Unemployment Insurance Takeup and the Business Cycle

WORK IN PROGRESS

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Abstract

While little attention has been paid to the stylized fact that the take-up rate of unemployment insurance is less than 100%, the question how a take-up rate (the share of those eligible for unemployment insurance actually claiming it) that varies over the business cycle could affect the general equilibrium of an economy has not yet been asked. I propose a simple model to allow for an endogenous take-up decision in a search and matching model with stochastic shocks. Nash bargaining implies a positive ceteris-paribus effect of take-up on wages. Since take-up turns out to be countercyclical, this induces a form of endogenous wage rigidity, amplifying fluctuations in key aggregates of the labor market. Quasi-experimental estimates using Austrian social security data confirm the validity of the wage mechanism and are used as a basis for the calibration of the model. Simulations reveal that the volatility of the key variables increases by almost 30%, demonstrating that the mechanism is not only theoretically, but also economically relevant.

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1 Introduction

The take-up rate of unemployment insurance (UI), i.e. the share of those eligible actually claiming it, has only received limited attention in labor economics. Theoretical models of the labor market generally assume that it is 100% – a natural assumption as it seems. Why should rational agents not accept free money? Given these considerations, it seems surprising that various empirical studies, while differing in the point estimates, consistently estimate take-up rates far below 100% (see Table 1 for an overview).

Country	Source	Estimated take-up	Time period
Canada	Storer and van Audenrode (1995)	77%	1981 – 1986
United Kingdom	DWP[1] (2012)	49% - 84%	1997 – 2010
United States	Anderson and Meyer (1997)	24% - 50%	1979 – 1982
	Blank and Card (1991)	68% - 75%	1977 – 1987
	McCall (1995)	65%	1982 – 1991

Table 1: Overview of estimated take-up in existing studies

Another important observation can be made in Figure 1, plotting the take-up rate (measured as initial jobless claims divided by job separations) against the unemployment rate and unemployment duration over time. It appears that – besides being far below 100% over the entire period covered – the take-up rate is far from constant over time and countercyclical, with a higher of the unemployed claiming benefits when the conditions are bad. A similar observation can also be made for Austria (Figure 2), using the data upon which the empirical section of this paper is based, and for the UK (Figure 3), one of the few countries where official estimates of the take-up rate are published. This suggests that this stylized fact is also robust in an international comparison.

But why do the unemployed deliberately choose not to file for UI? A first step toward an understanding of this issue can be made by considering a special CPS supplement administered in 2005, asking those with self-reported eligibility who did not claim UI for their reasons (Table 2). The general

[1] The British Department for Work and Pensions (DWP) is one of the few government agencies that regularly publish estimates of take-up rates.

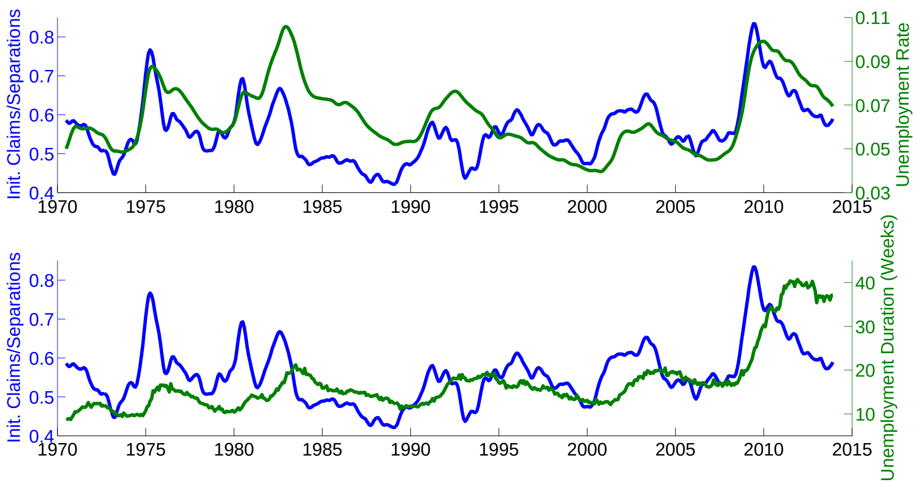

Figure 1: Take-up rate, unemployment rate, and unemployment duration in the US over time (Source: BLS)

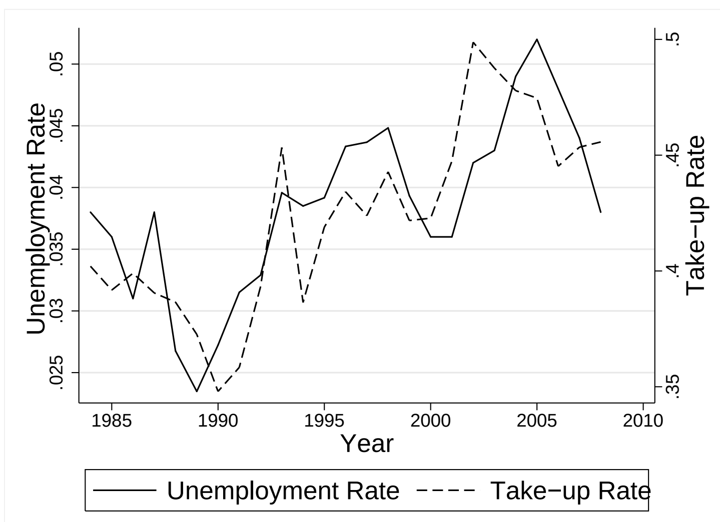

Figure 2: Take-up rate and unemployment rate in Austria over time (Source: ASSD, IMF)

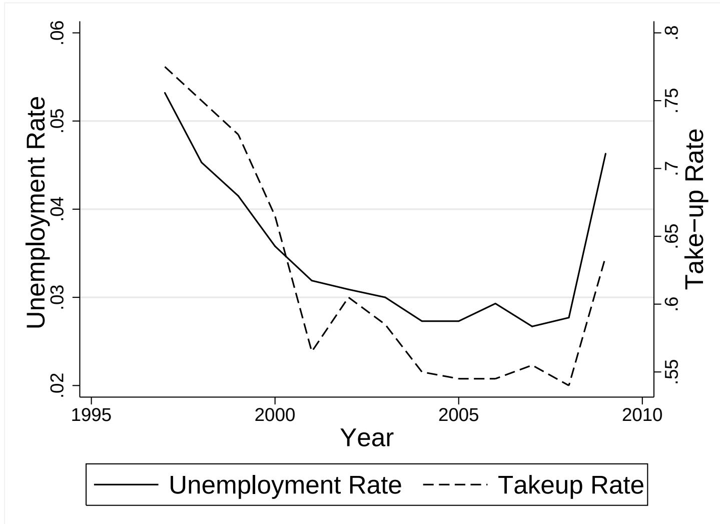

Figure 3: Take-up rate and unemployment rate in UK over time (Source: DWP)

conclusion from the numbers is that non-filing is either due to claiming costs of some sort (most of the reasons mentioned under point 1) or due to a short expected spell of unemployment (point 2)–or a combination of both, since respondents had to decide for one reason. If this is the main mechanism at work, we can also explain the cyclical properties of UI take-up: More unemployed find it worthwhile to bear claiming costs under bad conditions given their longer expected length of benefit reception.

While the idea that the take-up decision is a tradeoff of claiming costs and expected benefits is not new (see Currie (2004) for a survey of the literature and Anderson and Meyer (1997) for a simple partial equilibrium model of the take-up decision), these insights have largely been ignored on the macro level. This despite the possibility that the cyclical variation of UI take-up might not only be interesting on its own, but also related to other variables, thus feeding back into the general equilibrium of the economy. Taking this into account can be important for the qualitative and quantitative predictions for the cyclical properties of the labor market and the role of unemployment insurance therein.

To assess these questions, I introduce an endogenous take-up decision in a stochastic version of the Mortensen-Pissarides (MP) search and matching model (D. T. Mortensen & Pissarides, 1994; Pissarides, 1985, 2000). I assume that filing for UI entails a fixed administrative cost, while the length of benefit reception and hence the payoff is uncertain. In line with the previous intuition,

Reasons for not applying for UI	Number in thousands	Percent
1) Attitude/understanding/barrier to UI benefits	778	37.00
1.1) Do not need money/do not want the hassle	220	10.40
1.2) Negative attitude about UI	78	3.74
1.3) Do not know about UI/how to file	212	10.19
1.4) Barrier to filing (e.g. language, transportation)	52	2.49
1.5) Told not eligible	175	8.32
1.6) Plan to file soon	42	2.08
2) Job expected/became employed	594	28.27
3) Not looking for a job	231	11.02
4) Other reasons/don't know	496	23.70
Total	4368	100.00

The figures represent population estimates of responses to the following question from a special CPS supplement administered in January, May, July, and November 2005: "What is the main reason . . . has not applied for unemployment compensation since . . . last job?" The population estimates are obtained using the CPS weights.

Table 2: Reason for not applying for UI benefits in current unemployment spell, job losers and leavers eligible for UI (self-reported) (Vroman (2009), Table 4)

this means that the unemployed will only be willing to incur the claiming costs if they expect a sufficiently long duration of unemployment. If the job-finding rate is procyclical, this setting will lead to a countercyclical take-up rate.

If we assume that wages are set by generalized Nash bargaining – as is standard in the MP model – workers' outside values and hence wages will be positively affected by the current take-up rate. Ceteris paribus this tends to push wages upward during recessions and downward during booms. Since this causes wages to be more rigid, profits will be more volatile. According to a zero-profit condition firms create vacancies until expected vacancy costs equal expected profits, and hence this translates into larger fluctuations in vacancies, unemployment and labor market tightness as well. Note that the mechanism will also work if wages are set unilaterally by firms. Since they will minimize wages subject to the reservation wages of workers, workers' outside values will directly translate into wages.

