce of Policy Development, Economics and Statistics Administration, U.S. Department of Commerce.

Haefke, C., Sonntag, M., and van Rens, T. (2013). Wage rigidity and job creation. *Journal of Monetary Economics*, 60(8):887–899.

Hagedorn, M. and Manovskii, I. (2008). The Cyclical Behavior of Equilibrium Unemployment and Vacancies Revisited. *American Economic Review*, 98(4):1692–1706.

Hirsch, B. T. (2005). Why do part-time workers earn less? The role of worker and job skills. *Industrial and Labor Relations Review*, 58(4):525–551.

Hornstein, A. and Price, D. A. (2016). Assessing the E□ect of the A□ordable Care Act on Part-Time Employment. Economic Brief, Federal Reserve Bank of Richmond.

Lynch, L. M. (2007). The Adoption and Di□usion of Organizational Innovation: Evidence for the U.S. Economy. NBER Working Papers 13156, National Bureau of Economic Research, Inc.

Madrian, B. C. and Lefgren, L. J. (1999). A Note on Longitudinally Matching Current Population Survey (CPS) Respondents. NBER Technical Working Papers 0247, National Bureau of Economic Research, Inc.

Maximiano, S. (2012). Two to tango: the determinants of workers' and firms' willingness to participate in job-related training. mimeo, Department of Economics, Krannert School of Management, Purdue University.

Merz, M. (1995). Search in the labor market and the real business cycle. *Journal of Monetary Economics*, 36(2):269–300.

Mulligan, C. B. (2014). The Economics of Work Schedules under the New Hours and Employment Taxes. NBER Working Papers 19936, National Bureau of Economic Research, Inc.

Nekarda, C. (2009). A Longitudinal Analysis of the Current Population Survey: Assessing the Cyclical Bias of Geographic Mobility. mimeo, Federal Reserve Board of Governos.

Polivka, A. E. and Miller, S. M. (1994). The CPS After the RedesignL Refocusing the Economics Lens. O□ce of survey methods research, Bureau of Labor Statistics.

Ramey, G., Den Haan, W. J., and Watson, J. (2000). Job Destruction and Propagation of Shocks. *American Economic Review*, 90(3):482–498.

Shimer, R. (2005). The Cyclical Behavior of Equilibrium Unemployment and Vacancies. *American Economic Review*, 95(1):25–49.

Shimer, R. (2012). Reassessing the Ins and Outs of Unemployment. *Review of Economic Dynamics*, 15(2):127–148.

Warren, L. F. (2015). Part-time Employmnet and Firm-level Labor Demand over the Business Cycle. University of Iowa.

