Reservation wages and the wage flexibility puzzle

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Abstract
Wages are only mildly cyclical, implying that shocks to labour demand have a larger short-run impact on unemployment rather than wages, at odds with the quantitative predictions of the canonical search and matching model. This paper provides an alternative and informative perspective on the wage flexibility puzzle, which explains why the canonical model can only match the observed cyclicality of wages if the replacement ratio is implausibly high. We show that this failure remains even if wages are only occasionally renegotiated, unless the persistence in unemployment is implausibly low. We then provide some evidence that part of the problem comes from the implicit model for the determination of reservations wages. Estimates for the UK and West Germany provide evidence that reservation wages are much less cyclical than predicted even conditional on the observed level of wage cyclicality. We present some evidence that elements of perceived “fairness” or “reference points” in reservation wages may address this model failure.

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1. Introduction

Empirical evidence suggests that real wages are only mildly pro-cyclical. For example, Blanchflower and Oswald (1994) conclude that, once one controls for the characteristics of workers, the elasticity of wages with respect to the unemployment rate is -0.1. Although this estimate should not be thought of as a universal constant (see, for example, the review by Card, 1995), most existing estimates are not very far from this benchmark, and the meta-analysis of Nijkamp and Poot (2005) reports a mean estimated elasticity of -0.07. This modest pro-cyclicality in wages explains why shocks to labour demand have a larger short-run impact on unemployment rather than wages.

In recent years most business cycle analysis of labour markets has used the currently dominant model of equilibrium unemployment – the search and matching framework developed by Diamond, Mortensen and Pissarides (see, Pissarides, 2000, for an overview). This model offers undoubtedly valuable insight in interpreting labour markets, but the quantitative predictions of the specific models used have difficulty in matching relatively mild wage cyclicity and relatively large unemployment fluctuations for plausible productivity shocks (see Shimer, 2005, and Rogerson and Shimer, 2011, for an overview).

In this paper, we first present an alternative perspective on the wage flexibility puzzle. We use a conventional search and matching framework to derive a relationship between wages and unemployment (or other measures of labour market tightness) that, under plausible assumptions, is not shifted by demand shocks. Demand shocks – independent of their source or magnitude – must then be associated with movements along this curve, and the elasticity of the ‘wage curve’ that we estimate determines the relative volatility of wages and unemployment over the business cycle. Our approach has a natural analogy in a perfectly competitive labour market model, in which the labour supply curve would not be shifted by labour demand shocks. Similarly, it is widely believed that the labour supply elasticity is not sufficient to explain the modest pro-cyclicality in real wages.

Secondly, we use this ‘wage curve’ to show that the model can only predict the modest observed pro-cyclicality in wages if replacement ratios are extremely high (see also Hagedorn and Manovskii, 2008). This problem is most severe in the version of the canonical model with continual wage re-negotiation. However, we also consider the case in which wages are only infrequently re-negotiated, implying higher wage cyclicity on new, rather than continuing, matches (Hall, 2005, Pissarides, 2009, Haefke, Sonntag and Rens, 2008). This extension ameliorates the quantitative predictions of the model, but a sizeable gap with respect to empirical estimates remains, unless one assumes implausibly low persistence in the unemployment rate.

The most common response to this problem is to alter the model of wage determination, typically by introducing some degree of wage rigidity: for example a backward-looking component in wages (see, for example, Hall, 2005, Gertler and Trigari, 2009; Gertler, Sala and Trigari, 2008, Shimer 2010, Rogerson and Shimer, 2011), or a different disagreement point in wage bargaining (Hall and Milgrom, 2008). Wage rigidity improves the performance of the search and matching models considerably – see, for example, Shimer (2011, 2013) or

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1 Failure to control for characteristics typically makes wages appear even less cyclical because unemployment in recessions tends to fall most heavily on less-skilled workers, making the skill composition of employment mildly counter-cyclical.
Michaillat (2012). But this paper argues that rigidity in wage-setting may not be the only source of the wage flexibility puzzle – this derives partly from the behaviour of reservation wages, which are less flexible than the theory predicts.

We show that one can decompose the wage curve we derive from the canonical model into two parts. The first is derived from wage bargaining and relates the bargained wage to the reservation wage and the mark-up of wages over outside options. The second part is derived from the behaviour of the unemployed, and relates the reservation wage to labour market conditions. In a recession, the value of having a job rises relative to the value of being unemployed, and as a result reservation wages should fall. We show that the canonical model predicts that reservation wages should be at least as cyclical as wages in new jobs.

We provide estimates of the cyclicality of wages and reservation wages for the UK and West Germany using micro data from the BHPS and the GSOEP, respectively. These are the only two known sources of information on (self-reported) reservation wages, which cover at least one full business cycle. Our estimates for the elasticity of wages and reservation wages to aggregate unemployment are about -0.17 and -0.16, respectively, for the UK, and we obtain slightly lower elasticities for West Germany. We do find some evidence that wages in newly-formed matches are more cyclical than wages in continuing matches. This is consistent with infrequent wage negotiation on a given job, and with previous estimates reported by Pissarides (2009). But even the higher elasticity in new jobs can be reconciled with the theory if unemployment is much less persistent than in the data. We also present evidence that reservation wages are less cyclical than the canonical model predicts.

Why are reservation wages less cyclical than the canonical model predicts? We show that allowing for on-the-job search or hyperbolic discounting does little to resolve the problem. We finally provide evidence that reservation wages are influenced by ‘reference points’, consistent with the view that the wages that are acceptable to workers have considerable rigidity to them and are plausibly influenced by what is perceived as ‘fair’ (e.g. Akerlof and Yellen, 1990, Falk Fehr and Zehnder, 2006). Reference points in reservation wages imply markedly lower cyclicality in reservation wages than predicted by the canonical model.

The paper is organized as follows. Section 2 derives a “wage curve” from the canonical search and matching model, and highlights quantitative implications for elasticity of wages with respect to the unemployment rate. Section 3 presents estimates of wage curves for the UK and West Germany showing that the wage elasticity can only be reconciled with the theory if replacement ratios are implausibly high. Section 4 then illustrates the determination of the reservation wage, derives model predictions for the cyclicality of reservation wages and shows that this is much larger than what is observed. Thus the data is inconsistent with implications of the canonical model for reservation wages determination. Section 5 discusses possible alternatives to the canonical model that would deliver less cyclical reservation wages, and argues that reference points are possibly the most promising approach and present some empirical evidence for their importance. Section 6 concludes.

2. The cyclicality of wages in the canonical model
This section presents the implications of the canonical search and matching model for the cyclicality of wages. An important recent line of research has argued that the distinction between the cyclicality of wages in new and continuing jobs is critical (see for example Pissarides, 2009), and this distinction only has consequences when the economy is not always in a steady-state. We therefore consider a model in which the economic environment is changing over time. In the interests of simplicity we assume there is no heterogeneity in workers or jobs.

We model the distinction between new and continuing jobs by assuming that wages in all new jobs are re-negotiated using the standard surplus sharing rule, but re-negotiation opportunities only arrive in existing matches at a rate \( \phi \), leading to a staggered wage setting process à la Calvo (1983). This approach is similar in spirit to Gertler and Trigari (2006), although they assume that some new matches are made at ‘old’ wages, whereas we assume that wages are negotiated in all new matches.

If the wage in an existing match is re-negotiated, we assume that the previous wage has no influence on the outcome of the wage bargain, i.e. neither the firm nor the worker have the option to continue the match at the old wage. This means that the value of a job is determined solely by the current time, \( t \), and the time, \( \tau \), at which the wage was last negotiated.

A. Employers

Each firm has one job, which can be either filled and producing or vacant and searching. The value function for a vacant job at time \( t, V(t) \), is given by:

\[
rV(t) = -c(t) + q(t)[J(t;w_n(t)) - V(t) - C(t)] + E_r \frac{\partial V(t)}{\partial t},
\]

(1)

where \( J(t;w) \) is the value of a filled job at time \( t \) that pays a wage \( w \), and \( w_n(t) \) is the wage negotiated at time \( t \). Following Pissarides (2009) and Silva and Toledo (2009), we allow the cost of a vacancy to include both a per-period cost, \( c(t) \), and a fixed cost (e.g. a training cost), \( C(t) \). In the literature these costs are sometimes indexed to productivity shocks or to wages, and we return to this issue later. For the moment we simply allow both components of the vacancy cost to be potentially time-varying, and the important assumption is that they are exogenous to the individual firm. Finally, \( q(t) \) is the rate at which vacancies are filled at time \( t \). The notation chosen allows it to vary over time (typically with shocks, and possibly only via the impact of shocks on labour market tightness), and further detail about the source of the time variation is not needed.

The value of a filled job that pays a wage \( w \) at time \( t \) is given by:

\[
rJ(t;w) = p(t) - w - s[J(t;w) - V(t)] + \phi[J(t;w_n(t)) - J(t;w)] + E_r \frac{\partial J(t;w)}{\partial t},
\]

(2)

\( \phi \) We assume renegotiation opportunities arrive exogenously at rate \( \phi \), not triggered by a threatened separation caused by a demand shock. This amounts to assuming that demand shocks never cause the surplus in continuing matches to become negative. Allowing for this possibility would induce an extra source of cyclicality as it implies more frequent renegotiation in recessions.

\( \phi \) Even this could be relaxed, but this would require more notation for little extra insight.
where \( p(t) \) denotes the productivity of a job-worker pair, and is the ultimate source of shocks, \( s \) is the exogenous rate at which jobs are destroyed, and \( \phi \) is the rate at which wages are re-negotiated. The second term in square brackets represents the capital gain (or loss) from wage re-negotiation in continuing jobs. Free entry of vacancies ensures \( V(t) = 0 \) at each point in time, so that (1) can be re-arranged to give:

\[
J(t; w_n(t)) - V(t) = C(t) + \frac{c(t)}{q(t)},
\]

i.e. the value of a newly-filled job at the current negotiated wage equals the expected cost of filling a vacancy.

**B. Workers**

Workers can be either unemployed and searching or employed and producing. The value of being unemployed at time \( t \) is given by:

\[
rU(t) = z + \lambda(t)[W(t; w_n(t)) - U(t)] + E_t \frac{\partial U(t)}{\partial t},
\]

where \( z \) is the flow of utility when unemployed (assumed to be fixed in the short-run\(^4\)), \( W(t; w) \) is the value at time \( t \) of a job that pays a wage \( w \), and \( \lambda(t) \) is the rate at which the unemployed find jobs, which is allowed to vary over time (possibly only because labour market tightness varies over time).

The value of being employed at a wage \( w \) is given by:

\[
rW(t; w) = w + \phi[W(t; w_n(t)) - W(t; w)] - s[W(t; w) - U(t)] + E_t \frac{\partial W(t; w)}{\partial t},
\]

where the notation embodies the assumption that a re-negotiated wage will be at the level \( w_n(t) \).

**C. Wage determination**

We use the conventional rent-sharing condition that a wage negotiated at time \( t \), \( w_n(t) \), is set to maximize:

\[
[W(t; w) - U(t)]^\beta \left[ J(t; w) - V(t) \right]^{1-\beta},
\]

which can be written as:

\[
(1-\beta) \frac{\partial J(t; w)}{\partial w}[W(t; w_n(t)) - U(t)] + \beta \frac{\partial W(t; w)}{\partial w} \left[ J(t; w_n(t)) - V(t) \right] = 0.
\]

Value functions (2) and (5) imply \( \frac{\partial W(t; w)}{\partial w} = -\frac{\partial J(t; w)}{\partial w} \), so that (7) can, using (3), be written way as:

\(^4\text{Chodorow-Reich and Karabarbounis (2013) argue that } z \text{ is pro-cyclical. Introducing this would obviously make wages even more pro-cyclical, making it even harder for other elements of the model to explain the wage flexibility puzzle.} \)
This wage setting condition states that the value of being employed is a mark-up – denoted by \( \mu(t) \) – over the value of being unemployed. This type of ‘mark-up’ wage curve can be derived from alternative models of wage determination (e.g. the efficiency wage model of Shapiro and Stiglitz, 1985, or the model of Elsby and Michaels, 2013, in which labour demand is downward sloping due to concavity of the production function), and the results that follow might be thought to have more general applicability than the specific model presented here.\(^5\) Note also that past conditions do not feature in (8), but expected future conditions do. Thus we refer to the wage-setting relationship in (8) as a forward-looking, mark-up wage equation.

Combining workers’ value functions (4) and (5) yields:

\[
W(t; w) - U(t) = \left[ \frac{w - z - (\phi + s)[W(t; w) - U(t)]}{r + \phi + s} + E, \frac{\partial W(t; w) - U(t)}{\partial t} \right] + (\phi - \lambda(t)) W(t; w) - U(t) + E, \frac{\partial W(t; w) - U(t)}{\partial t} \right),
\]

where the second equality follows from (8). The differential equation in (9) has solution:

\[
W(t; w) - U(t) = \frac{w - z}{r + \phi + s} + E, \int_0^\infty e^{-(r + \phi + s)(t - \tau)} (\phi - \lambda(t)) \mu(t) d\tau.
\]

Using (8), the wage setting condition (10) can be re-arranged to derive the following closed-form solutions for wages negotiated at time \( t \):

\[
w_n(t) = z + (r + \phi + s) \left[ \mu(t) - E, \int_0^\infty e^{-(r + \phi + s)(\tau - \tau)} (\phi - \lambda(t)) \mu(t) d\tau \right].
\]

To understand the workings of the model, it is easiest to start with the simplest case of a static steady-state.