While this effect can be shown to hold theoretically, it is another question whether it is also economically relevant. Using a policy discontinuity in the UI system in Austria, I can test the validity of the Nash bargaining assumption and discipline my calibration, which proceeds from Hagedorn and Manovskii (2008a). Simulations of the model with the baseline calibration then show that the volatility of labor market tightness, unemployment, and vacancies is increases by almost 30% compared to a model with exogenous take-up. Hence, though not primarily intended, the paper also adds to the literature initiated by Shimer (2005), who demonstrated that the stochastic version of the standard MP model failed to account for the empirical volatility in the aggregates of the labor market if standard parameter choices are made – a fact that had already been noted by Andolfatto (1996). While Hagedorn and Manovskii (2008a) succeeded in matching the empirical volatility using a different calibration, Shimer's critique also triggered other attempts to reconcile the MP-model with the data.

While these include job destruction shocks and job-to-job worker flows (e.g. D. Mortensen & Nagypál, 2007), countercyclical vacancy costs (e.g. Shao & Silos, 2008), and fixed matching costs (e.g. Pissarides, 2009) as well as turnover costs (e.g. Braun, 2005; Silva & Toledo, 2009), among others, most attempts have been directed at wages. Shimer (2005) had already argued that the main reason that the tightness was not volatile enough was that wages set according to Nash bargaining fluctuated too much in response to productivity shocks, thereby leaving little movements in firm profits. Various forms of exogenous and endogenous wage rigidity have since been discussed (e.g. Shimer, 2004; Hall, 2005; Gertler & Trigari, 2009; Kennan, 2010; Menzio & Moen, 2010).

The way I introduce the take-up decision in the MP-model, I will end up with a form of endogenous wage rigidity which acts to amplify fluctuations. Clearly, while the literature mentioned in the previous paragraph is directly aimed at closing the gap between the textbook search and matching model, this aspect is only a byproduct of the present analysis. Hence, it is no problem that the simulations reveal that the take-up channel is unlikely to be the only answer to the Shimer critique.

I begin in the next section by discussing related literature. In Section 3, I describe the theoretical model, while Section 4 summarizes empirical evidence on the wage mechanism. Building on this, Section 5 describes the calibration and the computation of the model. Section 6 summarizes the results and Section 7 concludes.

2 Related Literature

Previous works on UI take-up primarily focus on empirical investigations of its determinants. These are surveyed in Currie (2004) and Hernanz, Malherbet, and Pellizzari (2004), notable examples are Blank and Card (1991), McCall (1995) and Anderson and Meyer (1997), all finding that replacement rates are significant determinants of take-up. Budd and McCall (1997) analyze the role of unions in the take-up decision, finding that eligible blue-collar workers laid-off from union jobs were 23% more likely to receive benefits. According to the authors' interpretation these results are primarily due to unions helping workers to exercise their rights, i.e. reduced claiming costs. Petrongolo (2009) empirically analyzes a mechanism similar to the one considered here, showing that a UK JSA reform increasing job search requirements significantly increased the share of non-claimants. Kroft (2008), on the other hand, investigates the implications of a variable take-up rate for optimal unemployment insurance in a static environment and finds that its level increases considerably (60% instead of 40% of pre-unemployment wages).

Only recently have there been attempts to come up with structural models to explain the take-up process in more detail. One of them is Blasco and Fontaine (2012), who incorporate a take-up decision in a detailed partial equilibrium job search model and then use structural estimation to identify the parameters (Petrongolo (2009) also applied a partial equilibrium search model to demonstrate the effect of higher job search requirements). Their results suggest that transaction costs in the claiming process are substantial. An early treatment of the take-up of welfare programs is Moffitt (1983), who emphasizes the role of stigma. However, recently authors have rejected stigma as an explanation for non-take-up in favor of transaction costs, since take-up of means-tested programs is not lower whereas they should be more stigmatic (see Currie (2004) for more on this).

The only model that introduces UI take-up in a general equilibrium setting I am aware of is Fuller, Auray, and Lkhagvasuren (2013). However, their setting is only relevant for the U.S., where firms are experience rated. This means that firms pay higher payroll taxes if more of their previous employees collected benefits. Since firms thus prefer workers not taking up UI, these will enjoy a higher job arrival rates and workers will select endogenously into registered and unregistered unemployment. While their model works well to predict long-term averages in the data, their mechanism is quite different from the one presented here. Indeed, until there has been no analysis of the general equilibrium implications of an endogenous take-up rate in a stochastic framework I am aware of.

3 The Model

3.1 Environment

The model is in discrete time. Productivity p is drawn from a first-order Markov process. L et $\mathbb{E}_p X(p')$ denote the expectation of some future value $X(p')$ conditional on the current realization p. Throughout, primes will denote next-period values. Firms and workers discount the future at the exogenous discount rate r. Define $\delta \equiv \frac{1}{1+r}$.

I depart from the standard MP model by assuming that workers and firms are informed at the beginning of a period whether their match is dissolved, which occurs with probability λ. The match continues to exist until the end of the period and wage bargaining occurs at the beginning of the period before the separation shock materializes. Until the end of the period, workers and firms have the opportunity to find a new match for the subsequent period. The reason for this modification of the standard environment lies in the way the UI claiming decision is introduced. I will discuss its implications more thoroughly later on – including an argument why I deem this modification of the model close to reality. Figure 4 summarizes the assumptions.

Let u and v denote unemployment and vacancy rate, respectively. The different timing explained in the previous paragraph implies that the number of unemployed and the number of searchers no longer coincides as is the case in the standard MP model, since now upcoming layoffs add to the pool of job searchers. Hence, the number of job searchers is given by $u + \lambda(1 - u)$. The number of matches is then given by $m = m(u + \lambda(1 - u), v)$, increasing in both arguments and assumed to satisfy constant returns to scale. Labor market

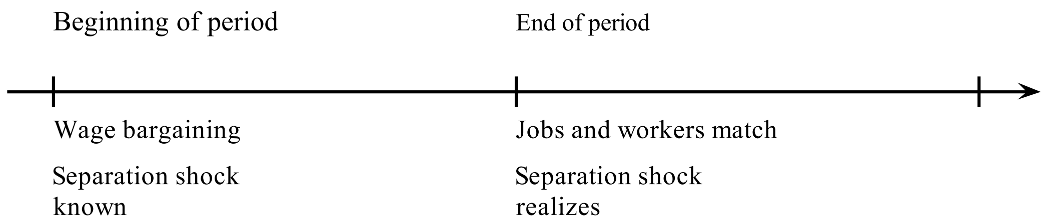

Figure 4: Sequence of events

tightness, usually specified as $\theta = v/u$, now has to be redefined to be

$$\theta = \frac{v}{u + \lambda(1-u)}.$$

We can write for the probability that a vacancy is filled

$$\frac{m(u + \lambda(1-u), v)}{v} = m(\theta^{-1}, 1) \equiv q(\theta).$$

The probability that an unemployed person finds a job can be written as

$$\frac{m(u + \lambda(1-u), v)}{u} = m\,(1, \theta) = \theta m(\theta^{-1}, 1) = \theta q(\theta) \equiv f(\theta).$$

3.2 Firms

Firms produce with a linear production technology. Hence the firm size is indeterminate and we can assume that one firm consists of one job, which is either occupied and produces p, or vacant and costs $c(p)$[2]. A separation occurs with exogenous probability λ. In these respects the labor demand side of the economy is standard and follows Pissarides (2000). As explained in the previous paragraph, however, firms are informed of the dissolution of their match at the beginning of the period and hence have the opportunity to search for a new match while the current match still persists.

The value of a vacancy given productivity p, $V(p)$, is unaffected by this modelling choice and reads (throughout this text, primes denote next period values)

$$V(p) = -c(p) + \delta\left[q(\theta(p))\mathbb{E}_p J(p') + (1 - q(\theta(p)))\mathbb{E}_p V(p')\right]. \tag{1}$$

[2] I follow Hagedorn and Manovskii (2008a)in assuming a variable hiring cost, which is motivated by adding capital to the model. In particular, hiring costs consist in labor and capital costs which both vary over the business cycle. Please refer to Hagedorn and Manovskii (2008a) for more detailled motivation.

A vacancy costs $c(p)$ in the current period and is transformed into a job, yielding value $J(p')$, in the subsequent period with probability $q(\theta(p))$, while the vacancy remains open with opposite probability, yielding $V(p')$.

The value of a filled job given p, $J(p)$, however, changes compared to the standard MP case and is now given as

$$\begin{aligned} J(p) &= p - w(p) - \lambda c(p) \\ &\quad + \delta\Big[(1-\lambda)\mathbb{E}_p J(p') + \lambda\Big(q(\theta)\mathbb{E}_p J(p') + (1-q(\theta))\mathbb{E}_p V(p')\Big)\Big]. \end{aligned} \tag{2}$$

Firms earn productivity p minus wages $w(p)$ in the current period. With probability λ a firm learns in the beginning of the period that a match is dissolved at the end of the period, in which case a cost $c(p)$ is incurred to find a match for the next period. If search in the current period is not successful, which happens with probability $1 - q(\theta)$, the dissolved job cannot be refilled and is vacant in the next period, yielding $V(p')$. With opposite probability, search is successful and the job continues to exist without interruption, yielding $J(p')$. Eventually, with probability $1 - \lambda$, a job separation shock does not arrive, in which case the firm earns a payoff of $J(p')$ in the subsequent period.

Free entry implies that everyone can set up a vacancy and hence we must have $V(p) = 0$ in equilibrium. Using this in (1), we find

$$c(p) = \delta q(\theta(p))\mathbb{E}_p J(p'). \tag{3}$$

Substituting (3) in (2) gives

$$\begin{aligned} J(p) &= p - w(p) - \lambda c(p) + (1-\lambda)\frac{c(p)}{q(\theta)} + \lambda c(p) \\ &= p - w(p) + (1-\lambda)\frac{c(p)}{q(\theta)}, \end{aligned}$$

and hence the value of a filled job turns out to coincide with the standard MP case. The intuition is that by the free entry condition, any opportunity to refill the dissolved match must yield zero ex-ante profits.

3.3 Workers

I will explain the labor supply side of the economy in more detail, since this is where I depart from the standard model. The model wants to capture the idea that claiming entails sunk costs, while the length of the unemployment spell and hence the benefit of claiming unemployment insurance is uncertain

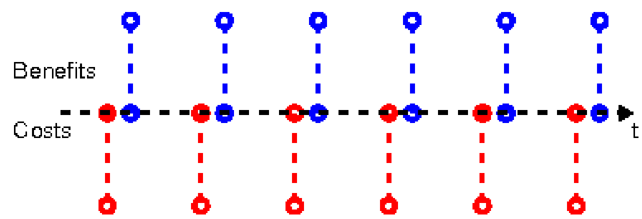

Figure 5: Time pattern of benefits and costs

a priori. This generates fluctuations in the take-up rate if unemployment durations are longer during recessions.