A Figures

Figure 7: Part-time Employment: Economics vs. Non-Economic Reasons

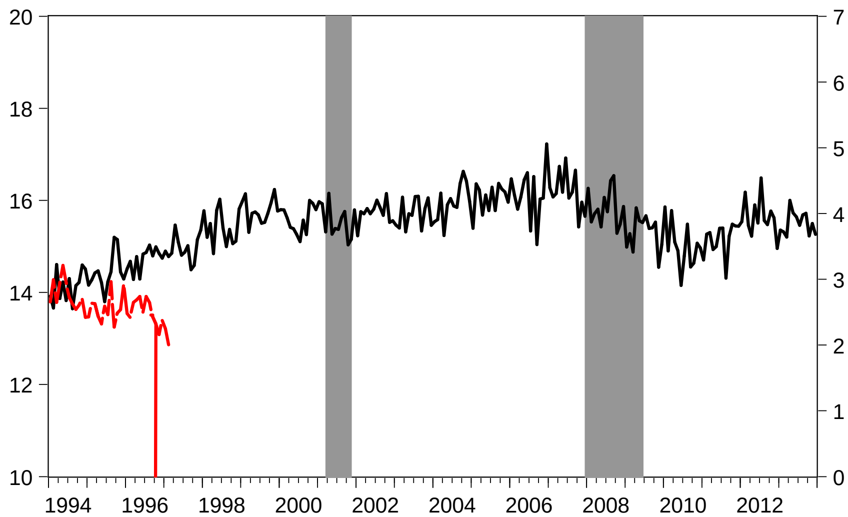
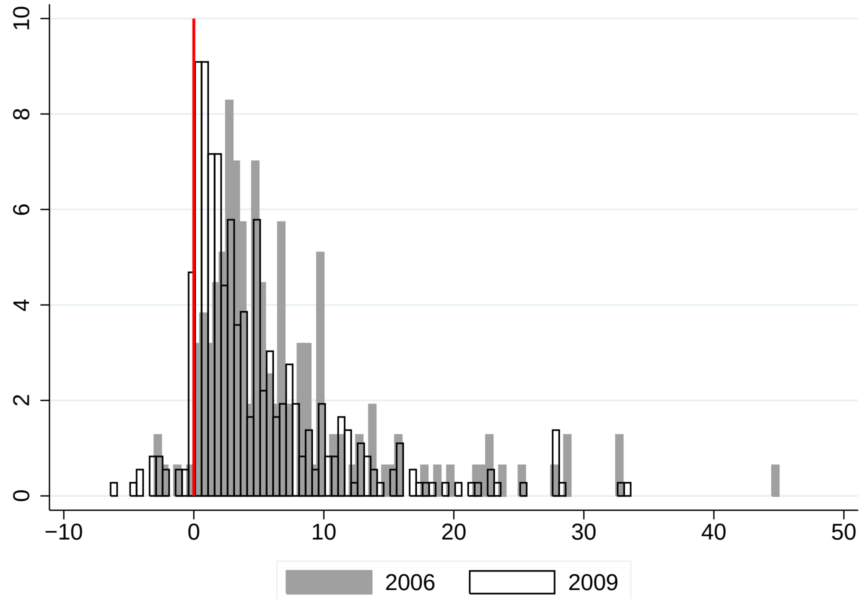


Figure 9: Transition Probabilities In and Out of Involuntary Part-time Employment

$\mathbf{p}^{FI}$

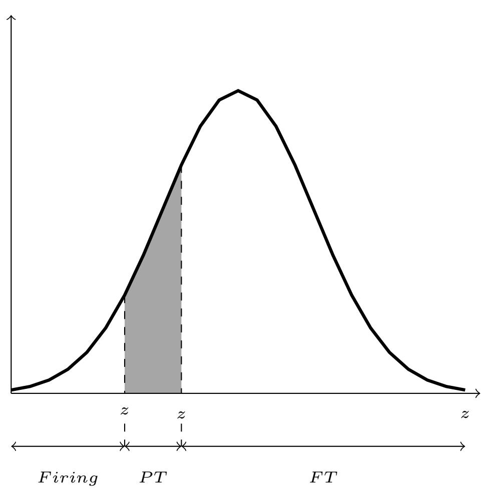
$\mathbf{p}^{IF}$

Figure 10: Involuntary Part-Time Hourly Wages and the Minimum Wage



Source. Own calculations based on data from CPS. Data on minimum wage for each state are from the Department of Labor.

Figure 11: Reallocation and Firing Decisions



C Firm Optimization

ADD DERIVATION OF OPTIMALITY CONDITIONS OF THE FIRM

D Nash Bargaining

ADD DERIVATION OF NASH BARGAINING WAGES FOR FULL-TIMERS AND PART-TIMERS

and

$$w_t^{P,NB} = \frac{\eta^P}{h} \left[(1-\alpha)\frac{Y_t}{n_t} \left(\frac{Y_t^P}{Y_t} \right)^{\varepsilon} \frac{z_t}{\int_{\tilde{z}_t} zf(z)dz} + \right.$$

$$\left. + \left(1-\rho^P\right)\theta_t g'(v_t) - \left(1-\rho^P\right)(1-\zeta. Rf\ d\ t. Rf\ Z \right.$$

F Log-logistic Distribution

For the quantitative exercise in this paper I assume that the idiosyncratic productivity is distributed log-logistic with scale parameter α and shape parameter β. This is equivalent to say that the logarithm of idiosyncratic productivity has a logistic distribution with mean $\mu = ln(\alpha_z)$ and $s = 1/\beta_z$