D. The static steady state

Assume the economy is in steady-state, i.e. current labour market conditions are expected to persist for ever. In this case (16) reduces to a very simple wage curve:

\[
w = z + \mu(r + \lambda + s).
\]

In the comparison of steady-states, there are two reasons why wages may be procyclical. First, \( \lambda \), the outflow rate from unemployment, is higher when unemployment is lower, making wages pro-cyclical. Secondly, the mark-up, \( \mu \), may be pro-cyclical. From (8) there are a number of reasons why this might be the case. First, wages will be pro-cyclical if there is a flow element to the cost of filling vacancies (\( c > 0 \)), which rises when unemployment is low as vacancy durations rise (i.e. \( q \) falls). Secondly, the vacancy costs themselves (\( c \) and

\(^5\) This also means that if the model does fit the data one should be cautious about assuming that the model is correct.
may vary, and the literature sometimes indexes them to productivity (see, for example, Pissarides, 2000) or to the level of wages (Hagedoorn and Manovskii, 2008, do both). The indexing of vacancy costs to either productivity or wages makes the mark-up pro-cyclical, and this accentuates the pro-cyclicality in wages.

As one of the aims of this paper is to show why it is hard for this type of model to generate the modest observed levels of cyclical in wages, in what follows we assume that the mark-up is acyclical. We would justify this on the grounds that most studies of the costs of filling jobs find the fixed cost component to be more important than the variable cost, so we assume \( c = 0 \) and that the fixed costs do not vary with short-term fluctuations in productivity and/or wages.\(^6\) These assumptions imply that \( \mu \) is a constant.

The empirical literature on the wage curve typically relates wages to the unemployment rate. We can use the definition of the steady-state unemployment rate \( u, \)

\[
\frac{s}{(s + \lambda)}
\]

\( w = z + \mu \left( r + \lambda + s \right) = z + \mu \left( r + \frac{s}{u} \right). \tag{13}
\]

The wage curve in (13) offers some interpretation advantages over the traditional wage setting condition of the search and matching model. It can be thought of as akin to a labour supply curve in a competitive model, in the sense that demand shocks do not feature in the wage curve and simply drive movements along the curve. The relative variation of wages and unemployment is given by (13), independent of the source or size of the shocks to labour demand, allowing us to be agnostic about their source and to evaluate the model without having to measure demand shocks, something which is often problematic.\(^7\)

Differentiating (13) under the assumption of a constant mark-up gives the elasticity of wages with respect to the unemployment rate across steady-states:

\[
\frac{\partial \ln w}{\partial \ln u} = -\frac{\mu s}{wu} = -\frac{w - z}{w} \left( \frac{s}{ru + s} \right) = -(1 - \eta) \left( \frac{s}{ru + s} \right), \tag{14}
\]

where \( \eta \equiv z / w \) is the replacement ratio. Because \( s \) is substantially larger than \( ru \) for conventional values of the interest rate,\(^8\) the term in square brackets is close to 1, and (14) implies that the elasticity of wages with respect to the unemployment rate should be close to one minus the replacement ratio. Using the Blanchflower and Oswald (1994) benchmark estimate for the elasticity of 0.1, the model requires a replacement ratio of 0.9, a value too

\(^6\) Of course, one has to assume that the vacancy cost is in the medium-run linked to productivity and/or wages as otherwise continued growth would make the vacancy filling costs less and less important. And in steady-state comparisons there is no distinction between short- and long-run linkages. But for the other models considered in this paper this is not a problem.

\(^7\) For example, the most common current approach seeks to explain the reduced-form response of endogenous variables like wages and unemployment to the measured average product of labour, which is assumed to be an exogenous shock. But, as pointed out by Rogerson and Shimer (2011), a drawback of this approach is that a Cobb-Douglas production function with decreasing returns to labor will always deliver proportionality between average labor productivity and the wage, though causation may run from the latter to the former.

\(^8\) Though it may be argued that the unemployed have limited access to credit so that the relevant interest rate for them is the one offered by payday lenders – in the UK this is currently a monthly rate of 36%. This rate of interest could explain why wages are not very responsive to unemployment but, as we discuss later in the paper, would then fail to explain why reservation wages are strongly correlated with expected wages.
high to be plausible and implying a huge sensitivity of unemployment to changes in the generosity of unemployment insurance (Costain and Reiter, 2008). Unless one is going to make assumptions that make the replacement ratio extremely high, the canonical model would fail to fit the data well.

While a replacement ratio of 0.9 is arguably implausible, it is not straightforward to obtain estimates of flow utility during unemployment, encompassing unemployment compensation and the utility of leisure while unemployed, net of job search costs. The OECD Benefits and Wages Statistics (http://www.oecd.org/els/benefitsandwagesstatistics.htm) show the proportion of net in-work income that is maintained when a worker becomes unemployed, by household composition and unemployment duration. In 2001, the overall average of this ratio across worker types in the U.K. and West Germany was 0.42 and 0.63, respectively. While there is no direct evidence on the value of leisure during unemployment or search costs, the empirical literature on the determinants of individual well-being has long identified a strong detrimental impact of unemployment on subjective well-being, even conditional on household income (see, among others, Winkelmann and Winkelmann, 1998; Clark, 2003; Kassenboehmer and Haisken-DeNew, 2009). This evidence points at large non-pecuniary effects of unemployment, and implies that benefit-to-income ratios would provide a rather generous upper bound for true replacement ratios. Later in the paper we also show how the ratio of expected to reservation wages is also inconsistent with a replacement ratio of 0.9.

E. Out of steady state

Under a constant mark-up $\mu$, the wage equation in (11) can be written as:

$$w_n(t) = z + \mu \left[ (r + s) + (r + \phi + s) E_t \int_0^\infty e^{-(r+\phi+s)(\tau-t)} \lambda'(\tau) d\tau \right],$$

(15)

stating that the current negotiated wage is a mark-up over the outside option, $z$, and such mark-up is influenced by future expected labour market conditions, $E_t \lambda(\tau)$. Labour market conditions in the near future carry a higher weight than those in the distant future, with the weight depending negatively on the interest rate, $r$, and positively on the expected duration of the current negotiated wage. This is inversely related to the separation rate, $s$, and the renegotiation rate, $\phi$. Note that wage determination is entirely forward-looking, i.e. existing wages in the labour market play no role in it, because there is no prospect for a worker of getting a job at a pre-existing wage – all new jobs will be at newly-negotiated wages.

Integrating (15) by parts finally gives:

$$w_n(t) = z + \mu \left[ (r + \lambda(t) + s) + E_t \int_0^\infty e^{-(r+\phi+s)(\tau-t)} \lambda'(\tau) d\tau \right],$$

(16)

implying that the current wage is influenced by current labour market conditions $\lambda(t)$ and expected changes in those conditions $E_t \lambda'(\tau)$.

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9 There may various ways to deliver a high replacement ratio, e.g. assuming that $z$ is close to $p$, or that worker’s bargaining power is very small. These different approaches may help or hinder the model in fitting the data in other directions.
F. Continuous wage re-negotiation

A special case of interest is the one in which wages are continuously re-negotiated ($\phi = \infty$). In this case the wage equation reduces to (12): when wages are continuously re-negotiated it is only the contemporaneous unemployment rate that matters for wage determination.\(^\text{10}\) The assumption that the economy is in steady state is not needed to derive this result, and this version of the model would have the same difficulty as the steady-state model in fitting the empirical data.

These issues with the canonical model are well-known. It has recently been argued (Hall, 2005, Pissarides, 2009, Haefke, Sonntag and Rens, 2008) that it is the cyclicality of wages on new hires that the theory has predictions about, and that this cyclicality is higher than the cyclicality of all wages (e.g. see Devereux and Hart, 2001). Our framework can address whether this solves the wage flexibility puzzle by considering the effect on the wage curve of occasional re-negotiation of the wage.

G. Occasional wage renegotiation

When wage negotiation is infrequent, set wages are expected to last for multiple periods, characterized by varying labour market conditions. Thus we need to make assumptions about the expected future path of job finding rates. We make the simplest assumption and that the expected path of $\lambda(t)$ can be approximated by the continuous time version of an AR(1) process:

$$E_t(\lambda(\tau)|\lambda(t)) = e^{-\xi|\tau-t|}\lambda(t) + [1-e^{-\xi|\tau-t|}]\lambda^*, \quad (17)$$

where $\lambda^*$ is the steady-state value of $\lambda$ and $\xi$ represents the rate of convergence to it, with higher values of $\xi$ implying lower persistence. Note that expression (17) is valid for any $\tau$, higher or lower than $t$, a property which will be useful below. Using (17), (15) can be written as:

$$w_n(t) = z + \mu \left[ (r + \lambda^* + s) + \frac{r + \phi + s}{r + \phi + s + \xi} (\lambda(t) - \lambda^*) \right]$$

$$= z + \mu \left[ (r + \frac{s}{u^*}) + \frac{r + \phi + s}{r + \phi + s + \xi} \frac{s}{u(t)} - \frac{s}{u^*} \right] \quad (18)$$

$$= z + \mu \left[ (r + \frac{s}{u^*}) + \gamma \left( \frac{s}{u(t)} - \frac{s}{u^*} \right) \right],$$

where $\gamma = \frac{r + \phi + s}{r + \phi + s + \xi} \leq 1$. The earlier special cases considered give $\gamma = 1$, and (18) reduces to (12).

\(^{10}\) There is an approximation here: out-of-steady state there is no longer a one-to-one mapping between $\lambda$ and $u$. But as Shimer (2005) has shown the difference between the two is tiny in practice, and understanding is greatly aided by ignoring it.
Differentiation of (18), and evaluating at $u(t)=u^*$, leads to the following expression for the elasticity of wages negotiated at time $t$ to contemporaneous unemployment:

$$\frac{\partial \ln w_a(t)}{\partial \ln u(t)} = -\frac{\mu \gamma s}{w^* u^*} = -(1-\eta^*) \frac{\gamma s}{ru^* + s} \approx -\gamma (1-\eta^*) \quad (19)$$

As $\gamma < 1$, the model now predicts a lower sensitivity of currently negotiated wages to current unemployment than in the case of continual re-negotiation. How much lower depends on the persistence in labour market conditions and the frequency of wage re-negotiation. The intuition for the lower sensitivity is simple. With negotiated wages that are expected to last a long time, but current labour market conditions that are not, negotiated wages are less sensitive to current conditions and will also be influenced by future expected conditions.

One might expect that the model of occasional wage re-negotiation comes closer to the data both because empirically wages in new jobs are found to be more sensitive to current unemployment than old jobs (e.g. Devereux and Hart, 2001), and because the target sensitivity implied by (19) is lower than in (14).

The discussion has so far focused on the sensitivity of newly-renegotiated wages to current unemployment, but the focus of most of the empirical literature in this area is the sensitivity of all wages to unemployment. Let us denote the average wage at time $t$ by $w_a(t)$. This is an average of wages negotiated at different points in time in the past. The distribution of jobs with wages last negotiated $\tau$ periods ago depends on the number of jobs that had wages re-negotiated at $\tau$, which have not subsequently been destroyed or had their wages re-negotiated. Out of a steady state this is quite complicated, but if we assume that the distribution of the time of renegotiation is the same as in a steady-state in which the flow of hires and the unemployment rate is constant, such distribution is exponential with parameter $s + \phi$. Using this result and the first line in (18) yields:

$$w_a(t) = z + \mu \left[ (r + \lambda^* + s) + \gamma \int_0^\infty (s + \phi) e^{-(s+\phi)\tau} \left( \lambda(t-\tau) - \lambda^* \right) d\tau \right]$$

i.e. current average wages are correlated not just with current labour market conditions but with past labour market conditions. So we would expect lagged unemployment to have explanatory power in wage curve estimates (Beaudry and diNardo, 1991; Hagedorn and Manovskii, 2013). But if one only regresses current average wages on current unemployment, the estimated effect of unemployment is driven by its persistence over time, as wages negotiated in the past are correlated with past unemployment. Using (17):

$$E_t \left( w_a(t) \mid \lambda(t) \right) = z + \mu \left[ (r + \lambda^* + s) + \gamma \frac{s + \phi}{s + \phi + \xi} \left( \lambda(t) - \lambda^* \right) \right]$$

$$= z + \mu \left[ (r + \frac{s}{u^*}) + \gamma \frac{s + \phi}{s + \phi + \xi} \left( \frac{s}{u(t)} - \frac{s}{u^*} \right) \right].$$

Differentiating this gives us the following expression for the sensitivity of the current average wage to current unemployment:

$$\frac{\partial \ln w_a(t)}{\partial \ln u(t)} = -(1-\eta^*) \frac{\gamma s}{ru^* + s} \approx -\gamma^2 (1-\eta^*), \quad (22)$$
where the final approximation comes from setting $r$ to zero. Expression (22) implies that the model now predicts that the average wage is even less sensitive to current unemployment than the wage in new jobs, and the ratio in sensitivity is $\gamma$. We next consider whether these predictions are empirically plausible.