The way the unemployment insurance is system is set up in most cases suggests that the registered unemployed incur sizable adminstrative costs throughout their spell: At the beginning, they have to gather information about the system, show up at the caseworker's office, fill in many forms and so on. Later on UI recipients have to show up regularly for appointments, have to write applications for jobs they cannot possibly get or take part in training programs that are ill-suited for their special needs[3].

The unemployed are only willing to bear these costs to qualify for future benefit payments, as failure to do so would mean that benefits are (partially) sanctioned away. On the other hand, if they knew for certain that they would be matched soon, there would not be a reason to bear these costs. Consider, for instance, an unemployed who finds a job starting immediately but has an appointment with her caseworker the same day. It appears unlikely that she will show up at the appointment, given that there are no sanctions for not doing so.

Given the explained characteristics of benefits and costs, I model the time pattern of benefits and costs using a simple stationary setting (Figure 5). I assume that the unemployed have to claim unemployment benefits z one period in advance at a fixed claiming cost $\psi < z$, while they only receive a payoff from claiming if they are not matched in the meantime. This reflects the fact that recipients always have the choice of not sticking to the rules and hence not qualifying for future payments. Hence, a claiming decision can also be regarded as that of buying an asset which only pays off in one state of nature. I plot the payoff profile of the asset in Figure 6. While this setting is stylized, it accounts for two important aspects: The take-up decision is forward-looking and the current takeup-rate is (in part) influenced by past

[3]These can be qualified as costs as they do not increase the matching probability. I will abstract from the possibility that being registered raises the matching probability as explained later.

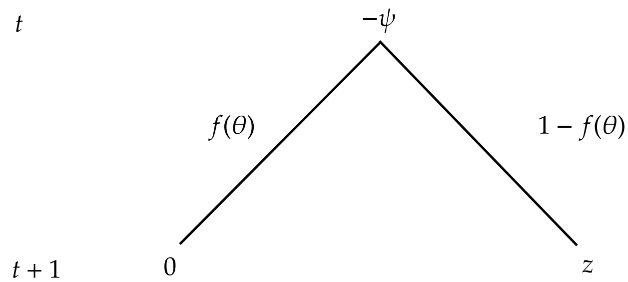

Figure 6: Payoff profile of unemployment insurance

decisions.

One could argue that claiming costs are higher in the beginning of the spell. In this case, the take-up decision at the beginning of a spell would be different from those afterwards. This would complicate the analysis considerably since one additionally would have to keep track of the composition of different cohorts of the unemployed. However, while the specific dynamics of the model should change, the main mechanism would be the same.

The unemployed find a job with probability $f(\theta)$. I focus on the polar case where being registered does not raise the matching probability. This allows me to look at the effect of the forward-looking nature of the take-up decision. To get an interior solution for the take-up rate, I assume that there is heterogeneity in the job finding rate

$$f_i(\theta) = f(\theta) + \varepsilon_i,$$

where $\mathbb{E}(\varepsilon_i) = 0$ and ε_i is drawn anew every period for simplicity. Note that this is the type of heterogeneity that turns out to be most tractable. An alternative would have been to assume heterogeneity in the take-up cost, leading to qualitatively similar outcomes.

Unemployed individual i then solves

$$U_i(p, s_i) = \max_{s_i' \in \{0,1\}} \left\{ \ell + s_i z - \psi s_i' + \delta \left[f_i(\theta(p)) \mathbb{E}_p W(p') + (1 - f_i(\theta(p))) \mathbb{E}_p U_i(p, s_i') \right] \right\},$$

where ℓ denotes the value of leisure which is exogenous and z denotes UI payments. s_i denotes the take-up indicator of person i for the current period, meaning that individual i currently receives benefits if $s_i = 1$. This value has been determined by a decision in the previous period and is hence a state variable. On the other hand, s_i' represents the take-up decision for the subsequent period. If UI is claimed, costs ψ are borne, while benefits are only received if no match occurs, which happens with probability $1 - f_i(\theta(p))$.

Define $\overline{\varepsilon}(\theta) \equiv -\psi/(\delta z) + (1 - f(\theta))$. The decision rule for person i is the given by

$$s_i' = \mathbb{1}\left[\varepsilon_i \leq \overline{\varepsilon}(\theta)\right], \tag{4}$$

from which we can infer the aggregate probability of filing for unemployment among the unemployed (claiming rate), $k(\theta)$:

$$k(\theta) = \text{Prob}(\varepsilon_i \leq \overline{\varepsilon}(\theta)).$$

Hence, as expected, since $\overline{\varepsilon}(\theta)$ is decreasing in $f(\theta)$, a lower of share of the unemployed claim UI if the job finding rate is higher, meaning that workers expect to be unemployed in the future with smaller probability. As $f'(\theta) > 0$ and θ turns out to be procyclical, we thus get a countercyclical claiming rate. Note that that the claiming rate generally differs from the share of the unemployed actually receiving UI, which is what is generally referred to as the take-up rate. This difference is due to a selection effect: Those with a lower job finding rate (low ε_i) are less likely to file for UI but are more likely to remain unemployed in the subsequent period. Hence, the take-up rate is higher than the claiming rate, which will be shown formally later on.

Aggregating over all individuals, the aggregate value of the unemployed reads

$$U(p,s) = \ell + sz - k(\theta)\psi + \delta\left[f(\theta)\mathbb{E}_p W(p') + (1 - f(\theta))\mathbb{E}_p U(p, s'(\theta))\right]. \tag{5}$$

The future take-up rate $s'(\theta)$, on the one hand, appears in the continuation values and depends on the current claiming rate $k(\theta)$ in a way to be demonstrated. The state variable s, on the other hand, is the current take-up rate, on which the currently unemployed had to decide in the previous period. However, the pool of the currently unemployed also comprises the group of those who were employed in the previous period. Hence, in order to determine s, we also have to model their claiming behavior. In particular, given the way the claiming decision is modelled here, we have to assume that claiming has to occur while still on the job. This is exactly the reason why I departed from MP in assuming that workers are informed of their subsequent layoff at the beginning of the period: Since this introduces a similar trade-off for the worker side, I can model their take-up behavior along the same lines as for the unemployed. Having been informed of their upcoming layoff, workers start to search for a new match while still on the job. At the same time, they can already register for UI, trading off claiming costs against the probability of being unemployed in the future.

While this departs from the standard MP assumption, it is in my opinion close to reality: People are often informed (or have to be informed) of their layoff well in advance[4], or they might consider a layoff likely (high λ). If this is the case, there is no reason to suppose that the still employed only start looking for a new job after their previous one has actually ended. Moreover, workers can also start to gather information about the system or register in advance for UI – which is, e.g., even explicitly allowed for in Austria ("Vorgemerkte Arbeitslosigkeit"). In all this, the same trade-off should be at work as with the unemployed.

Proceeding from these considerations, the value of worker i reads

$$
\begin{aligned}
W_i(p) = \max_{s_i' \in \{0,1\}} \Big\{ & w(p) - \lambda s_i' \psi \\
& + \delta \Big[(1-\lambda)\mathbb{E}_p W(p') + \lambda \Big(f_i(\theta)\mathbb{E}_p W(p') + (1 - f_i(\theta))\mathbb{E}_p U(p', s_i') \Big) \Big] \Big\}.
\end{aligned}
$$

Workers currently earn wage $w(p)$. In case of a separation a worker can decide to register in advance for UI by choosing $s_i' = 1$, incurring cost ψ. Moreover, the worker manages to find another job during the same period with probability $f_i(\theta)$, earning $W(p')$, while in the opposite case the worker becomes unemployed, earning $U(p', s')$. If no separation shock occurs, the worker continues to be employed, earning $W(p')$.

It can easily be seen that this setting leads to the decision rule given in (4), and hence workers about to lose their job have the same claiming rate $k(\theta)$ as the unemployed. After aggregating over i, we obtain

$$
\begin{aligned}
W(p) = & \; w(p) - \lambda k(\theta)\psi \\
& + \delta \Big[(1-\lambda)\mathbb{E}_p W(p') + \lambda \Big(f(\theta)\mathbb{E}_p W(p') + (1 - f(\theta))\mathbb{E}_p U(p', s'(\theta)) \Big) \Big]. \quad (6)
\end{aligned}
$$

While the modification of the model to allow for an advance notice of subsequent job separations on the one hand allows me to model claiming on the job and should – as argued above – reflect reality quite well, it extends the basic MP setting by allowing for a limited form of job-to-job flows. Even though a very simple model of search on the job, the model correctly predicts that job-to-job flows, given by $\lambda(1 - f(\theta_t))(1 - u_t)$, are higher in booms than in recessions, which is consistent with empirical findings (e.g O. J. Blanchard & Diamond, 1989).

Eventually, having determined the claiming behavior on and off the job, I need to determine how the take-up rate in the subsequent period, $s'(\theta)$, is

[4] Many countries have regulations according to which employees have to be informed a certain period before their layoff.

determined. Since a take-up only occurs in the subsequent period if there is no match in between, we find, using $\mathbb{E}(\varepsilon_i) = 0$ and $f_i(\theta) = f(\theta) + \varepsilon_i$,

$$\begin{aligned}
s'(\theta) &= \frac{\int_{-\infty}^{\infty}(1 - f_i(\theta))s_i'(\theta)dF(\varepsilon)}{\int_{-\infty}^{\infty}(1 - f_i(\theta))dF(\varepsilon)} \\
&= \frac{\int_{-\infty}^{\bar{\varepsilon}(\theta)}(1 - f_i(\theta)) \cdot 1\, dF(\varepsilon) + \int_{\bar{\varepsilon}(\theta)}^{\infty}(1 - f_i(\theta)) \cdot 0\, dF(\varepsilon)}{1 - f(\theta)} \\
&= \frac{(1 - f(\theta)) \int_{-\infty}^{\bar{\varepsilon}(\theta)} dF(\varepsilon) - \int_{-\infty}^{\bar{\varepsilon}(\theta)} \varepsilon dF(\varepsilon)}{1 - f(\theta)} \\
&= k(\theta) - \frac{\int_{-\infty}^{\bar{\varepsilon}(\theta)} \varepsilon dF(\varepsilon)}{1 - f(\theta)} \\
&= k(\theta) + \Delta(\theta),
\end{aligned}$$

where $\Delta(\theta) > 0$ is a selection effect.