3. **Empirical wage curves**

   A. **Wage curve estimates**

   In the empirical part of this paper we use two data sets - British data from the British Household Panel Study (BHPS) and West German data from the German Socioeconomic Panel (GSOEP). These are both longitudinal studies, running from 1991 to 2009 and from 1984 to 2010, respectively. The advantage of these data sets is that they both contain information on reservation wages over a long period of time, something we turn to later in the paper.

   We start by providing estimates of wage curves in line with the literature which gained momentum following the publication of Blanchflower and Oswald (1994). The typical approach in this literature regresses the (log of) hourly wages on the usual set of individual covariates and the (log) unemployment rate or some alternative indicator of the business cycle. Blanchflower and Oswald (1994) provide estimates of this specification for several OECD countries, and suggest – as an “empirical law in economics” – a remarkably stable elasticity of real wages to the unemployment rate of -0.1. Their work has been extended to cover more recent US evidence by Devereux (2001), Hines, Hoynes and Krueger (2001) and Blanchflower and Oswald (2005).

   Bell, Nickell and Quintini (2002) provide wage curve estimates for the UK, and obtain a short-run elasticity of wages to unemployment around 0.03, and long-run elasticities varying between 0.05 and 0.13. Further work for the UK has found that the sensitivity of wages to unemployment has increased over recent decades (Faggio and Nickell, 2005, and Gregg, Machin and Salgado, 2014), and that wages of job movers are more procyclical than wages of job stayers (Devereux and Hart, 2006). For West Germany, Blanchflower and Oswald (1994) provide estimates for the elasticity of wages to unemployment between -0.1 and -0.2 using ISSP data, and Wagner (1994) finds elasticities between 0 and -0.09 using GSOEP data, and slightly higher estimates up to -0.13 in IAB surveys. More recent work by Baltagi, Blien and Wolf (2009) estimates dynamic specifications on IAB data and finds elasticities significantly lower than -0.1. Ammermueller et al. (2010) use data from the German micro census and suggest a -0.03 upper bound for the elasticity in empirical specifications that are closest to ours.

   Our empirical specification for the wage equation is in line with the wage bargaining model of Section 2, and controls for the usual demographics that influence wages, as well as a measure of the unemployment rate.

   Wage curves estimated for the US typically use the state-level unemployment rate as the measure of the cycle, and include both year and state fixed effects. This is a feasible empirical strategy because state level unemployment rates do not show high persistence (Blanchard and Katz, 1992, Hines, Hoynes and Krueger, 2001). But in both the UK and
West Germany, regional unemployment differentials are very persistent, making it impossible to identify any cyclicity in wages if both time and region fixed effects are included. As a result, our baseline specifications use national unemployment as the business cycle indicator. This obviously means that we cannot also include unrestricted year effects in the regression so we model underlying productivity growth by a linear or quadratic trend. We later present estimates based on regional unemployment – these results typically show even less cyclicity in wages, though the estimates suffer from a lack of precision.

Our working sample includes all employees aged 16-65, with non-missing wage information. Descriptive statistics for our wage samples are reported in Table A1 for both the BHPS and the GSOEP. Results for the UK are presented in Table 1. The dependent variable is the log hourly gross wage, deflated by the aggregate consumer price index. All specifications control for individual characteristics (gender, age, education, job tenure and household composition) and region fixed-effects, and standard errors are clustered at the yearly level. Column 1 includes the (log of the) aggregate unemployment rate and a linear trend, and delivers an insignificant impact of unemployment on wages. The unemployment effect becomes significant in column 2, which includes a quadratic trend. This better absorbs non linearities in aggregate productivity growth, while cyclical wage fluctuations are now captured by the unemployment rate, with an elasticity of about -0.16. Column 3 controls for region-specific trends, and the unemployment elasticity is only marginally affected, and column 4 includes the lagged dependent variable, which automatically restricts the sample to individuals continuously employed, and the unemployment elasticity falls slightly to -0.12. Columns 5 also controls for lagged unemployment, but its effect on wages is not statistically significant.

Columns 6-8 distinguish between wages on new and continuing jobs, by including an interaction term between the unemployment rate and an indicator for the current job having started within the past year. Indeed column 6 shows that newly-negotiated wages are 50% more cyclical than wages on continuing jobs, in line with the hypothesis that wages are only infrequently renegotiated. Note however, that even wages on continuing jobs significantly respond to the state of the business cycle, consistent with some degree of on-the-job renegotiation. Column 7 shows that this result is robust to the introduction of individual fixed-effects. But when job fixed effects are included in column 8, the difference in cyclicity between old and continuing wages is much lower and borderline significant. As the effect of the interaction term in column 8 is identified by aggregate unemployment fluctuations within a job spell, and unemployment is highly persistent, we likely lack power to identify the effect of interest within job spells, as the average job spell is only observed during 2.6 waves on average. The alternative explanation is that the quality of newly-created jobs is procyclical, and when such cyclicity is captured by match fixed-effects the excess cyclicity in newly-negotiated wages is much reduced (see also Gertler and Trigari, 2009).

\[ \text{While Table 1 only reports the coefficients on various business cycle indicators, the full results for our main specification are reported in Table A2. All coefficients have the expected sign in both reservation wage and wage equations.} \]

12 This is the short-run elasticity of wages with respect to unemployment. Because the coefficient on the lagged dependent variable is large the implied long-run elasticity is considerably larger. But later specifications show that the coefficient on the lagged dependent variable has an upward bias because of omitted fixed effects.
If wages are infrequently renegotiated, one would expect that the unemployment rate at the start of a job continues to have a significant impact on the wage while in that job, over and above the impact of current unemployment. This is tested in column 9, which shows that both starting unemployment and current unemployment have a significant impact on wages. If job fixed effects are included in this specification, the initial unemployment effect falls to -0.020 and is statistically significant at the 1% level. Column 10 controls for the lagged dependent variable, which renders the coefficient on starting unemployment both small and insignificantly different from zero. In other words, the lagged wage is a sufficient statistics for the long-lasting impact of unemployment in a model with infrequent renegotiation. Column 11 uses the first difference in log wages as the dependent variable and the unemployment elasticity is somewhat reduced. Finally, column 12 introduces individual fixed-effect and the associated cyclicality of wages is, if anything, slightly higher drops further, but it is still significantly different from zero.

Other aggregate indicators like the output gap of the output growth rate have no impact on wages, while the (log) labour market tightness has an impact on wages that is very similar to the impact of the (log) aggregate unemployment rate (results not reported). When controlling for regional unemployment, specifications that also include a quadratic trend deliver a negative and significant unemployment elasticity but its magnitude does not go beyond 5%, as illustrated in Table A3. Similarly as for aggregate wage curves, we do find evidence of excess cyclicality of wages on new jobs (columns 7 and 8), but this falls when job fixed-effects are introduced (column 9). In summary, our wage curve estimates obtained on the BHPS are very similar to those obtained by other studies on other datasets.

The corresponding results for West Germany are presented in Table 2. The dependent variable is the log monthly wage, deflated by the consumer price index, and all regressions control for the log of monthly hours worked. The use of monthly, as opposed to hourly, wages is motivated by comparability with the reservation wages regressions presented in the next section, as information on reservation wages is only available at the monthly level. The unemployment elasticity of wages on all jobs is similar to that obtained for the UK, and ranges between virtually zero when controlling for fixed effects and 19% in OLS estimates. A clear similarity between the two countries is that the unemployment elasticity of wages is substantially higher for new hires than for continuing jobs.

B. Review of the theory and the evidence.

We use the estimates presented above to review how well the theory and the evidence can be reconciled. Consider first the version of the canonical model with continual wage renegotiation, in which case $\gamma = 1$ (from (19)), and (the absolute value of) the unemployment elasticity of wages equals one minus the replacement rate. An estimated elasticity in the region of -0.1 would imply a replacement rate of 90%, which is implausible, making the model incompatible with the data.\footnote{One might also mention the cross-section problem that most studies find greater cyclicality in wages for low-skilled workers for whom the replacement ratio in higher on average, the opposite of the prediction of the model.}
However, wages are not continually re-negotiated, and the higher cyclicality of wages in new jobs than continuing jobs indeed suggests that there is only occasional re-negotiation. To empirically evaluate the elasticity of newly-negotiated wages to current unemployment using (19), we need an estimate of $\gamma = \frac{r + \phi + s}{r + \phi + s + \xi}$. For the UK, appropriate monthly values are $s = 0.0125$ and $\xi = 0.003$. Using a monthly interest rate of $r = 0.003$, and an expected contract length of 12 months, $\phi = 0.0833$. Combining these parameters gives a value of $\gamma = 0.97$, i.e. not very far from 1. From (22) this also implies that the elasticity of new and continuing jobs with respect to unemployment should be very similar – in fact something like what is found when we include job fixed-effects. The intuition is that while wages determined in the past obviously cannot be influenced by the current unemployment rate they are correlated with the current unemployment rate because the high persistence in the unemployment rate.

Most of our estimates are not consistent with the theory for any plausible value of the replacement ratio. But our highest estimates of the elasticity for newly-negotiated wages to unemployment are -0.22 in the UK and of -0.20 in West Germany, which would require replacement ratios of 0.78 for the UK and 0.79 for West Germany, which are both higher than the uppermost end of plausible values. But, these estimates still have the problem of a very low value for the elasticity for continuing jobs and an implausible value for the ratio of the cyclicality of wages in continuing and new jobs is also at odds with the evidence. The empirical ratio between the two elasticities is 0.66 and according to the theory this should also be an estimate for $\gamma$, but this is far too low to be plausible.

This section has tried to explain, using a novel perspective on a known puzzle, why the canonical model, even with only occasional wage re-negotiation, has difficulties at matching the modest degree of pro-cyclicalit y in wages. This problem has often been addressed via alternative modelling of the wage setting process, notably by introducing some backward-looking element into wage determination. While this is likely to be important, the next section argues that an additional problem may lie with the model for the determination of reservation wages.

4. The cyclicality in the reservation wage: Theory and evidence

A. Theory

The theoretical wage curve of Section 2 has been derived without introducing the concept of a reservation wage, which is now helpful to introduce. The reservation wage at time $t$, denoted by $\rho(t)$, is defined as the minimum wage at which a worker would currently accept a job:

\[\text{Data for the separation rate, } s, \text{ are obtained from the Quarterly Labour Force Survey and for the persistence in the unemployment rate, } \xi, \text{ from the estimate of a time series model. Flows are lower in the UK than the US and unemployment persistence higher, so these are numbers different from those often used in the literature for the analysis of US data.}\]
\[ W(t; \rho(t)) = U(t). \]  
(23)

Using (10), this can be expressed as:
\[ \rho(t) = z - (r + \phi + s) E \int_1^\infty e^{-(r+\phi+s)(\tau-t)} (\phi - \lambda(\tau)) \mu(\tau) d\tau. \]  
(24)

Using (11) the relationship between newly-negotiated wages and reservation wages can be very simply expressed as:
\[ w_n(t) = \rho(t) + (r + \phi + s) \mu, \]  
(25)

from which one derives directly:
\[ \frac{\partial \ln \rho(t)}{\partial \ln u(t)} = \frac{w_n(t)}{\rho(t)} \frac{\partial \ln w_n(t)}{\partial \ln u(t)}, \]  
(26)

i.e. the cyclicality of reservation wages should be higher than the elasticity in wages in new jobs, with the ratio of elasticities given by the ratio of the wage to the reservation wage. We start our empirical investigation of reservation wages by showing that this is not the case in the data.

**B. Evidence**

There is no existing literature on the relative cyclicality of wages and reservation wages and the implications for the canonical model. An obvious reason for this gap in the literature is the scarcity of data on reservation wages.\(^15\) In the US, there is no data set that has systematically collected reservation wage data on a regular basis for a long period of time, and there is only a handful of studies analysing reservation wage data that has occasionally been collected.\(^16\)

In the BHPS respondents in each wave 1991-2009 are asked about the lowest weekly take-home pay that they would consider accepting for a job, and about the hours they would expect to work for this amount. Using answers to these questions we construct a measure of the hourly net reservation wages, and deflate it using the aggregate consumer price index. A similar question is asked of GSOEP respondents in all waves since 1987, except 1990, 1991 and 1995. The reservation wage information is elicited in monthly terms\(^17\) and is not supplemented by information on expected hours, thus our analysis on West Germany refers to monthly reservation wages, and our wage regressions for West Germany control for whether an individual is looking for a full-time or part-time job, or a job of any duration.\(^18\)

The working sample includes all individuals with information on reservation wages. In the BHPS the question on reservation wages is asked of all individuals who were out of work in the survey week and were actively seeking work or, if not actively seeking, would like to

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\(^{15}\) Or the lack of trust of the quality of such data, an argument we address below.

\(^{16}\) For example, reservation wage data was collected in a CPS supplement in 1976 (Feldstein and Poterba, 1984), the NLSY from 1979-1986 (Holzer, 1986a,b; Petterson, 1998) and the 1984 SIPP Panel (Ryscavage, 1988). In recent years the panel data collected by Krueger and Muller (2013) has greatly added to the knowledge on reservation wages, but these cover too short a period to investigate their cyclicality. Early work on reservation wages for the UK has used cross-section survey data (Lancaster and Cheshire, 1983, Jones, 1988).

\(^{17}\) The actual question in German is “Wie hoch müsste der Nettoverdienst mindestens sein, damit Sie eine angebotene Stelle annehmen würden? (im Monat)?”

\(^{18}\) The omitted category is “don’t know preferred hours”.
have a regular job. In the GSOEP the same question is asked of all individuals who are currently out of work but contemplate to go back to work in the future. Descriptive statistics for the reservation wage samples are also reported in Table A1.

Our empirical specification for the reservation wage is based on the predictions of the theory. This implies that reservation wages should respond to three sets of variables. First, as the reservation wage depends on expected wage offers, reservation wage equations should control for factors typically included in earnings functions, namely gender, human capital components, regional and aggregate effects, as well as a measure of the bargaining power of workers, proxied by the unemployment rate (or, equivalently, labour market tightness). As the duration of unemployment affects a worker’s set of skills, whether actual or perceived, this should also be controlled for in reservation wage equations. Second, the reservation wage responds to the probability of receiving a wage offer, and therefore to the unemployment rate. Cyclical factors, as captured by the unemployment rate, thus would affect the reservation wage via both the probability of receiving an offer and the expected wage offer. Finally, the reservation wage depends on the level of utility enjoyed while out of work, and as a proxy for this we use available measures of unemployment benefits and family composition.

The estimates for the reservation wage equations on the BHPS are reported in Table 3. The dependent variable is the log of the real hourly reservation wage. All specifications control for the same set of individual characteristics as wage equations, having replaced job tenure with the elapsed duration of a jobless spell, as well as for the amount of benefit income received. In column 1 the state of the business cycle is captured by the (log) national unemployment rate and a linear trend is included. The elasticity of reservation wages to the unemployment rate is close to -0.10 and it is significant at the 5% level. Such elasticity rises to -0.175 when a quadratic trend is included in column 2, and very slightly declines if one controls for region specific trends in column 3. Column 4 controls for current as well as lagged unemployment, and shows that the main source of cyclicality in the reservation wage is lagged rather than current unemployment. If one only controls for lagged unemployment, the associated coefficient is -0.148 and it is significant at the 5% level (results not reported). Finally, column 5 controls for worker unobserved heterogeneity by including individual fixed-effects, and the elasticity with respect to (lagged) unemployment is somewhat reduced with respect to OLS estimates.

We experiment with a number of alternative business cycle indicators to address the possible concern that reservation wages may display stronger cyclicality to other variables not yet considered here. First, we use alternative aggregate indicators, and namely the output gap, the growth rate in output and the (log) labour market tightness. The only one that has a significant impact on the reservation wage in the specification that includes a quadratic trend is labour market tightness, with an elasticity of 0.168 (s.e. 0.029), which is remarkably similar in absolute value to the elasticity with respect to the unemployment rate obtained in column 2. The coefficients on either the output gap or the growth rate in output are very close to zero (0.000, s.e. 0.008; and -0.004, s.e. 0.005, respectively). Second, we estimate reservation wage equations that only control for regional unemployment. The results are reported in Table A5 and show that only when one controls for a quadratic trend is the unemployment elasticity significant, and again lagged unemployment has a stronger impact on reservation wages than current unemployment. Overall, the elasticity of reservation wages
to regional unemployment is markedly lower than the elasticity with respect to aggregate unemployment.

We estimate similar reservation wage specifications for West Germany, and the results are reported in Table 4. While the elasticity of reservation wages with respect to current unemployment is not significant (and actually wrongly signed if only a linear trend is included), the elasticity of reservation wages with respect to lagged unemployment is around -0.2 and very similar to the corresponding estimates for the UK.

These results can be broadly summarized by noting that, at best, there is fairly limited cyclical variation in reservation wages and that the cyclical variation in reservation wages is similar to the cyclical variation in all wages, and considerably lower than the cyclical variation of wages in new jobs. This is inconsistent with the theory.

However one potential problem with comparing the cyclical variation of wages in new jobs with the cyclical variation in reservation wages is that these equations are estimated on different groups of people so any difference in elasticity may simply reflect the different samples. But, for the UK, we can investigate this further as the BHPS also asks workers about the wage that they expect to get. Specifically, workers looking for jobs are asked how many hours in a week they would be able to work, and what weekly net pay they would expect to receive for those hours. We can then construct a measure of the expected hourly wage. Its estimated elasticity with respect to unemployment, obtained in a specification identical to that of column 2 of Table 3, is -0.179 (s.e. 0.053). This value is remarkably close to the elasticity of the reservation wage, while the theory predicts the latter should be higher. In particular, given a mean ratio of (net) expected to reservation wages in our sample equal to 1.21, equation (26) predicts that the reservation wage elasticity should be about 20% higher than the elasticity of expected wages.

C. The quality of reservation wage data

One potential explanation for the lack of strong cyclical variation in our estimates is that the self-reported reservation wage information is not very good quality, so that the estimated cyclical variation is not reliable. In passing it should be noted that, as Table A2 shows, most of the factors (e.g. age, education and gender) estimated to affect reservation wages are very sensible. Below we address concerns about the quality of reservation wage data by investigating whether the correlation between reservation wages and job search outcomes has the sign predicted by search theory. Ceteris paribus we would expect those with higher reservation wages to have a lower probability of finding employment, and thus a higher expected duration on unemployment, but higher entry wages once they do find work.

19 Due to benefit entitlement rules, we need to use an instrument for unemployment benefits in Germany. The duration of unemployment benefits in Germany is a nonlinear function of age and previous social security contributions. These are potentially correlated to individual characteristics that also determine wages. Thus we control for age and months of social security contributions linearly in the regressions, and we exploit nonlinearities in entitlement rules to obtain the number of months to benefit expiry, which we use as an instrument for unemployment benefits. No such instruments are required for the U.K. as the duration of benefits in the UK is determined by job search behaviour rather than previous employment history.

20 This is also very similar to the mean ratio of (net) post-unemployment wages to reservation wages.
Table 5 investigates the effect of reservation wages on each outcome for the UK. Column 1 simply regresses an indicator of whether a worker has found a job in the past year on the reservation wage recorded at the beginning of that year and a set of year and region dummies. The impact of the reservation wage is virtually zero, both in terms of the point estimate and its significance, but this estimate is likely to be upward biased due to omitted variables, as more able workers have both higher reservation wages and are more likely to find a job. Columns 2 and 3 include a number of explanatory variables, including the unemployment rate (national or local, respectively), and indeed we find that, conditional on such covariates, workers with higher reservation wages tend to experience significantly longer unemployment spells.

Columns 4-6 show the impact of reservation wages on wages for those who find jobs. In column 4, which does not control for characteristics, the elasticity of re-employment wages to reservation wages is likely to be upward biased by unobserved individual factors that are associated to both higher reservation wages and re-employment wages. Indeed such elasticity falls by about a quarter in column 5, which controls for individual characteristics, but it remains highly significant. Note that when we control for the aggregate unemployment rate in column 5, its impact on wages is of similar magnitude to the impact estimated in column 7 of Table 1 on the subsample of new job hires, although the sample in Table 1 is much larger because it includes new matches from any origin, while the sample in Table 5 only includes new job matches that originated in non-employment.

Similar results for West Germany are presented in Table 6 and they are clearly in line with the results for the U.K., except the negative impact of reservation wages on job-finding rates is stronger for West Germany than for the U.K.

The conclusion from this analysis is that the reservation wage data, though undoubtedly noisy, do show the expected correlations with search outcomes for both countries, and therefore there is no particular reason to think that the estimate of its cyclical sensitivity is seriously under-estimated.

D. Replacement ratios conditional on wages

The evidence presented shows that reservation wages are roughly as cyclical as actual wages and both less than predicted by the canonical model. The most common approach taken in the existing literature is to introduce a backward-looking component to wages in new jobs or some other form of wage rigidity. This might be expected to reduce the predicted wage cyclicality but it is less clear that it can explain the low cyclical ity in reservation wages as in a recession, the value of having a job rises relative to the value of being unemployed, and as a result reservation wages should fall – this is the case even if wages themselves are not cyclical.

The reservation wage equation (24) is a reduced form, in that it only relates reservation wages to current and future expected labour market conditions and is built on the model of wage determination given by (25). If (25) is incorrectly specified this will mean that (24) is also mis-specified. But, one can avoid this problem by deriving a reservation wage equation that is conditional on the level of wages – this should be satisfied however
wages are determined. First, we show in Appendix B1 that the reservation wage can be written as:

\[ \rho(t) = z + E \int_{0}^{\infty} e^{-\int_{0}^{\infty} [(r+\lambda + s)dt]} \left( w_n(\tau) - z \right) \left( \lambda(\tau) - \phi \right) d\tau. \]  

(27)

This expression might be more familiar when written in the steady-state form when \( r = \phi = 0 \) i.e. there is no re-negotiation of wages:

\[ \rho = \frac{sz + \lambda w}{\lambda + s} = uz + (1-u)w. \]  

(28)

(28) makes clear the dependence of reservation wages on the unemployment even if wages are not cyclical.

(27) expresses the reservation wage as a function of wages, both present and future, and expected labour market conditions. The overall cyclicality in reservation wages thus has a component driven by the cyclicality in wages and a component driven by the direct effect of labour market conditions.

Second, we show in Appendix B2 that in a steady-state the elasticity of the reservation wage with respect to unemployment can be expressed as:

\[ \frac{\partial \ln \rho(t)}{\partial \ln u(t)} = \frac{w_n}{\rho} \frac{\partial \ln w_n(t)}{\partial \ln u(t)} \frac{\lambda - \phi}{r + s + \lambda + \xi} - \left( \frac{w_n}{\rho} - 1 \right) \frac{s + \lambda}{r + s + \lambda + \xi}. \]  

(29)

The two terms in (29) represent the two sources of cyclicality in the reservation wage, driven by the cyclicality in wages and labour market conditions, respectively.

We discuss this second term first. Its magnitude depends on the gap between wages and reservation wages \( \left( \frac{w_n}{\rho} - 1 \right) \), which is a measure of the attractiveness of work relative to non-work in terms of flow pay-offs. If this term is close to zero, the predicted cyclicity in reservation wages from this source is also close to zero. This is essentially a restatement of the result that if the replacement ratio is close to one the model predicts little sensitivity in the reservation wages. But the data suggests that \( \left( \frac{w_n}{\rho} - 1 \right) \) is not close to zero. In the BHPS workers reporting reservation wages are also asked about their expected wage, and on average expected wages are 20% higher than reservation wages, implying \( \left( \frac{w_n}{\rho} - 1 \right) \approx 0.2 \).

This is then multiplied by \( \left( s + \lambda \right) / \left( r + s + \lambda + \xi \right) \). As \( \lambda \) (and to a lesser extent \( s \)) are very large relative to \( r \) and \( \xi \) this ratio is close to 1 (0.97 for the parameter values we have used earlier). So the second term of (29) alone predicts as much or more cyclicity in reservation wages than we observe in the data, even if actual wages in new jobs were acyclical.

The first term in (29) derives from the cyclicality of newly-negotiated wages. The coefficient on the wage elasticity depends on \( (\lambda - \phi) \), i.e. the difference between the rate at which unemployed workers receive a wage offer, and the rate at which employed workers renegotiate their contracts (so they also get a new wage). Plausible parameter values imply \( \lambda > \phi \), i.e. the expected duration of a spell of unemployment is shorter than the expected duration of a wage contract. But the gap is not so large so that the multiplier on the wage elasticity for our benchmark parameter values is 0.08. This implies that the predicted cyclicity in reservation wages at our benchmark parameters values is not very sensitive to
the wage elasticity. But if wages are somewhat cyclical, the cyclicality in reservation wages would be overpredicted further.

This analysis has been based on the assumption that workers expect that, if they are employed at the reservation wage, their wage will be re-negotiated at the same rate as other wages, and upon renegotiation it will jump to the market rate. That is why if there is continuous wage re-negotiation ($\phi = \infty$) inspection of (29) shows that the cyclicality in reservation wages will be the opposite in sign to that of actual wages. The intuition is that if there is continual wage re-negotiation one will accept any job at any wage, safe in the knowledge that it will be instantaneously re-negotiated. To allay concerns that our conclusions might be sensitive to this assumption, we investigate in Appendix B3 the predictions for the cyclicality of reservation wages under the extreme opposite assumption, namely that there is no renegotiation on reservation wage jobs. In this case the predicted cyclicality of reservation wages and wages in new jobs are very similar, again contrary to what is observed.

Our conclusion is that there seems to be a failure in the canonical model for the determination of reservation wages, and this is likely to be one cause of the wage flexibility puzzle, as actual wages are linked to reservation wages. The next section considers some modifications of the reservation wage model as possible routes to address such failure.

5. Alternative models for the reservation wage

We have documented that the cyclicality in reservation wages is considerably below the predictions of the canonical model. This section investigates this puzzle further using more general models for the determination of reservation wages, and namely a search model with the possibility of on-the-job search, a model in which workers use hyperbolic discounting, and a model with reference points in job search behaviour.