3.4 Wages

As is standard in the Mortensen-Pissarides model, wages are formed by generalized Nash bargaining. Bargaining at the micro level would entail different wages for those previously registered and those previously not registered. However, θ will be determined by the free entry condition of firms where wages only enter in expectation and will turn out to be linear in take-up. Hence, it is sufficient to derive the average wage to derive the equilibrium of the economy. Put differently, the dynamics implied by bargaining at the micro and macro level are the same.

Defining the common surplus $S(p,s) \equiv J(p) + W(p) - U(p,s)$, Nash bargaining implies

$$W(p) - U(p,s) = \beta S(p,s) \quad \text{and} \quad J(p) = (1-\beta)S(p,s),$$

where β denotes the bargaining power of workers[5].

Substituting (2), (5) and (6) for the value functions and using the free entry condition (3) yields

$$w(p) = \beta(p + (1-\lambda)c(p)\theta(p)) + (1-\beta)(\ell + sz - (1-\lambda)k(\theta)\psi), \tag{7}$$

where, plugging in for s and $k(\theta)$, we can derive the wages for the respective subgroups at the micro level.

[5]Of course, due to the relationship implied by Nash bargaining, J and W will depend on s as well. I will suppress this argument for the subsequent analysis.

The terms following β and $1-\beta$ represent the upper and lower margin of the bargaining range, respectively. The inherent assumption in Nash bargaining is that wages are always positioned at a fraction β of the way between the lower and the upper margin.

The upper margin depends positively on productivity and labor market tightness. Workers are rebated part of their productivity Workers are rebated part of their productivity and compensated for their outside opportunities if unemployed. The only difference to the standard case here is that the factor $1-\lambda$ enters, reflecting the fact that workers have the opportunity to find another job if laid off, for which employers are compensated. I depart farther from the standard model in the lower margin, standing for the flow utility if unemployed. sz is the current average benefit payment, while $(1-\lambda)k(\theta)\psi$ are the savings in take-up costs while employed compared to being unemployed.

Thus, wages go up if many people have claimed benefits last period (high s) but tend to be pushed down if many people are claiming for the subsequent period. Since $z > \psi$ and $s'(\theta) > k(\theta)$, the former dominates the latter if the claiming rate is constant over time. Hence, on average this mechanism will work against the procyclical movements of the other components of the wage, leading to an endogenous wage stickiness.

3.5 Equilibrium

Equilibrium in this economy is defined by a policy function $\theta(p)$ that solves firms' free entry condition (3) subject to the wage function given by (7). Recalling the free entry condition

$$\frac{c}{\delta q(\theta)} = \mathbb{E}_p J(p') = \mathbb{E}_p \left\{ p' - w(p') + \frac{(1-\lambda)c(p')}{q(\theta(p'))} \right\},$$

we can see how the modified wage function will influence the equilibrium and hence cyclical properties of the economy. It says that firms increase vacancies until the expected cost of a vacancy equals its expected discounted payoff. Clearly, the more $w(p)$ moves in line with p, the less expected discounted profit will vary with p and the less incentive there is to vary θ. Wage stickiness in whatever form hence leads to larger fluctuations in θ and hence in aggregate unemployment and vacancies.

Plugging in for the wage using (7), we arrive at a rational expectations functional equation in $\theta(p)$,

$$\frac{c(p)}{\delta q(\theta(p))} = \mathbb{E}_p\Bigg\{(1-\beta)\left[p' - \ell + (1-\lambda)\psi k(\theta(p')) - s'(\theta(p))z\right] - \beta(1-\lambda)c(p')\theta(p') + \frac{(1-\lambda)c(p')}{q(\theta(p'))}\Bigg\}. \quad (8)$$

This equation pins down a policy function $\theta(p)$ of arbitrary form, yielding firms' choice of the vacancies relative to unemployment for a given p.

Given the policy function $\theta(p)$, all other variables in the economy follow directly. In particular, given the assumptions on job-to-job transitions made here, the law of motion for unemployment is given by

$$u_{t+1} = \lambda(1 - f(\theta_t))(1 - u_t) + (1 - f(\theta_t))u_t, \quad (9)$$

while vacancies follow from the definition of labor market tightness as

$$v_t = \theta_t(u_t + \lambda(1 - u_t)). \quad (10)$$

3.6 Analysis

To get an idea how a variable take-up rate affects equilibrium, I follow Hagedorn and Manovskii (2008b) in deriving the elasticity of labor market tightness with respect to productivity under certainty equivalence (i.e. assuming constant productivity) and constant hiring costs.

Lemma 1. *Under certainty equivalence (i.e. $p' = p$) and assuming that c does not depend on p, the elasticity of labor market tightness with respect to productivity, $\varepsilon_{\theta,p}$, is given by*

$$\varepsilon_{\theta,p} = \frac{p}{p - \ell - s'(\theta)\left(z - (1-\lambda)\psi\right)} \times \frac{\beta(1-\lambda)f(\theta) + \frac{1-\delta(1-\lambda)}{\delta}}{\beta(1-\lambda)f(\theta) + (1-\eta_f)\frac{1-\delta(1-\lambda)}{\delta} + \frac{1-\beta}{c}q(\theta)\left(s'(\theta)z(-\eta_s) - (1-\lambda)k(\theta)\psi(-\eta_k)\right)}, \quad (11)$$

where $\eta_f \equiv \left|\frac{\partial f(\theta)}{\partial\theta}\frac{\theta}{f(\theta)}\right|$, $\eta_s \equiv \left|\frac{\partial s'(\theta)}{\partial\theta}\frac{\theta}{s'(\theta)}\right|$ and $\eta_k \equiv \left|\frac{\partial k(\theta)}{\partial\theta}\frac{\theta}{k(\theta)}\right|$ denote the elasticities of the job-finding rate, the take-up rate and the claiming rate with respect to the labor market tightness, respectively.

Proof. See appendix. □

A direct consequence of this result is the following:

Proposition 1. *$\varepsilon_{\theta,p}$ increases in η_s and decreases in η_k.*

Proof. This result can be seen directly from (11) □

Hence, a variable take-up rate increases volatility, while the variable claiming rate leading to fluctuations in claiming costs dampens it. The take-up rate and the claiming rate, on the other hand, are linked by the selection term $\Delta(\theta)$. As long as this term is not strongly negative, the net effect will be positive:

Proposition 2. *The take-up channel increases $\varepsilon_{\theta,p}$ if*

$$1 + \frac{\partial\Delta(\theta)}{\partial\theta} > (1-\lambda)\frac{\psi}{z}.$$

Proof. The net effect of both mechanisms is positive if

$$\frac{\eta_s}{\eta_k} > \frac{(1-\lambda)k\psi}{sz}.$$

Moreover,

$$\eta_s = \left|\left(\frac{\partial k}{\partial\theta} + \frac{\partial\Delta}{\partial\theta}\right)\frac{\theta}{k+\Delta}\right|.$$

Assuming η_s and η_k have the same sign,

$$\frac{\eta_s}{\eta_k} = \frac{k}{k+\Delta}\left(1 + \frac{\partial\Delta(\theta)}{\partial\theta}\right),$$

from which the result directly follows. □

The preceding condition coincides with the condition that the wage becomes more rigid due to the take-up channel. This is what we need to generate higher volatility compared to full take-up. Setting $\eta_s = \eta_k = z = \psi = 0$ and $\tilde{\ell}$ equal to average relative flow utility of workers relative to unemployed in (11), we obtain the elasticity in the MP model with full take-up, $\tilde{\varepsilon}_{\theta,p}$,

$$\tilde{\varepsilon}_{\theta,p} = \frac{p}{p-\tilde{\ell}} \times \frac{\beta(1-\lambda)f(\theta) + \frac{1-\delta(1-\lambda)}{\delta}}{\beta(1-\lambda)f(\theta) + (1-\eta_f)\frac{1-\delta(1-\lambda)}{\delta}}.$$

This result is similar to the elasticity derived in Hagedorn and Manovskii (2008b) for the standard MP case, the only difference being that $1-\lambda$ enters in front of $f(\theta)$ in the numerator and denominator for the same reason as explained above.

To get an idea of the direction and the magnitude of the take-up effect, we need to calibrate and simulate the model. A caveat to Proposition 1 is that the statement is made for a given take-up rate $s'(\theta)$ and hence holds locally. However, comparing an economy with full take-up[6] to an economy with endogenous take-up over time in a global analysis, we note that the movements of the take-up rate itself will cause movements in $\varepsilon_{\theta,p}$ which are absent in the full take-up case.

4 Some Evidence on the Wage Mechanism

It is evident from the presentation of the model that the crucial link is a positive association of take-up and wages. I motivated my results assuming Nash bargaining. In principle, however, any model guaranteeing that wages stay within the bargaining range can be argued to be a suitable wage setting mechanism in the present model. Other mechanisms have been considered, among others, by Hall (2005) and O. Blanchard and Galí (2010).

Hence, it is useful to look for direct evidence on the association between UI take-up and post-unemployment wages. If take-up can be shown to have a positive effect on post-unemployment wages, we can be confident that bargaining assumption is a valid approximation of reality and that the proposed mechanism exists. I do so by exploiting a policy discontinuity in the Austrian unemployment insurance system, namely that job losers above 25 need to have been employed at least for 52 weeks during the preceding 24 months if it is their first unemployment spell. The mapping from employment during the previous two years and eligibility is not deterministic, however: On the one hand, the law lists several spells that can be counted toward the eligibility, that cannot be observed in the data, such as civil service or working spells abroad. This leads to a non-zero probability to be eligible and hence a non-zero take-up probability below the cutoff. On the other hand, the preceding analysis suggests that take-up will not be perfect even above the cutoff. Nevertheless, the take-up probability jumps at the cutoff and we can estimate its effect on post if we can justify the assumption that individuals are as good as randomly assigned around the cutoff.