A. The reservation wage with on-the-job search

The model used so far assumes that only unemployed workers search for jobs, while a fraction close to half of new jobs are taken by workers currently employed (Manning, 2003). We next consider how the reservation wage is altered when both the unemployed and the employed search for jobs. As in the previous section, the analysis is conditional on the expected level of wages, without need to specify the process for the determination of wages. For simplicity, we assume that the economy is in steady-state, so wages and job offer arrival rates are constant.

Arrival rates of job offers for the employed and for the unemployed are denoted by $\lambda^e$ and $\lambda^u$, respectively, and both depend on labour market tightness, and the corresponding value functions are given by:

$$ rW(w) = w - s[W(w) - U] + \lambda^e \int_w^w [W(x) - W(w)] dF(x), $$

and

$$ rU = z + \lambda^u \int_U^W [W(x) - U] dF(w), $$

(30)

(31)
respectively. The reservation wage satisfies \( W(\rho) = U \), and can be expressed as:

\[
\rho = z + (\lambda^u - \lambda^e) \int \left[ W(w) - U \right] dF(w)
\]

\[
= z + (\lambda^u - \lambda^e) \int_{\rho}^{r+s+\lambda^e\left[1-F(w)\right]} \frac{1-F(w)}{r+s+\lambda^e\left[1-F(w)\right]} dw,
\]

where the second equality follows from integration by parts, given \( W'(w) = \{r+s+\lambda^e\left[1-F(w)\right]\}^{-1} \). Appendix C shows that, if the interest rate is small relative to transition rates, the reservation wage approximately satisfies:

\[
\rho \approx z + (1-u) \left(1-\frac{\lambda^e}{\lambda^u}\right)(w_a-z),
\]

where \( w_a \) denotes the average wage across workers (which differs from the average wage offer if there is search on-the-job).\(^{21}\) This reduces to (28) if there is no on-the-job search. Expression (33) can be used to address the cyclicity of the reservation wage, conditional on the average wage.

First, reservation wages are acyclical whenever the job arrival rate functions for employed and unemployed workers are the same. In this case \( \lambda^e = \lambda^u \) and (33) implies that the reservation wage equals the flow of income when unemployed, \( \rho = z \) (Burdett and Mortensen, 1998). Intuitively, taking or leaving a job offer has no consequences for future job opportunities when arrival rates are independent of one’s employment status, and the optimal search strategy consists in accepting the first offer that offers a higher flow utility than one enjoys while unemployed. If \( z \) is not cyclical, neither is the reservation wage. While this seems an attractive path to address the puzzle, it comes with the less palatable predictions that the reservation wage is independent of factors that influence the distribution of wages. This prediction is strongly rejected in the data, as high-wage workers tend to have relatively higher reservation wages (Manning 2003, ch 9). Detailed results reported in columns 2 and 4 of Table A2 show that gender, age and education affect both wages and reservation wages in the same direction, thus the reservation wage is positively related to the wage that workers expect to earn.\(^{22}\) Taken to (33), this result implies that off-the-job search is more effective than on-the-job search, a conclusion that is also in line with direct estimates of labour market transition rates.

In general, (33) implies that the reservation embodies the cyclicity in wages, plus a further cyclical component coming from \((1-u)\left(1-\frac{\lambda^e}{\lambda^u}\right)\). The term \((1-u)\) is obviously pro-cyclical, but the cyclicity of \(\frac{\lambda^e}{\lambda^u}\) is less clear. Our path to provide evidence on the cyclicity of \(\frac{\lambda^e}{\lambda^u}\) – described in Appendix D – consists in assessing the cyclicity of the fraction of new jobs filled by workers who were previously employed, and to relate this

\^21\ If \( \lambda^e = 0 \), equation (33) reduces to the familiar condition in which the reservation wage is a weighted average of \( z \) and \( w \), with the unemployment rate representing the weight on \( z \), i.e. the reservation wage can be thought of as expected income.

\^22\ One could perhaps explain this through wealth effects but most of the unemployed have very little in the way of accumulated wealth or access to capital markets.
fraction to $\lambda^e / \lambda^u$. Intuitively, the two measures are related as the more effective on-the-job search, the higher the fraction of new jobs that are filled by someone already employed. Using data from the UK Labour Force Survey, Appendix D shows that the fraction of new jobs filled by previously employed workers is strongly countercyclical. Using a simple search model to calibrate this statistic, we find that $\lambda^e / \lambda^u$ is below 1 (about 0.6 at the mean unemployment rate) and counter-cyclical. The result $\lambda^e / \lambda^u < 1$ makes reservation wages less cyclical than in the case without on-the-job search, but its cyclical $\lambda^e / \lambda^u$ makes the reservation wage more cyclical. The latter effect dominates quantitatively, thus on-the-job search does not seem to be able to solve the puzzle of the modest cyclical in the reservation wage.

B. The reservation wage and hyperbolic discounting

The models considered so far have assumed that individuals have rational expectations and time-consistent preferences, but a growing body of evidence casts doubt on both these assumptions. In the area of job search, Spinnewijn (2013) has argued that the unemployed tend to be too optimistic about their job prospects, and Della Vigna and Paserman (2005) and Paserman (2008) argue that hyperbolic discounting has large effects on search intensity and on the exit rate from unemployment, as the search intensity decision involves trading off current and future utility. However, they argue that impatience does not affect the reservation wage as that is not derived by comparing pay-offs at different periods in time. They do not investigate the implication of their model for the cyclical of reservation wages, but Appendix E shows that hyperbolic discounting does not have important implications for the cyclical of the reservation wage.

C. Reference points in job search

A number of studies have long suggested that reservation wages are determined by perceptions of fairness, and that these are heavily influenced by both past personal experience and reference groups (see, for example, Akerlof, 1980; Akerlof and Yellen, 1990; Blanchard and Katz, 1999). For example, Falk, Fehr and Zehnder (2004) show, in an experimental setting, that past minimum wages that are no longer in effect influence reservation wages, leading reservation wages to be less cyclical than in the optimizing job search models.

If past wages shape reference points, which in turn influence reservation wages, we should observe a significant correlation between past wages and reservation wages, which will be investigated in this subsection. While such correlation is consistent with the existence of reference points, it is clearly also consistent with alternative mechanisms. One possible confounding factor is any direct link between unemployment benefits and past wages, as unemployment income is a key component of reservation wages in the canonical model. This is the case for West Germany, where benefit entitlement is a function of age and previous social security contributions, which are in turn directly linked to past wages, implying a positive correlation between past and reservation wages, over and above the role of reference points. By contrast, in the UK unemployment compensation is simply a function of family
composition, and is not directly linked to previous wages, making the UK an ideal case study for reference points in reservation wages. We thus restrict the analysis that follows to the UK.

The second confounding factor is represented by unobserved productivity components of past wages, which are reflected in reservation wages in the canonical model via their effect on the wage offer distribution. Our approach consists in isolating the component of past wages that can be reasonably interpreted as rents – as opposed to productivity – and observe its correlation with reservation wages. A rational worker should not use past rents in forming their current reservation wages (absent wealth effects which we do not find to be very important), whereas a worker who uses past wages as a reference point might do so.

Let’s consider the simple empirical model for the reservation wage:

$$\log \rho_i = \beta_1 X_i + \beta_2 w^* + \beta_3 \mu_{it-d} + \epsilon_i, \quad (34)$$

where $X_i$ denotes observable characteristics, $w^*$ denotes worker ability, and $\mu_{it-d}$ denotes the level of rents in the last job observed ($d$ periods ago). The coefficient of interest is $\beta_3$, indicating whether rents lost with past jobs influence current reservation wages.

Assume that the last observed wage is given by:

$$\log w_{it-d} = \gamma_1 X_{it-d} + w^* + \mu_{it-d} + u_{it-d}, \quad (35)$$

and we simply regress the reservation wage on the last observed wage:

$$\log \rho_i = \delta_1 X_i + \delta_2 \log w_{it-d} + \epsilon_i. \quad (36)$$

The OLS estimate for $\delta_2$ would capture the effect of both unobserved heterogeneity and rents on the reservation wage, as well as being possibly attenuated by the presence of measurement error in past wages. Identification of the effect of interest would require an instrumental variable that represents a significant component of past rents, while being orthogonal to worker ability.

As a proxy for the size of rents in a given job we use industry affiliation, in line with a long-established literature concluding that part of inter-industry wage differentials represent rents (see the classic papers, Krueger and Summers, 1988, and Gibbons and Katz, 1992; and Benito, 2000, and Carruth, Collie and Dickerson, 2004, for British evidence). Specifically, we use as an instrument for previous wages the predicted, inter-industry wage differential obtained on an administrative dataset, the Annual Survey of Hours and Earnings (ASHE), whose sample size allows us to control for industry affiliation at the 4-digit level. We estimate a log wage regression for 1982-2009 on ASHE, controlling for 4-digit industry effects, unrestricted age effects, region, and individual fixed effects. The inclusion of individual fixed effects allows us to capture the component of inter-industry wage differentials that is uncorrelated to individual unobservables, and is thus crucial to justify the identifying assumption. We then use the estimated industry effects to construct predicted industry-level wages, which we then match to individual records in the BHPS, and use as an instrument for last observed wages in reservation wage regressions.
Having controlled for unobserved heterogeneity in the construction of our instrument, the exclusion restriction would still be violated in the presence of wealth effects in the determination of reservation wages (see for example Shimer and Werning, 2007, for a model of job search with asset accumulation). Rents received in previous jobs would have an impact on asset accumulation, which in turn affects worker utility during unemployment and reservation wages. This does not seem to be a major issue in our working sample, in which more than three quarters of unemployed workers have no capital income, and another 11% have capital income below £100 per year, but in order to control for wealth effects, if any, we include indicators for household assets and housing tenure in the estimated reservation wage equations.

Past wages can be obtained for currently unemployed respondents who had previous employment spells over the BHPS sample period. For those who are observed in employment at any of the previous interview dates, we use contemporaneous information on their last observed job. For those who are not observed in employment at any interview date, but had between-interview employment spells, we use the most recent retrospective information on previous jobs. Retrospective employment information is typically more limited than contemporaneous information, and in particular it does not cover working hours. The analysis that follows is thus entirely based on monthly wages and reservation wages.

Our results are reported in Table 7. Column 1 reports OLS estimate of reservation wage equations for the UK, controlling for the last observed wage in the BHPS panel. The sample is substantially smaller than the original sample of Table 3, as for about 45% of the reservation wage sample we do not observe any previous job in the BHPS panel. The coefficient on the wage in the last job is, not surprisingly, positive and highly significant. The specification in column 2 allows for some gradual decay of the influence of past wages on reservation wages, controlling for the interaction between the past wage and the number of years since it was observed. The coefficient on the interaction term implies that the influence of previous wage realizations on current reservation wages should vanish about 10 years after job loss. Column 3 introduces individual fixed-effects, and the coefficient of interest is identified from individuals with multiple unemployment spells, originated from different industries. The coefficient on the past wage is markedly lower than in column 2, but still positive and significant. The difference between OLS and FE coefficients is, not surprisingly, revealing a sizeable ability component in the past effect estimated in column 2.

Column 4 instruments the previous wage with its rent component, as proxied by the 4-digit industry level differential, and shows that this rent component has a positive and significant impact on the reservation wage, consistent with a model in which previous rents affect workers’ reference points during job search. The IV coefficient on the past wage is higher than the OLS coefficient, due to the presence of transitory components and (classical) measurement error in the actual wage (see also Manning, 2003, chapter 6). The specification in Column 5 allows for decay of reference points over time, introducing the product between the industry level wage differential and the duration since the last wage was observed as a further instrument. The speed of the decay is very close quantitatively to that obtained using OLS. Column 6 finally introduces individual fixed-effects, and the coefficient on the past wage is only very slightly reduced with respect to column 5, although the decay effect is no longer significant.
In summary, we do find evidence that rents in previous jobs tend to affect reservation wages. Overall, this finding is not consistent with the determination of reservation wages in the canonical model, but is instead consistent with a model in which past wages shape workers’ reference points and job search behaviour.

D. Rigidity in Reservation Wages

Having empirically established that reference points influence reservation, this section outlines a model that incorporates some backward-looking behaviour in the determination of reservation wages. One would expect that this to make reservation wages less cyclical and, via wage determination, reduce the cyclicality of wages themselves. We also compare the performance of this model with that of a model with a backward-component to the determination of wages in new jobs, by relaxing the assumption that wages in all new jobs are newly-negotiated, as Gertler and Trigari (2009).