I use Austrian Social Security Data (ASSD), focussing on job losses between 1985 and 2010 of males between 25 and 50. Moreover, I only consider first time unemployment occuring between employment spells. Unpaid unemployment spells are not recorded in the data. I take all gaps in the employment history to be unpaid unemployment. In order to limit the number of spells

[6] For the rest of this paper, I will refer to the case of an exogenous take-up rate as full take-up, even though it does not matter whether we consider take-up to be equal to 1 or to any other fraction.

that are only due to job changes, I only consider spells above 10 days (paid and unpaid). The law is not precise in its statement regarding incomplete working weeks. It is not clear whether an individual who has worked for 51 weeks and 4 days will be credited 51 or 52 weeks. For the main specification, I thus exclude individuals who are less than ten days away from the cutoff. I exclude individuals that are recalled to their previous employers and potential quitters (more than 28 days between previous job and entry into unemployment insurance). In order to not introduce sample selection between registered and non-registered unemployed and be able to exclude quitters, I have to eliminate all unemployment spells lasting less than 29 days.

In Figure 8 in Appendix B, I plot regression discontinuity estimates for different bandwidths. In particular, I estimate the model

$$y_i = \beta_0 + \beta_1 \mathbb{1}\left[dw_i \geq 365\right] + \beta_2 \mathbb{1}\left[dw_i \geq 365\right] \times (dw_i - 365) + \beta_3 (dw_i - 365) + \varepsilon_i,$$

where dw_i denotes the days worked during the preceding two years and is restricted according to the bandwidth.. As suggested by Hahn, Todd, and Van der Klaauw (2001), observations are weighted using a triangular kernel giving more weight to observations close to the cutoff. Reported standard errors are bootstrapped with 2000 replications.

On the one hand, it is apparent that the eligibility mechanism works quite well, creating jumps of about 54 to 55% at the threshold across all bandwidths. This jump can be interpreted as a jump in take-up if we assume that individuals directly to the left of the cutoff would have had the same take-up rate as those to the right in the absence of the policy discontinuity. On the other hand, a positive intention-to-treat effect on wages, ranging from about 5.7% to 7.6% is also consistently measured across all specifications. While estimates with the two larger bandwidth are very precise (p-values of 0.004 and 0.001, respectively), the most narrow bandwidth fails to be significant due to the reduced sample size[7], while the magnitude of the point estimate still falls within the range of the other estimates. Importantly, all of the given estimates are consistent with a positive effect of outside values on wages as predicted by the model.

The significance of these results would not be clear if we could not be sure that variables influencing wages other than take-up are smooth around the threshold. In order to concisely address this question, I estimate a regression of log wages on a rich set of controls[8] and generate fitted values. In Figure

[7]The sample sizes corresponding to bandwidths of 90, 120 and 150 days are 7621, 11033 and 14256, respectively.

[8]The variables used are gender, age, age squared, experience, experience squared, log duration of previous job, log duration of previous job squared, log wage of previous job, log wage of

9(a) in Appendix B, I plot regression discontinuity estimates using these fitted values as dependent variables. Apparently, other covariates are reasonably balanced around the cutoff. An insignificant difference is only visible with the narrowest bandwidth, but it goes into the opposite direction, hence tending to reduce my estimates. Clearly, this analysis does not directly address potential biases due to unobserved variables. However, given the rich set of controls I am confident that these variables would also be correlated with some of the observed variables, which would then tend to produce jumps at the cutoff.

For the rest of the paper, I will regard the estimates with bandwidth of 150 days as the baseline. These imply the smallest effect of take-up on wages among my estimates, since the measured jump in take-up is highest (about 55%) and the effect on wages is smallest (about 5.72%), leading to an effect of about 10.04% of take-up on wages.

In a more complicated search model, the given increase in post-unemployment wages could be seen as a combined effect of an increased outside value in bargaining and an increased reservation wage when receiving UI. On the one hand, using the same dataset, Card, Chetty, and Weber (2007) did not find any significant effect of extended benefit duration on reemployment wages. This should isolate the effect of increased reservation wages, while leaving the effect of take-up constant. On the other hand, even if this effect were relevant, it would not pose any problems for the mechanics of the model. In this case, the wage equation (7) implied by bargaining could be seen as a reduced-form approximation of the relationship between wages and take-up. Since the RDD estimates summarize this reduced-form relationship and do not depend on the bargaining assumption and the basic mechanism of the model works as long as firms expect take-up to have an effect on wages for whatever reason, the basic story of this paper still goes through.

A natural limitation of the approach I have taken is that I can only estimate a local effect for those who were employed one year during the preceding two years (discontinuity group). For the quantitative exercise that follows, we have to assume that this estimate is a good approximation of the relationship between take-up and wages for the entire group of the unemployed. As a first point, note that the discontinuity group is probably more representative of the group of the unemployed than of the entire working population, as the unemployed are likely to have had short spells in the past. Problems could arise if the bargaining power is strongly correlated with previous employment,

previous job squared, dummies for six different categories of family status, a dummy for being an Austrian citizen, a dummy for bluecollar workers, firm size of the previous employer, dummies for regions according to the NUTS classification, dummies for month of job loss and dummies for year of job loss.

as the pressure of workers' outside value on wages is highest if workers' bargaining power is lowest. However, estimates in the literature suggest that workers' bargaining power is quite low in general. As argued in Hagedorn and Manovskii (2008a), estimates in, for instance, Christofides and Oswald (1992), Blanchflower, Oswald, and Sanfey (1996), and Hildreth and Oswald (1997) suggest that β is about 0.05, which is exceeded by the calibrated value here.

5 Calibration and Computation

In calibrating the model, I proceed from Hagedorn and Manovskii (2008a), who calibrated a stochastic version of the standard MP model without on-the-job search and full take-up. Choosing a comparably high opportunity cost of labor ℓ and low bargaining power β, they manage to match the observed volatility in labor market tightness, while Shimer (2005) only managed to generate negligible volatility using standard parameter values. On the other hand, Hagedorn and Manovskii's setting has been criticized for implying a too high labor supply elasticity (see, e.g., Hall and Milgrom (2008)).

My main goal lies in understanding the potential quantitative impact of an endogenous take-up rate. In order for the take-up rate to display sufficient variation with a take-up function fitted to observed data, I need sufficient variation in the labor market tightness. For this matter, the above mentioned concerns should not be relevant as the direction and the extent of the effect should be the same irrespective of how the volatility in the labor market tightness as an input to the take-up decision is generated.

As Hagedorn and Manovskii (2008a), I follow den Haan, Ramey, and Watson (2000) in specifying the matching function as

$$m(u,v) = \frac{\tilde{u}v}{\left(\tilde{u}^l + v^l\right)^{1/l}},\ l \geq 0,$$

where here – as explained above – the number of job searchers $\tilde{u} = u + \lambda(1-u)$ differs from the number of unemployed u. While den Haan et al. (2000) also provide a micro foundation for this functional form, the main advantage as opposed to the standard Cobb-Douglas function lies in the fact that the implied matching probabilities are guaranteed to be between zero and one for all $\tilde{u}$ and v. In addition, $m(\tilde{u}, v)$ is increasing in both arguments and satisfies constant returns to scale.

The productivity process $\{p_t\}$ is specified as

$$\log p_{t+1} = \rho \log p_t + \varepsilon_{t+1},\ \text{where } \varepsilon \sim \mathcal{N}(0, \sigma_\varepsilon^2),$$

Parameter	Definition	Value
ℓ	Value of nonmarket activity	0.955
β	Workers' bargaining power	0.052
l	Matching parameter	0.407
c	Cost of vacancy when $p = 1$	0.584
δ	Discount rate	$0.99^{1/12}$
λ	Separation rate	0.0081
ρ	Persistence of the productivity process	0.9895
σ_ε^2	Variance of innovations in productivity process	0.0034

Table 3: Calibration in Hagedorn and Manovskii (2008a)

and approximated by a 4-state Markov chain. Also, following the motivation given in Hagedorn and Manovskii (2008a), I specify vacancy costs as

$$c(p) = 0.474p + 0.110p^{0.449}.$$

I follow Hagedorn and Manovskii (2008a) in imposing an average job-finding rate of $f(\theta^*) = 0.14$. In order to on average match their separation rate, I set $\lambda = 0.0081/(1 - f(\theta^*)) = 0.0095$. I choose the same values for the parameters δ, ρ and σ_ε^2.

I need to make progress on the setting by Hagedorn and Manovskii (2008a) in finding the take-up function $s'(\theta)$. To determine $s'(\theta)$, I assume that

$$\varepsilon_i \sim \mathcal{N}(0, \sigma^2),$$

implying that the claiming rate is given by

$$k(\theta) = \text{Prob}\left(\frac{\varepsilon}{\sigma} \leq -\frac{1}{\delta}\frac{\psi}{z}\frac{1}{\sigma} + \frac{1}{\sigma}(1 - f(\theta(p)))\right) = \Phi\left(\beta_0 + \beta_1(1 - f(\theta(p)))\right).$$

To calculate the take-up rate in the subsequent period $s'(\theta)$, observe that with a normal distribution

$$\begin{aligned}\int_{-\infty}^{\bar{\varepsilon}(\theta)} \varepsilon dF(\varepsilon) &= F(\bar{\varepsilon}(\theta))\frac{\int_{-\infty}^{\bar{\varepsilon}(\theta)} \varepsilon dF(\varepsilon)}{F(\bar{\varepsilon}(\theta))} \\ &= F(\bar{\varepsilon}(\theta))\mathbb{E}\left(\varepsilon|\varepsilon \leq \bar{\varepsilon}(\theta)\right) \\ &= \Phi(\bar{\varepsilon}(\theta)/\sigma)\left(-\sigma\frac{\phi(\bar{\varepsilon}(\theta)/\sigma)}{\Phi(\bar{\varepsilon}(\theta)/\sigma)}\right) \\ &= -\sigma\phi(\bar{\varepsilon}(\theta)/\sigma) \\ &= -(1/\beta_1)\phi(\beta_0 + \beta_1(1 - f(\theta(p)))),\end{aligned}$$

implying

$$\begin{aligned}s'(\theta) &= k(\theta) - \frac{\int_{-\infty}^{\bar{\varepsilon}(\theta)} \varepsilon dF(\varepsilon)}{1 - f(\theta)} \\ &= \Phi\left(\beta_0 + \beta_1(1 - f(\theta(p)))\right) + \frac{1}{\beta_1(1 - f(\theta(p)))}\phi\left(\beta_0 + \beta_1(1 - f(\theta(p)))\right).\end{aligned}$$

We still need to find values for the parameters $\beta, l, s, z, \psi, \beta_1$, while β_0 is implied by these variables using

$$\beta_0 = -\frac{1}{\delta}\frac{\psi}{z}\beta_1.$$

These have to be chosen by simultaneously solving a number of restrictions to be explained in the following. First, we need to target the average job-finding rate by setting $f(\theta^*) = 0.14$, where θ^* solves the certainty-equivalent version of the rational expectations functional equation given by (8).