For wage determination, we assume that, with probability \( \alpha_w \), wages in new job are newly-negotiated, at a wage denoted by \( \omega_r \), while with probability \( 1 - \alpha_w \) wages in new jobs are equal to the average wage in the economy. The expected wage in a new job is thus given by:

\[
w_n(t) = \alpha_w \omega_r(t) + (1 - \alpha_w) \omega_a(t)
\]  

A lower value of \( \alpha_w \) represents stronger backward-looking persistence in wages. For reservation wages, we consider two alternative models with a backward-looking element. In the first, reservation wages are a linear combination of the optimal reservation wage derived in (27), which we will denote by \( \rho_0(t) \), and a constant, acyclic reference point component, \( k \):

\[
\rho(t) = \alpha_r \rho_0(t) + (1 - \alpha_r) k
\]  

A lower value of \( \alpha_r \) represents stronger backward-looking persistence in reservation wages. In the second model, the reference point is represented by the average wage, which is itself cyclical, and affects reservation wages up to a constant \( k \):

\[
\rho(t) = \alpha_r \rho_0(t) + (1 - \alpha_r)(\omega_a(t) - k)
\]  

The details of the solution of this model are shown in Appendix F, and we simply summarize the results below. Consider first the cyclicality in average wages at benchmark parameter values and \( \alpha_r = 1 \), as a function of the degree of persistence in wage-setting behaviour. This is denoted by the line ‘Persistence in Wages’ in Figure 1. As expected, wage cyclicality falls with their persistence, but quantitatively this effect is mild. The reason for this is the persistence in unemployment: even though most wages have been negotiated in the past and were influenced by the unemployment rate prevailing at that time, current unemployment is strongly correlated with past unemployment.
Figure 1 also displays the cyclicality in wages at benchmark parameter values and \(\alpha_w = 1\), as a function of the degree of persistence in reservations wages. The notation ‘Model 1’ and ‘Model 2’ refers to the cases shown in equations (38) and (39), respectively. Both models generate less cyclicality in actual wages than a model that introduces the same level of persistence in wage determination. Unsurprisingly, the reduction in cyclicality is greater when the reference point in reservation wages is assumed to be completely acyclical (Model 1). If the reference point is as cyclical as average wages (Model 2), a high reference point dependence is needed to generate the cyclicality that is observed in the data.

Although this model is very stylized, it does suggest that some degree of persistence in reservation wages – possibly driven by reference points – is needed for the model to explain the low observed cyclicality in wages.

6. Conclusions
In this paper we use a canonical search and matching model to derive a ‘wage curve’, i.e. a relationship between wages and unemployment that is plausibly unaffected by demand shocks. The slope of this curve is an estimate of the relative variability of wages and unemployment in response to demand shocks. We show how the model can only explain the modest pro-cyclicality observed in wages if replacement ratios are implausibly high. The wage flexibility puzzle persists even if one allows for occasional wage re-negotiation, unless unemployment itself has implausibly low persistence.

We then argue that one source of the problem is likely to be the model for the determination of reservation wages. Using British and German data we show that reservation wages are less cyclical than the model would predict, even conditioning on the observed cyclicality in actual wages. We finally show evidence of significant, backward-looking reference point elements in reservation wages, which help rationalize the mild cyclicality in both wages and reservation wages.
Table 1: Estimates of a Wage Equation for the UK, 1991-2009.

**Business cycle indicator: Aggregate unemployment**

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>1</th>
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<td>Log wage</td>
<td>Log wage</td>
<td>Log wage</td>
<td>Log wage, Δ</td>
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<tr>
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<td>0.759***</td>
<td></td>
<td>0.759***</td>
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<td></td>
<td>0.759***</td>
<td>0.102**</td>
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<td></td>
<td>(0.005)</td>
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<tr>
<td>Log unemp rate</td>
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<td>-0.165***</td>
<td>-0.155***</td>
<td>-0.123***</td>
<td>-0.106***</td>
<td>-0.141***</td>
<td>-0.146***</td>
<td>-0.110***</td>
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<td>(0.017)</td>
<td>(0.025)</td>
<td>(0.044)</td>
<td>(0.011)</td>
<td>(0.011)</td>
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<td>Log unemp * new job</td>
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<td></td>
<td></td>
<td>(0.018)</td>
<td>(0.008)</td>
<td>(0.009)</td>
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<tr>
<td>Log unemp rate, at start of job</td>
<td></td>
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<td></td>
<td>-0.039***</td>
<td>-0.003</td>
<td>0.004</td>
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<td>(0.008)</td>
<td>(0.004)</td>
<td>(0.004)</td>
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<tr>
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<td>96,270</td>
<td>70,901</td>
<td>70,901</td>
<td>96,270</td>
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<td>95,584</td>
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<td>70,438</td>
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<td>R-squared</td>
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<td>0.397</td>
<td>0.398</td>
<td>0.748</td>
<td>0.748</td>
<td>0.398</td>
<td>0.398</td>
<td>0.398</td>
<td>0.398</td>
<td>0.748</td>
<td>0.748</td>
<td>0.015</td>
</tr>
</tbody>
</table>

Notes. The wage measure is hourly. All regressions include a gender dummy, age and its square, three education dummies, a cubic trend in job tenure, a dummy for married, number of children in household, and eleven region dummies. Regressions in columns 6-8 also include a dummy for new job. Estimates in column 12 are obtained using the Arellano Bond (1991) estimator for dynamic panel data models. Standard errors are clustered at the year level in columns 1-11, and using 2-way cluster-robust variance (Cameron and Miller, 2013) in column 12. Source: BHPS.
Table 2: Estimates of a Wage Equation for the West Germany, 1987-2010

<table>
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<th>Dependent variable</th>
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<th>10</th>
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<th>12</th>
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<tr>
<td>Log wage, lagged</td>
<td>0.729*** (0.007)</td>
<td>0.729*** (0.007)</td>
<td>0.729*** (0.007)</td>
<td>0.398 *** (0.027)</td>
<td>0.398 *** (0.027)</td>
<td>0.398 *** (0.027)</td>
<td>0.398 *** (0.027)</td>
<td>0.398 *** (0.027)</td>
<td>0.398 *** (0.027)</td>
<td>0.398 *** (0.027)</td>
<td>0.398 *** (0.027)</td>
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<td>0.002 (0.025)</td>
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<td>0.011 (0.020)</td>
<td>-0.015 (0.018)</td>
<td>-0.005 (0.015)</td>
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<td>-0.016 (0.014)</td>
<td>0.034** (0.015)</td>
<td>-0.018 (0.025)</td>
<td>-0.018 (0.025)</td>
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<tr>
<td>Log unemployment rate, lagged</td>
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<td>-0.038* (0.020)</td>
<td>-0.038* (0.020)</td>
<td>0.026*** (0.041)</td>
<td>0.096*** (0.026)</td>
<td>0.034 (0.022)</td>
<td>0.027*** (0.007)</td>
<td>0.007*** (0.002)</td>
<td>0.000 (0.002)</td>
<td>0.027*** (0.002)</td>
<td>0.000 (0.002)</td>
<td>0.027*** (0.002)</td>
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<tr>
<td>Log unemployment rate * new job</td>
<td>-0.268*** (0.041)</td>
<td>-0.096*** (0.026)</td>
<td>-0.038* (0.020)</td>
<td>0.026*** (0.041)</td>
<td>0.096*** (0.026)</td>
<td>0.034 (0.022)</td>
<td>0.027*** (0.007)</td>
<td>0.007*** (0.002)</td>
<td>0.000 (0.002)</td>
<td>0.027*** (0.002)</td>
<td>0.000 (0.002)</td>
<td>0.027*** (0.002)</td>
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<tr>
<td>Log unemp rate, at start of job</td>
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<td>-0.038* (0.020)</td>
<td>-0.038* (0.020)</td>
<td>0.026*** (0.041)</td>
<td>0.096*** (0.026)</td>
<td>0.034 (0.022)</td>
<td>0.027*** (0.007)</td>
<td>0.007*** (0.002)</td>
<td>0.000 (0.002)</td>
<td>0.027*** (0.002)</td>
<td>0.000 (0.002)</td>
<td>0.027*** (0.002)</td>
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<td>166,614</td>
<td>129,323</td>
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<td>0.651</td>
<td>0.651</td>
<td>0.858</td>
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<td>0.652</td>
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<td>0.199</td>
<td>0.652</td>
<td>0.858</td>
<td>0.858</td>
<td>0.045</td>
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</table>

Notes. The wage measure is monthly. All regressions include log hours worked, a gender dummy, age and its square, three education dummies, a cubic trend in job tenure, a dummy for married, number of children in household, and sixteen region dummies. Estimates in column 12 are obtained using the Arellano Bond (1991) estimator for dynamic panel data models. Standard errors are clustered at the year level in columns 1-11, and using 2-way cluster-robust variance (Cameron and Miller, 2013) in column 12. Source: GSOEP.

<table>
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<td>OLS</td>
<td>OLS</td>
<td>OLS</td>
<td>FE</td>
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</tr>
<tr>
<td></td>
<td>-0.095* (0.046)</td>
<td>-0.175 *** (0.058)</td>
<td>-0.164 ** (0.058)</td>
<td>0.115 (0.156)</td>
<td>0.010 (0.104)</td>
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</tr>
<tr>
<td></td>
<td>Log unemployment rate, lagged</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.215* (0.112)</td>
<td>-0.119 (0.073)</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
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<td>linear</td>
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<td>quadratic</td>
<td>quadratic</td>
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<tr>
<td></td>
<td>Region specific trends</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Observations</td>
<td>14,874</td>
<td>14,874</td>
<td>14,874</td>
<td>14,874</td>
<td>14,874</td>
</tr>
<tr>
<td></td>
<td>R-squared</td>
<td>0.248</td>
<td>0.249</td>
<td>0.249</td>
<td>0.249</td>
<td>0.249</td>
</tr>
</tbody>
</table>

Notes. Dependent variable: log reservation wage. The reservation wage measure is hourly. All regressions also include a gender dummy, age and its square, three education dummies, a cubic trend in unemployment duration, a dummy for married, the number of children in the household, the log of unemployment benefits, a dummy for receipt of housing benefits, and eleven region dummies. Standard errors are clustered at the year level in columns 1-4, and using 2-way cluster-robust variance (Cameron and Miller, 2013) in column 5. Source: BHPS.
Table 4: Estimates of a Reservation Wage Equation for West Germany, 1987-2009.

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<tr>
<td></td>
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<td>IV</td>
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<td>Log unemployment</td>
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<td>0.173**</td>
<td>0.001</td>
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<td>0.184**</td>
<td>0.175**</td>
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<td>rate</td>
<td></td>
<td>(0.070)</td>
<td>(0.065)</td>
<td>(0.064)</td>
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<td>-0.255***</td>
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<td>rate, lagged</td>
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<td>(0.051)</td>
<td>(0.064)</td>
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<tr>
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<td>quadratic</td>
<td>quadratic</td>
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<td>trends</td>
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<td>7,911</td>
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<td>R-squared</td>
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<td>0.414</td>
<td>0.418</td>
<td>0.418</td>
<td>0.419</td>
<td>0.125</td>
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Notes. Dependent variable: log reservation wage. The reservation wage measure is monthly. All regressions also include a gender dummy, age and its square, three education dummies, a cubic trend in unemployment duration, a dummy for married, the number of children in the household, the log of unemployment benefits, a dummy for receipt of housing benefits, controls for whether an individual looks for full-time, part-time or any job (the omitted category being “unsure about preferences”), months of social insurance contributions and sixteen region dummies. Unemployment benefits are instrumented by months to benefit expiry. These are obtained by exploiting benefit entitlement rules, based on (nonlinear) functions of age and previous social security contributions. Standard errors are clustered at the year level in columns 1-4, and using 2-way cluster-robust variance (Cameron and Miller, 2013) in column 5. Source: GSOEP.
Table 5
Reservation wages, post-unemployment wages and job finding probabilities in the UK, 1991-2009

<table>
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<tr>
<th>Dependent variable</th>
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<th>6</th>
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</thead>
<tbody>
<tr>
<td>Estimation method</td>
<td>OLS</td>
<td>OLS</td>
<td>OLS</td>
<td>OLS</td>
<td>OLS</td>
<td>OLS</td>
</tr>
<tr>
<td>Log reservation wage</td>
<td>-0.001</td>
<td>-0.020***</td>
<td>-0.022***</td>
<td>0.436***</td>
<td>0.312***</td>
<td>0.308***</td>
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<tr>
<td></td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.007)</td>
<td>(0.021)</td>
<td>(0.036)</td>
<td>(0.037)</td>
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<tr>
<td>Log unemployment rate, aggregate</td>
<td>-0.069</td>
<td>-0.216**</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td>(0.069)</td>
<td>(0.077)</td>
<td>(0.077)</td>
<td>(0.077)</td>
<td>(0.077)</td>
<td>(0.077)</td>
</tr>
<tr>
<td>Log unemployment rate, regional</td>
<td>-0.036</td>
<td>-0.036</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.026)</td>
<td>(0.026)</td>
<td>(0.026)</td>
<td>(0.026)</td>
<td>(0.026)</td>
</tr>
</tbody>
</table>

Year dummies √ quadratic √ quadratic √ quadratic √ quadratic √ quadratic
Trend no no no no no no
Further controls √ √ √ √ √ √
Observations 15,278 14,701 14,700 2,685 2,594 2,593
R-squared 0.018 0.078 0.085 0.217 0.299 0.303

Notes. The wage measure is hourly. Further controls in columns 2, 3, 5 and 6 are a gender dummy, age and its square, three education dummies, a cubic trend in unemployment duration, a dummy for married, the number of children in the household, and eleven region dummies. Standard errors are clustered at the year level. Source: BHPS.
### Table 6
Reservation wages, post-unemployment wages and job finding probabilities in West Germany, 1987-2010

<table>
<thead>
<tr>
<th>Dependent variable</th>
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<th>2</th>
<th>3</th>
<th>4</th>
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<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimation method</td>
<td>OLS</td>
<td>OLS</td>
<td>OLS</td>
<td>OLS</td>
<td>OLS</td>
<td>OLS</td>
</tr>
<tr>
<td>Log reservation wage</td>
<td>0.033***</td>
<td>-0.081***</td>
<td>-0.081***</td>
<td>0.737***</td>
<td>0.390***</td>
<td>0.389***</td>
</tr>
<tr>
<td>(0.007)</td>
<td>(0.011)</td>
<td>(0.011)</td>
<td>(0.023)</td>
<td>(0.034)</td>
<td>(0.034)</td>
<td></td>
</tr>
<tr>
<td>Log unemployment rate, aggregate</td>
<td>-0.067*</td>
<td>-0.243</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>(0.038)</td>
<td>(0.141)</td>
<td></td>
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<td></td>
<td></td>
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<td>Log unemployment rate, regional</td>
<td>-0.018</td>
<td>-0.086</td>
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<td></td>
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<tr>
<td>(0.029)</td>
<td>(0.068)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year dummies</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Trend</td>
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<td>quadratic</td>
<td>quadratic</td>
<td>no</td>
<td>quadratic</td>
<td>quadratic</td>
</tr>
<tr>
<td>Further controls</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
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<td>11,534</td>
<td>11,534</td>
<td>2,984</td>
<td>2,984</td>
<td>2,984</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.006</td>
<td>0.071</td>
<td>0.071</td>
<td>0.239</td>
<td>0.349</td>
<td>0.348</td>
</tr>
</tbody>
</table>

Notes. The wage measure is monthly. Further controls in columns 2, 3, 5 and 6 are a gender dummy, age and its square, three education dummies, a cubic trend in unemployment duration, a dummy for married, the number of children in the household, whether an individual looks for a full-time, part-time or any job (the omitted category is “unsure about preferences”) and sixteen region dummies. Standard errors are clustered at the year level. Source: GSOEP.
### Table 7

**Reservation wages and rents in previous jobs: UK, 1991-2009.**

<table>
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<th></th>
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<th>3</th>
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<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
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<td>Estimation method</td>
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<td>OLS</td>
<td>FE</td>
<td>IV</td>
<td>IV</td>
<td>IV+FE</td>
</tr>
<tr>
<td>Last observed log wage</td>
<td>0.083***</td>
<td>0.101***</td>
<td>0.042***</td>
<td>0.133***</td>
<td>0.177***</td>
<td>0.153***</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.008)</td>
<td>(0.011)</td>
<td>(0.018)</td>
<td>(0.022)</td>
<td>(0.067)</td>
</tr>
<tr>
<td>Last observed log wage</td>
<td>-0.009***</td>
<td>-0.011*</td>
<td>-0.017***</td>
<td>-0.002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* years since observed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.006)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log unemployment rate</td>
<td>-0.183***</td>
<td>-0.182***</td>
<td>-0.174***</td>
<td>-0.159*</td>
<td>-0.156*</td>
<td>-0.166*</td>
</tr>
<tr>
<td></td>
<td>(0.081)</td>
<td>(0.081)</td>
<td>(0.075)</td>
<td>(0.084)</td>
<td>(0.084)</td>
<td>(0.078)</td>
</tr>
<tr>
<td>Trend</td>
<td>quadratic</td>
<td>quadratic</td>
<td>quadratic</td>
<td>quadratic</td>
<td>quadratic</td>
<td>quadratic</td>
</tr>
<tr>
<td>Observations</td>
<td>8,091</td>
<td>8,091</td>
<td>5,737</td>
<td>7,732</td>
<td>7,732</td>
<td>5,520</td>
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<tr>
<td>R-squared</td>
<td>0.284</td>
<td>0.286</td>
<td>0.099</td>
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<tr>
<td>First stage, F-test(a)</td>
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<td></td>
<td></td>
<td>908.9</td>
<td>544.9</td>
<td>48.2</td>
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<tr>
<td>First stage, F-test(b)</td>
<td></td>
<td></td>
<td></td>
<td>292.9</td>
<td>52.8</td>
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</tbody>
</table>

Notes. Dependent variable: log monthly reservation wage. All regressions also include a gender dummy, age and its square, three education dummies, a cubic trend in the number of years since the last job was observed, a dummy for married, the number of children in the household, the log of unemployment benefits, three dummies for capital income (0, <100£, 100£+ per year, where the excluded category is “don’t know”), three dummies for housing tenure (owned with mortgage, local authority rented, other rented, where the excluded category is outright owned) and eleven region dummies. **Instruments used:** predicted industry wage (4-digit) for previous job (column 4); predicted industry wage (4-digit) for previous job and its interaction with years since previous job (columns 5-6). (a) denotes Angrist and Pischke (2009) first-stage F-statistic for the first equation (last observed log wage) and (b) denotes the corresponding statistic for the second equation (last observed log wage*years since observed). Standard errors are clustered at the year level in columns 1-2 and 4-5, and using 2-way cluster-robust variance (Cameron and Miller, 2013) in columns 3 and 6. Source: BHPS.
Figure 1

The Impact of Persistence in Wages and Reservation Wages on the Predicted Cyclicality in Actual Average Wages

Notes: These are the predictions from the model of Section 5D in which the parameter values are as described in section 3B and assuming a steady-state unemployment rate of 6% and a ratio of expected to actual wages of 1.2 which corresponds to a replacement ratio of 57%.
### Appendix Tables and Figures

#### Table A1: Descriptive statistics

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<th>West Germany</th>
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<th></th>
<th></th>
</tr>
</thead>
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<td>Wage sample</td>
<td></td>
<td>Reservation wage sample</td>
<td>Wage sample</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No. obs</td>
<td>Mean</td>
<td>St. dev.</td>
<td>No. obs</td>
<td>Mean</td>
<td>St. dev.</td>
<td>No. obs</td>
</tr>
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<td>Reservation wage</td>
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<td>5.226</td>
<td>6.206</td>
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<td></td>
<td>11221</td>
</tr>
<tr>
<td>Wage</td>
<td></td>
<td>96270</td>
<td>9.866</td>
<td>6.203</td>
<td></td>
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<tr>
<td>Female</td>
<td>14874</td>
<td>0.546</td>
<td>0.498</td>
<td>96270</td>
<td>0.526</td>
<td>0.500</td>
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<td>Age</td>
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<td>34.666</td>
<td>14.024</td>
<td>96270</td>
<td>38.106</td>
<td>11.691</td>
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<td>0.247</td>
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<td>Upper secondary education</td>
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<td>0.478</td>
<td>96270</td>
<td>0.269</td>
<td>0.443</td>
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<td>Lower secondary education</td>
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<td>0.464</td>
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<td>0.405</td>
<td>0.491</td>
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<td>No qualifications</td>
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<td>0.280</td>
<td>96270</td>
<td>0.209</td>
<td>0.407</td>
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<td>Married</td>
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<td>0.514</td>
<td>0.500</td>
<td>96270</td>
<td>0.717</td>
<td>0.451</td>
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<td>No. Kids</td>
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<td>0.917</td>
<td>1.168</td>
<td>96270</td>
<td>0.686</td>
<td>0.965</td>
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<td>Duration in current status (years)</td>
<td>14874</td>
<td>4.387</td>
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<td>96270</td>
<td>4.880</td>
<td>5.969</td>
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<td>Benefits</td>
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<td>11221</td>
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<tr>
<td>Looking for part-time work</td>
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<td>Looking for either</td>
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<td>Months to benefit expiry</td>
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Table A2. Detailed results on reservation wage equations and wage equations for the UK and West Germany

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<th>4</th>
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<td>United Kingdom</td>
<td>West Germany</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log aggregate unemployment rate</td>
<td>-0.175***</td>
<td>-0.165***</td>
<td>0.001</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(0.058)</td>
<td>(0.044)</td>
<td>(0.065)</td>
<td>(0.025)</td>
</tr>
<tr>
<td>Female</td>
<td>-0.102***</td>
<td>-0.263***</td>
<td>-0.188***</td>
<td>-0.265***</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.009)</td>
<td>(0.018)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Age</td>
<td>0.033***</td>
<td>0.073***</td>
<td>0.018***</td>
<td>0.082***</td>
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<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.003)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Age² (/100)</td>
<td>-0.034***</td>
<td>-0.084***</td>
<td>-0.003***</td>
<td>-0.009***</td>
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<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Lower secondary qualification</td>
<td>0.068***</td>
<td>0.193***</td>
<td>-0.016</td>
<td>0.023**</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.008)</td>
<td>(0.024)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>Upper secondary qualification</td>
<td>0.157***</td>
<td>0.361***</td>
<td>0.093***</td>
<td>0.230***</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.007)</td>
<td>(0.023)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Higher education</td>
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<td>Duration in current status³ (years/100)</td>
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<td>Receives housing benefits</td>
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<td>(Year-1990)²</td>
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Notes. Wage measures are hourly for the U.K. and monthly for West Germany. All regressions include region dummies. Standard errors are clustered at the year level. Source: BHPS and GSOEP.

**Business cycle indicator: regional unemployment**

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<tr>
<td>Log wage, lagged</td>
<td>0.759*** (0.005)</td>
<td>0.759*** (0.005)</td>
<td>0.759*** (0.005)</td>
<td>0.073 (0.052)</td>
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</tr>
<tr>
<td>Log unemp rate</td>
<td>0.010 (0.010)</td>
<td>-0.009 (0.011)</td>
<td>-0.036*** (0.012)</td>
<td>-0.051*** (0.011)</td>
<td>-0.018** (0.010)</td>
<td>-0.022* (0.013)</td>
<td>-0.042*** (0.006)</td>
<td>-0.042*** (0.006)</td>
<td>-0.027 (0.018)</td>
<td>-0.018 (0.011)</td>
<td>-0.022** (0.010)</td>
<td>-0.058*** (0.022)</td>
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<td>Log unemp * new job</td>
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<td>-0.035*** (0.005)</td>
<td>-0.012*** (0.005)</td>
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<tr>
<td>Log unemp rate, at start of job</td>
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<td>-0.051*** (0.010)</td>
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</table>

Notes. The wage measure is hourly. All regressions include a gender dummy, age and its square, three education dummies, a cubic trend in job tenure, a dummy for married, the number of children in the household and eleven region dummies. Estimates in column 12 are obtained using the Arellano Bond (1991) estimator for dynamic panel data models. Standard errors are clustered at the (year) level in columns 1-11, and using 2-way cluster-robust variance (Cameron and Miller, 2013) in column 12. Source: BHPS.
Table A4: Estimates of a Wage Equation for West Germany – further estimates with regional controls

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<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
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<td>0.729***</td>
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<td>0.398***</td>
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<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.017)</td>
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<tr>
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<td>0.006</td>
<td>0.013</td>
<td>-0.011*</td>
<td>0.011</td>
<td>0.016</td>
<td>-0.003</td>
<td>0.001</td>
<td>-0.000</td>
<td>-0.012*</td>
<td>-0.024***</td>
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<td>(0.012)</td>
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<tr>
<td>Log unemp * new job</td>
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<td>-0.039***</td>
<td>-0.011</td>
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<td>(0.017)</td>
<td>(0.012)</td>
<td>(0.010)</td>
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<td>0.007***</td>
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</table>

Notes. The wage measure is monthly. All regressions include a gender dummy, age and its square, three education dummies, a cubic trend in job tenure, a dummy for married, the number of children in the household, log hours worked and sixteen region dummies. Estimates in column 12 are obtained using the Arellano Bond (1991) estimator for dynamic panel data models. Standard errors are clustered at the year level in columns 1-11, and using 2-way cluster-robust variance (Cameron and Miller, 2013) in column 12. Source: GSOEP.
Table A5: Estimates of a Reservation Wage Equation for the UK – further estimates with regional controls

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<td>OLS</td>
<td>OLS</td>
<td>OLS</td>
<td>FE</td>
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<td>Log unemployment rate, regional</td>
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<td>-0.054*</td>
<td>-0.064**</td>
<td>0.028</td>
<td>0.048</td>
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<td>(0.026)</td>
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<td>(0.028)</td>
<td>(0.028)</td>
<td>(0.039)</td>
<td>(0.031)</td>
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<td>Year dummies</td>
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Notes. Dependent variable: log reservation wage. The reservation wage measure is monthly. All regressions also include a gender dummy, age and its square, three education dummies, a cubic trend in unemployment duration, a dummy for married, the number of children in the household, the log of unemployment benefits, a dummy for receipt of housing benefits, and eleven region dummies. Standard errors are clustered at the year level in columns 1-15, and using 2-way cluster-robust variance (Cameron and Miller, 2013) in column 5. Source: BHPS.
Table A6: Estimates of a Reservation Wage Equation for West Germany – further estimates with regional controls

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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>11,221</td>
<td>11,221</td>
<td>11,221</td>
<td>11,221</td>
<td>11,221</td>
<td>7,911</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.421</td>
<td>0.413</td>
<td>0.418</td>
<td>0.418</td>
<td>0.419</td>
<td>0.125</td>
</tr>
</tbody>
</table>