Moreover, I impose that the take-up function matches observed take-up rates for the first and third quantiles of labor market tightness, (θ_1, θ_3), and the take-up rate, (s_1, s_3), respectively:

$$\begin{aligned}s_1 &= \Phi\left(\beta_0 + \beta_1(1 - f(\theta_3))\right) + \frac{1}{\beta_1(1 - f(\theta_3))}\phi\left(\beta_0 + \beta_1(1 - f(\theta_3))\right) \\ s_3 &= \Phi\left(\beta_0 + \beta_1(1 - f(\theta_1))\right) + \frac{1}{\beta_1(1 - f(\theta_1))}\phi\left(\beta_0 + \beta_1(1 - f(\theta_1))\right)\end{aligned}$$

(s_1, s_3) are found from weekly time-series data constructed using ASSD data and corrected for a share of job quitters (who are not able to claim UI before 28 days after quitting) estimated to be 20.6%, yielding $s_1 = 0.36/(1-0.206) = 0.46$ and $s_3 = 0.45/(1 - 0.206) = 0.56$. (θ_1, θ_3), on the other hand, are determined by simulating the model with exogenous take-up using the calibration in Table 3 and determining the quantiles of the resulting distribution of θ. This should be appropriate since Hagedorn and Manovskii (2008a) can closely match empirical moments of the labor market tightness.

In the preceding section we estimated a jump in the take-up rate accompanied by an increase in wages. Using the take-up function, I deduce implied claiming rates k_0 and k_1. Plugging into the wage equation (7), assuming for simplicity that the take-up rate is constant over time, and setting productivity to its steady-state value $p = 1$, we get

$$\frac{w_1}{w_0} = \frac{\beta(p + (1-\lambda)\theta c) + (1-\beta)\left(\ell + s_1 z - (1-\lambda)k_1\psi\right)}{\beta(p + (1-\lambda)\theta c) + (1-\beta)\left(\ell + s_0 z - (1-\lambda)k_0\psi\right)}.$$

In addition, define $\bar{\ell}$ to be the average value of nonmarket activity in the model with variable takeup, to be compared to ℓ in Table 3 for the model with full take-up. After dividing by z, it is given by

$$\frac{\ell}{z} + \bar{s} - (1-\lambda)\bar{k}\frac{\psi}{z} = \frac{\bar{\ell}}{z},$$

where $\bar{s}$ is the average take-up rate chosen to be 0.5063 to match the data $\bar{k}$ is the average claiming rate deduced from the claiming function. I choose $\bar{\ell}$ so as to approximately match the standard deviation of θ obtained in the model with exogenous take-up calibrated as in Table 3.

Table 4 summarizes the calibration I obtain. Note that the additional structure of the model, i.e. the take-up channel and on-the-job search allow us to decrease the average value of nonmarket activity and increase the bargaining power of workers. Given these values, I solve equation (8) numerically for the policy function $\theta(p)$ using the Miranda and Fackler (2002) CompEcon Toolbox in MATLAB. I then simulate 1000 realizations of $\{p_t\}$ of 3600 weeks length. To eliminate the influence of initial conditions, I throw away the first 1200 entries of every trajectory, ending up with 2400 weeks. I then aggregate to the quarterly level, for simplicity taking 12 weeks to be equal to one quarter. This leaves me with 200 quarters, corresponding to 50 years of data.

Time paths for θ_t are found by evaluating the policy function $\theta(p)$. Given an initial value u_0[9], trajectories for the unemployment rates and vacancies are found using (9) and (10).

[9] I use the certainty equivalent steady-state $\frac{\lambda}{\lambda+f(\theta^*)}$. But this should be of negligible importance, given that we get rid of the first 1200 realizations.

Parameter	Definition	Value
β_0	Take-up parameter	-4.749
β_1	Take-up parameter	5.307
ℓ	Value of leisure	0.848
z	UI benefit	0.629
ψ	Take-up cost	0.562
$\overline{\ell}$	Average flow utility	0.932
β	Workers' bargaining power	0.114
l	Matching parameter	0.426
c	Cost of vacancy when $p = 1$	0.584
δ	Discount rate	0.999
λ	Separation rate	0.009
ρ	Persistence of the productivity process	0.990
σ_ε^2	Variance of innovations in productivity process	0.003

Table 4: Baseline calibration

6 Results

Section 3.6 analyzed the impact of the take-up channel theoretically and predicted that it will lead to an increase in volatility of the labor market tightness. However, in deriving the result I assumed a simplified setting with certainty equivalence and constant vacancy costs. Moreover, the result only holds locally, i.e. when the economy with endogenous take-up and the counterfactual with full take-up are shocked in the same state. A different question is how both economies compare over a longer horizon. Eventually, I also want to use the considerations of the previous section in order to assess whether the take-up channel is also economically significant.

The experiment I conduct in the simulation exercise is to choose $\overline{\ell}$ such that the model with endogenous take-up closely matches the volatility in v/u observed in US data as reported by Hagedorn and Manovskii (2008a) (0.259). Setting $\overline{\ell} = 0.933$ results in a standard deviation of v/u that is very close to this target. I will then simulate my baseline model and a model with full take-up and the value of nonmarket activity fixed to $\overline{\ell}$ to concentrate on the net effects of the take-up channel.

Figure 6 plots the policy functions $\theta(p)$ we obtain solving the model with full and endogenous take-up. Clearly, the result that labor market tightness is more elastic in productivity with endogenous take-up carries over to the stochastic case (at least for my parameter constellation, but I tried many other constellations and never received the opposite result) and the difference is sizable.

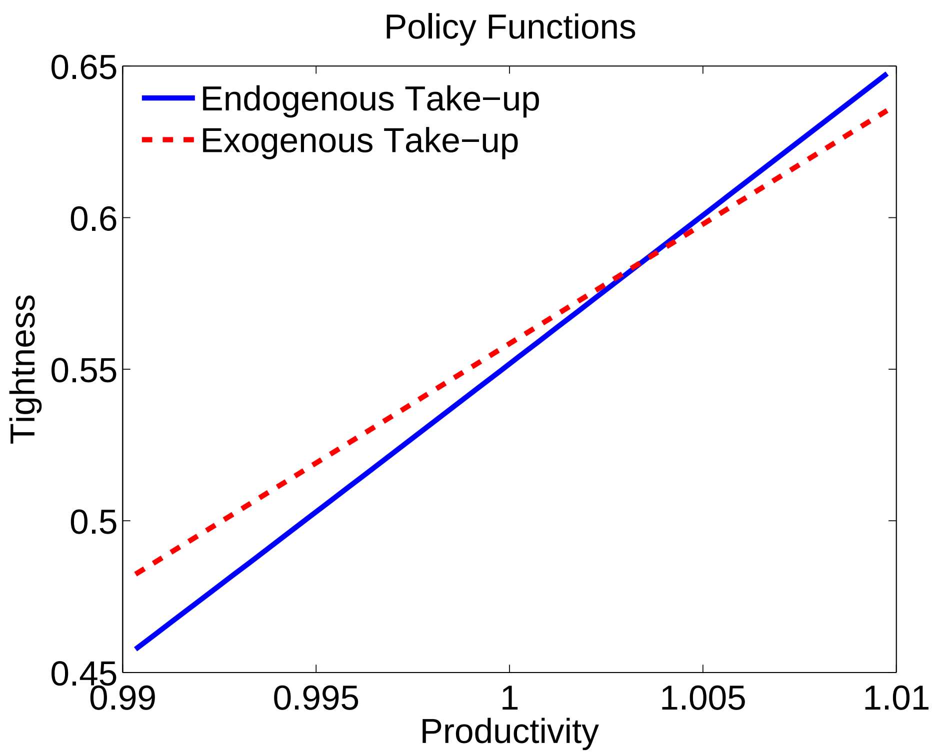

Figure 7: Policy functions

The higher-order moments resulting from a simulation of the models with endogenous and exogenous take-up are summarized in Tables 5 and 6. For reference, I also report summary statistics calculated from US data by Hagedorn and Manovskii (2008a) in Table 7. As expected, the volatilities of all endogenous variables in the model with endogenous take-up clearly exceed those in the model with exogenous take-up, with differences ranging from 26 to 28%. On the other hand, the autocorrelations and cross-sectional correlations are virtually unchanged.

While the former is a basic result of this paper, the latter is an encouraging finding given that the original model already matched autocorrelations and correlations reasonably well. Thus, we can be sure that the take-up mech-

		u	v	v/u	θ	p
Standard deviation		0.139	0.134	0.256	0.237	0.013
Quarterly autocorrelation		0.824	0.599	0.768	0.758	0.759
Correlation matrix	u	1.000	-0.762	-0.941	-0.931	-0.928
	v	–	1.000	0.937	0.946	0.940
	v/u	–	–	1.000	1.000	0.995
	θ	–	–	–	1.000	0.994
	p	–	–	–	–	1.000

Table 5: Results from the model with endogenous take-up

Notes: All variables are reported in logs as deviations from an HP trend with smoothing parameter 1.600. Calibrated parameter values are described in Table 4.

anism, while increasing the volatility of θ and v/u, does not introduce any counterfactual implications elsewhere in the model.

The mechanics behind these results are best understood by looking at the impulse response graphs in Appendix C, depicting the dynamic reaction to a one standard deviation shock in productivity. In both variants of the model, labor market tightness increases on impact. Due to the increased job-finding rate, fewer unemployed find it worthwhile to file for unemployment insurance, leading to a decrease in the take-up rate.

Wages show a combination of different effects. Both wages with full and endogenous take-up are pushed upward due to increased labor market tightness. However, only wages with endogenous take-up are influenced by take-up behavior: Directly on impact, only the term $(1-\lambda)\,k(\theta)\psi$ changes, since s is fixed by last period's claiming behavior. The unemployed face smaller claiming costs on average, increasing workers' outside value, for which workers are compensated.

This upward jump in wages is corrected one period later, once s has decreased. Leaving aside the first period, one can see that the net effect of these two components is negative and hence the wage reacts less strongly than with full take-up[10]. This translates into higher expected discounted profits $\delta\mathbb{E}_p J(p')$. Since in both cases wages rise less than one-to-one with productivity, expected

[10]This does not have to be the case, since θ reacts more strongly with endogenous take-up and wages depend positively on θ, which could overcompensate the effect of take-up.

		u	v	v/u	θ	p
Standard deviation		0.111	0.106	0.189	0.013	
Quarterly autocorrelation		0.824	0.604	0.760	0.760	
Correlation matrix	u	1.000	-0.774	-0.935	-0.933	
	v	–	1.000	0.948	0.945	
	v/u	–	–	1.000	0.996	
	θ	–	–	–	1.000	

Table 6: Results from the model with exogenous take-up

Notes: All variables are reported in logs as deviations from an HP trend with smoothing parameter 1.600. Calibrated parameter values are described in Table 4. In addition, the take-up decision is held fixed at its steady-state value.

		u	v	v/u	p
Standard deviation		0.125	0.139	0.259	0.013
Quarterly autocorrelation		0.870	0.904	0.896	0.765
Correlation matrix	u	1.000	-0.919	-0.977	-0.302
	v	–	1.000	0.982	0.460
	v/u	–	–	1.000	0.393
	p	–	–	–	1.000

Table 7: Summary statistics, quarterly US data, 1951:I to 2004:IV

Notes: Seasonally adjusted unemployment, u, is constructed by the BLS from the Current Population Survey (CPS). The seasonally adjusted help-wanted advertising index, v, is constructed by the Conference Board. Both u and v are quarterly averages of monthly series. Average labor productivity p is seasonally adjusted real average output per person in the nonfarm business sector, constructed by the BLS from the National Income and Product Accounts and the Current Employment Statistics. All variables are reported in logs as deviations from an HP trend with smoothing parameter 1,600.

discounted profits rise and firms have an incentive to increase vacancies until recruiting costs again equal expected discounted profits, translating into higher tightness.

However, since wages react less strongly in the case of endogenous take-up, expected discounted profits increases more strongly, translating into a stronger increase in vacancies and the labor market tightness. Moreover, while the initial spike in wages is an unrealistic artifact of the special assumptions regarding the claiming process, we can see that it has no consequences for the rest of the model. The effect of wages on the rest of the economy works through expected discounted profits. But since firms only react to take-up expected for the subsequent periods, shocks to current take-up leading to spikes in contemporaneous wages are innocuous, which can be seen in the smooth trajectory of expected discounted profits.

7 Conclusion

The aim of this paper was to study in a parsimonious setting how a variable take-up rate can have an impact in general equilibrium. The main contributions of the paper are twofold: On a theoretical level, I came up with a simple and yet realistic way of introducing a take-up decision in a stochastic version of the DMP model. On a practical level, disciplining my calibration using quasi-experimental findings I could demonstrate that the effect can also be quantitatively relevant, with fluctuations increasing by almost 30%. This effect is due to a form of endogenous wage rigidity introduced by a varying take-up rate.

While the model is deliberately parsimonious, I argued that it should hold as an approximation under alternative assumptions. Although this observation is not true for the most important link within the model, the positive association of the take-up rate and wages hinging on the bargaining assumption, I was able to gain robust findings on this exploiting policy discontinuities in Austria.

Of course, this analysis does not claim to give a complete picture of the mechanics of take-up over the business cycle. It just isolated one channel and demonstrated that this channel can be quantitatively relevant, thus showing that take-up is far from a pure partial equilibrium phenomenon. Most importantly, I have assumed exogenous search effort, whereas the interaction of search effort and take-up should be important since take-up influences the search return. A thorough examination of this channel is subject of an ongoing project. However, preliminary results suggest that also through this channel endogenous take-up acts to amplify fluctuations of unemployment and vacancies, since take-up is countercyclical and search effort is higher if no take-up is made.

As a preliminary policy conclusion, fluctuations of aggregates in the labor market could be dampened if access to UI were simplified, making it less sensitive to business cycle fluctuations. However, one has to keep in mind that the setting in this paper is too simple to conduct a thorough normative analysis of the UI system with an endogenous take-up rate. Whether the general conclusions regarding optimal UI would change given the setting adopted in this paper would be an interesting question for future research.

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A Omitted Proofs

PROOF OF LEMMA 1:
Using the same strategy as Hagedorn and Manovskii (2008b), I can write for the surplus under certainty equivalence and a constant c:

$$S = \frac{p - \ell - (s'(\theta)z - (1-\lambda)k(\theta)\psi)}{1 - \delta(1-\lambda)(1 - f(\theta)\beta)}.$$

Plugging this into the free entry condition $c = \delta q(\theta)(1-\beta)S$ and rewriting, we end up with

$$\frac{1 - \delta(1-\lambda)}{\delta q(\theta)} + \beta(1-\lambda)\theta = (1-\beta)\frac{p - \ell - (s'(\theta)z - (1-\lambda)k(\theta)\psi)}{c}. \tag{12}$$

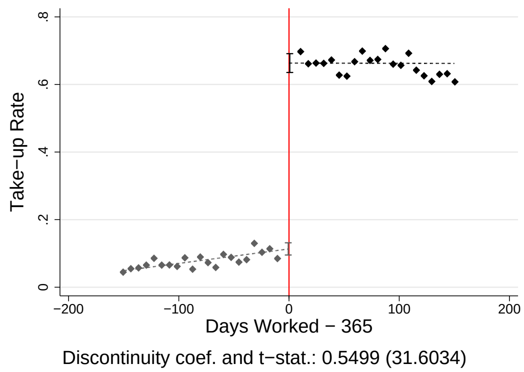
Implicit differentiation yields

$$\begin{aligned}
\frac{\partial\theta}{\partial p} &= \frac{(1-\beta)/c}{\beta(1-\lambda) - \frac{1-\delta(1-\lambda)}{\delta}\frac{\frac{\partial q(\theta)}{\partial\theta}}{q(\theta)^2} + \frac{1-\beta}{c}\left(\frac{\partial s'(\theta)}{\partial\theta}z - \frac{\partial k(\theta)}{\partial\theta}(1-\lambda)\psi\right)} \\
&= \frac{1}{p - \ell - s'(\theta)\left(z - (1-\lambda)\psi\right)}\times \\
&\qquad \frac{\beta(1-\lambda)\theta + \frac{1-\delta(1-\lambda)}{\delta q(\theta)}}{\beta(1-\lambda) - \frac{1-\delta(1-\lambda)}{\delta}\frac{\frac{\partial q(\theta)}{\partial\theta}}{q(\theta)^2} + \frac{1-\beta}{c}\left(\frac{\partial s'(\theta)}{\partial\theta}z - \frac{\partial k(\theta)}{\partial\theta}(1-\lambda)\psi\right)} \\
&= \frac{\theta}{p - \ell - s'(\theta)\left(z - (1-\lambda)\psi\right)}\times \\
&\qquad \frac{\beta(1-\lambda)\theta q(\theta) + \frac{1-\delta(1-\lambda)}{\delta}}{\beta(1-\lambda)\theta q(\theta) - \frac{1-\delta(1-\lambda)}{\delta}\frac{\frac{\partial q(\theta)}{\partial\theta}}{q(\theta)}\theta + \frac{1-\beta}{c}\left(\frac{\partial s'(\theta)}{\partial\theta}z - \frac{\partial k(\theta)}{\partial\theta}(1-\lambda)\psi\right)\theta q(\theta)} \\
&= \frac{\theta}{p - \ell - s'(\theta)\left(z - (1-\lambda)\psi\right)}\times \\
&\qquad \frac{\beta(1-\lambda)f(\theta) + \frac{1-\delta(1-\lambda)}{\delta}}{\beta(1-\lambda)f(\theta) + (1-\eta_f)\frac{1-\delta(1-\lambda)}{\delta} + \frac{1-\beta}{c}q(\theta)\left(s'(\theta)z\eta_s - (1-\lambda)k(\theta)\psi\eta_k\right)},
\end{aligned}$$

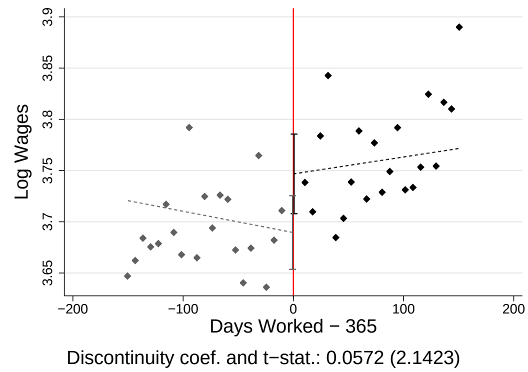
where I substitute from (12) in the second equality, expand by $\theta q(\theta)$ in the third equality and use $\eta_f = 1 - \frac{\partial q(\theta)}{\partial \theta}\frac{\theta}{q(\theta)}$ in the fourth equality. Hence

$$\begin{aligned}
\varepsilon_{\theta,p} &= \frac{\partial \theta}{\partial p}\frac{p}{\theta} \\
&= \frac{p}{p - \ell - s'(\theta)\left(z - (1-\lambda)\psi\right)} \times \\
&\qquad \frac{\beta(1-\lambda)f(\theta) + \frac{1-\delta(1-\lambda)}{\delta}}{\beta(1-\lambda)f(\theta) + (1-\eta_f)\frac{1-\delta(1-\lambda)}{\delta} + \frac{1-\beta}{c}q(\theta)\left(s'(\theta)z(-\eta_s) - (1-\lambda)k(\theta)\psi(-\eta_k)\right)}.
\end{aligned}$$

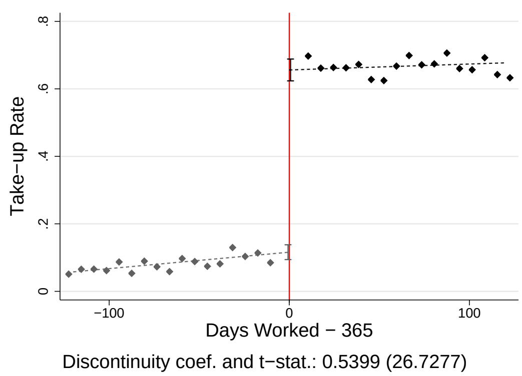
B Regression Discontinuity Estimates



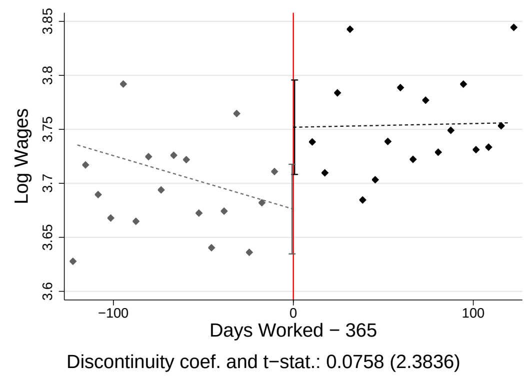
(a) Take-up (bandwidth 150 days)



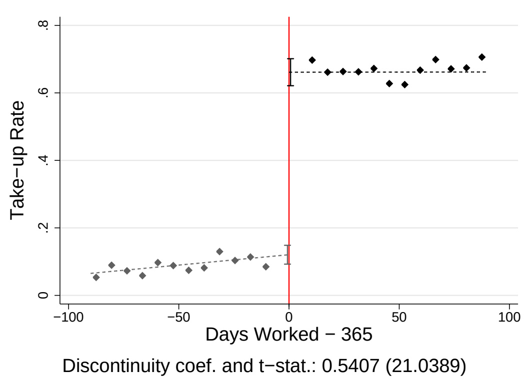
(b) Wages (bandwidth 150 days)



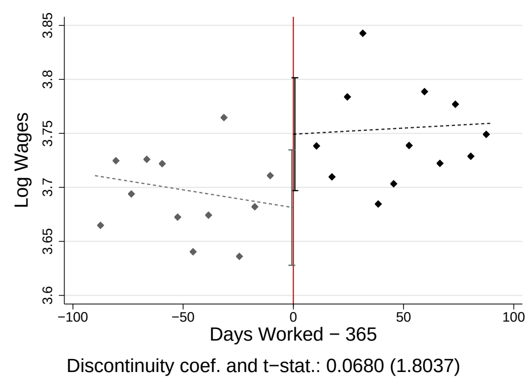
(c) Take-up (bandwidth 120 days)



(d) Wages (bandwidth 120 days)

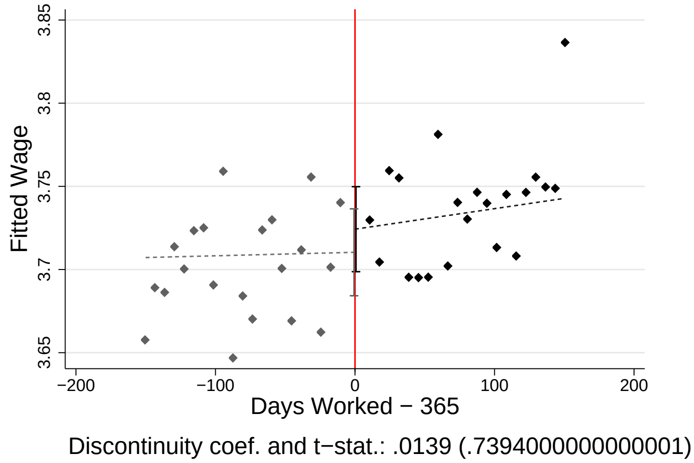


(e) Take-up (bandwidth 90 days)

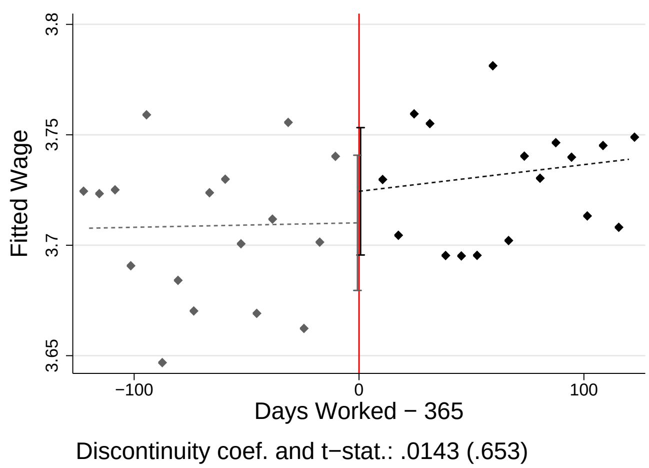


(f) Wages (bandwidth 90 days)

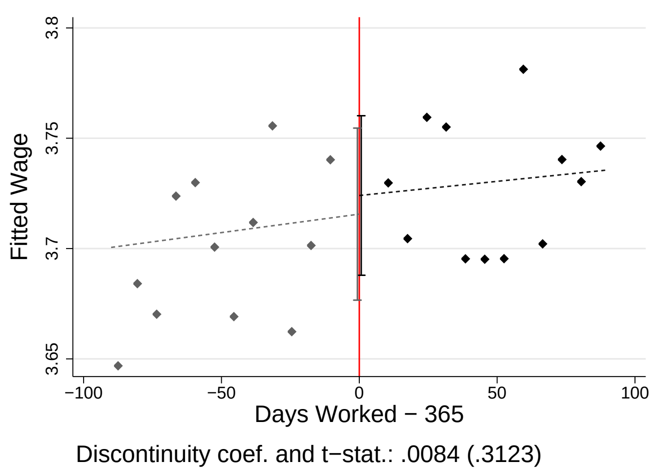
Figure 8: Log wages, take-up and normalized days worked for different bandwidths



(a) Bandwidth 150 days



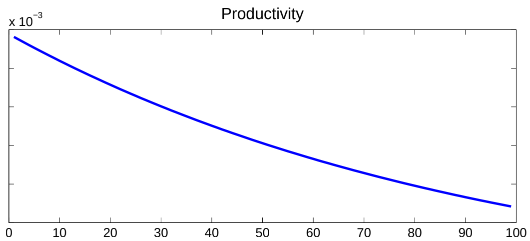
(b) Bandwidth 120 days



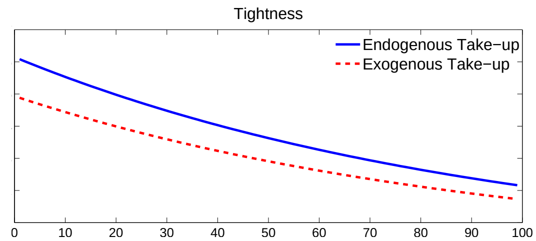
(c) Bandwidth 90 days

Figure 9: Fitted values from a wage regression for different bandwidths

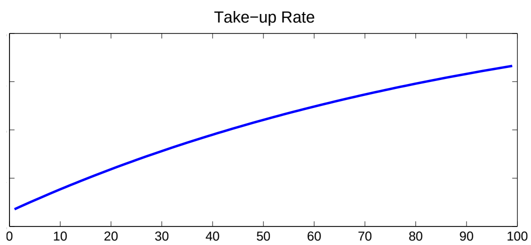
C Impulse Response Graphs



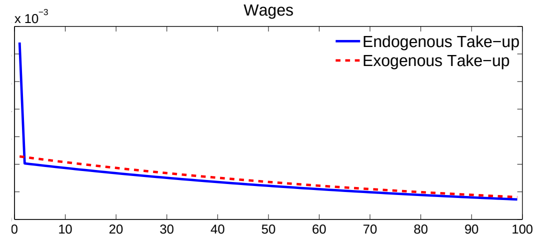
(a) Productivity



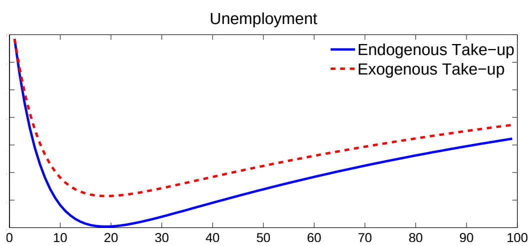
(b) Tightness



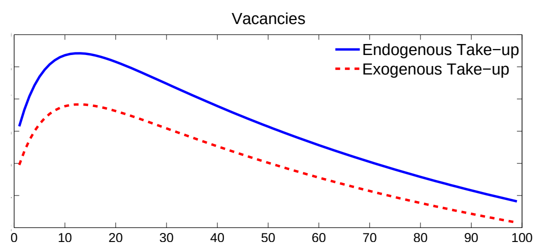
(c) Take-up Rate



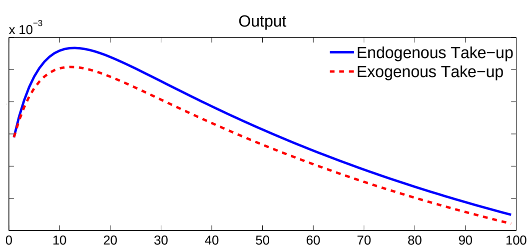
(d) Wages



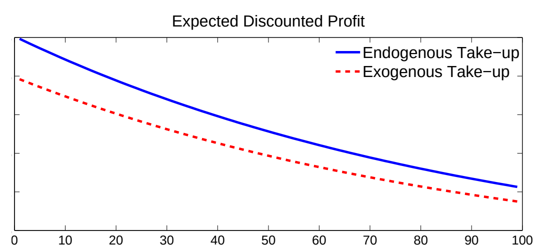
(e) Unemployment



(f) Vacancies



(g) Output



(h) Expected Discounted Profit

One standard deviation shock in p. Initial values are set to their steady state values. Figures show percentage differences from initial value.

Figure 10: Impulse response graphs