Notes. Dependent variable: log reservation wage. The reservation wage measure is monthly. All regressions also include a gender dummy, age and its square, three education dummies, a cubic trend in unemployment duration, a dummy for married, the number of children in the household, the log of unemployment benefits, a dummy for receipt of housing benefits, controls for whether an individual looks for full-time, part-time or any job (the omitted category being “unsure about preferences”), months of social insurance contributions and sixteen region dummies. Unemployment benefits are instrumented, see notes to Table 4. Standard errors are clustered at the year) level in columns 1-15, and using 2-way cluster-robust variance (Cameron and Miller, 2013) in column 5. Source: GSOEP.
Appendix B

The reservation wage conditional on wages

B.1 Proof of result (27)

In deriving (10) from (9) we used the wage bargaining solution (8). Below we will not impose (8) and derive a value of a job paying a wage $w$, conditional on the expected future path of wages. Let’s rewrite (9) as:

$$(r + \phi + s)[W(t;w) - U(t)] = w - z + (\phi - \lambda(t))[W(t;w_n(t)) - U(t)] + E_t \frac{\partial}{\partial \tau} [W(t;w) - U(t)]$$

which has solution:

$$W(t;w) - U(t) = \frac{w - z}{r + \phi + s} + E_t \int_0^\infty e^{-(r+\phi+s)(\tau-t)} (\phi - \lambda(\tau))[W(\tau;w_n(\tau)) - U(\tau)] d\tau$$

(40)

Evaluating at $w = w(t)$ and differentiating yields:

$$\frac{\partial}{\partial t} [W(t;w_n(t)) - U(t)] = \frac{w_n'(t)}{r + \phi + s} + (r + \phi + s)E_t \int_0^\infty e^{-(r+\phi+s)(\tau-t)} (\phi - \lambda(\tau))[W(\tau;w_n(\tau)) - U(\tau)] d\tau$$

$$- (\phi - \lambda(t))[W(t;w_n(t)) - U(t)]$$

$$= \frac{w_n'(t)}{r + \phi + s} - (w_n(t) - z) + (r + \lambda(t) + s)[W(t;w_n(t)) - U(t)]$$

(41)

with solution:

$$W(t;w_n(t)) - U(t) = E_t \int_0^\infty e^{-\int_0^\infty (r+\lambda(\tau) + s)d\tau} \left[ (w_n(\tau) - z) - \frac{w_n'(\tau)}{r + \phi + s} \right] d\tau$$

(42)

Integrating the term in $w_n'(\tau)$ by parts this can be written as:

$$(r + \phi + s)[W(t;w_n(t)) - U(t)] =$$

$$\left( w_n(t) - z \right) - E_t \int_0^\infty e^{-\int_0^\infty (r+\lambda(\tau) + s)d\tau} \left( w_n(\tau) - z \right) (\lambda(\tau) - \phi) d\tau$$

(43)

From (44) and (41) we can derive the following result:

$$E_t \int_0^\infty e^{-\int_0^\infty (r+\lambda(\tau) + s)d\tau} \left( \lambda(\tau) - \phi \right) [W(\tau;w_n(\tau)) - U(\tau)] d\tau$$

$$= \frac{1}{r + \phi + s} E_t \int_0^\infty e^{-\int_0^\infty (r+\lambda(\tau) + s)d\tau} \left( w_n(\tau) - z \right) (\lambda(\tau) - \phi) d\tau$$

(45)

Imposing $W(t;\rho(t)) = U(t)$, (41) and (45) imply (27).

B.2 Proof of result (29)

Let’s differentiate (27) with respect to $t$:
\[
\frac{d\rho(t)}{dt} = -(w_n(t) - z)(\lambda(t) - \phi) + (r + \lambda(t) + s)(\rho(t) - z)
\]  
(46)

Writing in terms of steady-state values (denoted with a star), and linearizing about the steady-state this can be approximated by:

\[
\frac{d\rho(t)}{dt} = (r + \lambda^* + s)(\rho(t) - \rho^*) - \lambda^*(\lambda(t) - \lambda^*)(\rho^* - w_n^*)
\]  
(47)

Under the assumption in (17) that \( \xi(\lambda - \lambda^*) \) all outcomes can be written solely as a function of \( \lambda \). Suppose that:

\[
\theta_{\rho}(\lambda - \lambda^*); \quad \theta_w(\lambda(t) - \lambda^*)
\]  
(48)

We can use (48) both in levels and differentiated to write (47) as:

\[
-\xi\theta_{\rho}(\lambda(t) - \lambda^*) = (r + \lambda^* + s)\theta_{\rho}(\lambda(t) - \lambda^*) - (\lambda^* - \phi)\theta_w(\lambda(t) - \lambda^*) + (\lambda(t) - \lambda^*)(\rho^* - w^*)
\]  
(49)

Collecting terms we have that:

\[
\frac{\partial \rho}{\partial \lambda} = \theta_{\rho} = \frac{(\lambda^* - \phi)\theta_w - (\rho^* - w^*)}{(r + \lambda^* + s + \xi)}
\]  
(50)

Converting (50) to an elasticity with respect to the unemployment rate leads to:

\[
\frac{\partial \ln \rho}{\partial \ln u} = \frac{(\lambda^* - \phi)\ln \frac{w_n^*}{\rho^*} - \left(1 - \frac{w_n^*}{\rho^*}\right)}{(r + \lambda^* + s + \xi)}
\]  
(51)

As \( \frac{\partial \ln u(t)}{\partial \lambda(t)} = -\frac{1}{(s + \lambda)} \), (51) can be written as (29) where we have omitted the asterisks for ease of notation.

### B.3 Derivation of model predictions under the assumption of no-renegotiation on reservation-wage jobs.

In the reservation wage model of Section 4, a job that is accepted at the reservation wage is expected to be re-negotiated at the same rate \( \phi \) as other jobs. We now consider an alternative – extreme – assumption, namely that a job accepted at the reservation wage continues to pay that wage until it ends.

Define \( \Omega(t, \rho) \) to be the value of a reservation wage job that pays \( \rho \) at time \( t \) (the notation is changed to reflect the fact that there is no re-negotiation expected). Using (9):

\[
r[\Omega(t; \rho) - U(t)] = \rho - z - s[\Omega(t; \rho) - U(t)]
\]

\[
+ - \lambda(t)[W(t; w_n(t)) - U(t)] + E_r \frac{\partial \Omega(t; \rho) - U(t)}{\partial t}
\]  
(52)

The differential equation in \( \Omega(t; \rho) - U(t) \) has solution:

\[
[\Omega(t; \rho) - U(t)] = \frac{\rho - z}{r + s} - E_r \int_{t}^{\infty} e^{-(r + s)(t-\tau)} \lambda(\tau) \left[W(\tau; w_n(\tau)) - U(\tau)\right] d\tau
\]  
(53)

Let us define \( S(\tau) = \left[W(\tau; w_n(\tau)) - U(\tau)\right] \). Given \( \Omega(t; \rho(t)) = U(t) \), we obtain:
\[
\rho(t) = z + (r + s) \int_{t}^{\infty} e^{-(r+s)(\tau-t)} \lambda(\tau) S(\tau) d\tau
\]  
(54)

Let’s differentiate (54) with respect to \( t \):
\[
\frac{d\rho(t)}{dt} = -(r + s)\lambda(t)S(t) + (r + s)(\rho(t) - z)
\]  
(55)

Writing in terms of steady-state values (denoted with a star), and linearizing about the steady-state this can be approximated by:
\[
\frac{d\rho(t)}{dt} = (r + s)(\rho(t) - \rho^*) - (r + s)\lambda^*(S(t) - S^*) - (r + s)S^*(\lambda(t) - \lambda^*)
\]  
(56)

As in the proof of the previous result assume that for any variable, \( x \), we have \((x(t) - x^*) = \theta_x(\lambda(t) - \lambda^*) \). Then we can, using the same method as for the previous result, derive:
\[
\frac{\partial \rho}{\partial \lambda} = \theta_{\rho} = \frac{(r + s)\lambda^*\theta_s + (r + s)S^*}{(r + s + \xi)}
\]  
(57)

Differentiating (43) with respect to time we have that:
\[
\frac{\partial S}{\partial t} = \frac{1}{(r + \phi + s)} \frac{\partial w_n}{\partial t} - \left(w_n(t) - z\right) + (r + \lambda(t) + s)S(t)
\]  
(58)

Writing in terms of steady-state values (denoted with a star), and linearizing about the steady-state this can be approximated by:
\[
\frac{\partial S}{\partial t} = \frac{1}{(r + \phi + s)} \frac{\partial w_n}{\partial t} - (w_n(t) - w^*) + (r + \lambda^* + s)(S(t) - S^*) + S^*(\lambda(t) - \lambda^*)
\]  
(59)

Using the '\( \theta \)' notation introduced earlier this can be written as:
\[
-\xi\theta_s(\lambda(t) - \lambda^*) = -\frac{-\xi\theta_w(\lambda(t) - \lambda^*)}{(r + \phi + s)} - \theta_w(\lambda(t) - \lambda^*) + (r + \lambda^* + s)\theta_s(\lambda(t) - \lambda^*) + S^*(\lambda(t) - \lambda^*)
\]  
(60)

Which can be re-arranged to yield:
\[
\theta_s = \frac{(r + \phi + s + \xi)\theta_w}{(r + \lambda^* + s + \xi)(r + \phi + s)} - \frac{S^*}{(r + \lambda^* + s + \xi)}
\]  
(61)

Substituting (61) into (57) leads to:
\[
\frac{\partial \rho}{\partial \lambda} = \theta_{\rho} = \frac{(r + \phi + s + \xi)(r + s)\lambda^*\theta_w}{(r + \lambda^* + s + \xi)(r + \phi + s)(r + s + \xi)} + \frac{(r + s)S^*}{(r + \lambda^* + s + \xi)}
\]  
(62)

Now, from (54) we have that in steady-state:
\[
(\rho^* - z) = \lambda S^*
\]  
(63)

And, from (44), we have that:
\[
S^* = \frac{w^* - z}{r + \lambda^* + s}
\]  
(64)

Combining (63) and (64) and substituting into (62) leads to:
Converting to an elasticity of the reservation wage with respect to unemployment we have that:

\[
\frac{\partial \rho}{\partial \lambda} = \theta = \frac{(r+\phi+s+\xi)(r+s)\lambda^*\theta_n}{(r+\lambda^*+s+\xi)(r+\phi+s)(r+s+\xi)} + \frac{(w_n^*-\rho^*)}{(r+\lambda^*+s+\xi)} \tag{65}
\]

Using \(\frac{\partial \ln u(t)}{\partial \lambda(t)} = -\frac{1}{s+\lambda^*}\), (66) can be written as:

\[
\frac{\partial \ln u}{\partial \lambda} = \theta u = \frac{(r+\phi+s+\xi)(r+s)\lambda^*\frac{w_n^*}{\rho^*} \frac{\partial \ln w_n}{\partial \lambda}}{(r+\lambda^*+s+\xi)(r+\phi+s)(r+s+\xi)} + \frac{(w_n^*-1)}{\rho^*} \frac{\partial \ln u}{\partial \lambda} = \frac{(s+\lambda^*)}{(r+\lambda^*+s+\xi)} \tag{67}
\]

In this case – at the benchmark parameter values – the second term is very small (0.03) but the coefficient on the wage elasticity is large (about 0.9) leading to the prediction that the elasticity of the reservation wage and the wage in new jobs should be very similar, something that is at variance with the data.

**Appendix C**

**The reservation wage with on-the-job search**

The possibility of search on-the-job causes the distribution of wages across workers, \(G(w)\), to be different from the distribution of wage offers \(F(w)\) and it can be shown (see, for example, Burdett and Mortensen, 1998) that the two are related by:

\[
1-G(w) = \frac{1-F(w)}{s+\lambda^*} \frac{s+\lambda^*}{s+1-F(w)} - \frac{s+\lambda^*}{1-F(w)} \tag{68}
\]

Under the usual approximation \(r \approx 0\) (given the size of labour market flows), (32) can be written as:

\[
\rho \approx z + \frac{(\lambda u^* - \lambda^*)[1-F(\rho)]}{s+\lambda^*} \int \rho [1-G(w)]dw = z + \frac{(\lambda u^* - \lambda^*)[1-F(\rho)]}{s+\lambda^*} (\bar{w} - \rho), \tag{69}
\]

where \(\bar{w}\) denotes the average wage across workers. Re-arranging gives:

\[
\rho \approx \frac{\{s+\lambda^*[1-F(\rho)]\} z + (\lambda u^* - \lambda^*)[1-F(\rho)] \bar{w}}{s+\lambda^* [1-F(\rho)]} \tag{70}
\]

The unemployment rate is given by:

\[
u = \frac{s}{s+\lambda^* [1-F(\rho)]} \tag{71}
\]

and substituting this in (70) gives (33).
Appendix D
The fraction of jobs filled by the currently employed

We obtain evidence on the fraction of workers who are recruited from previously existing jobs from the UK Quarterly Labour Force Survey for 1993-2012 (the UK equivalent to the US Current Population Survey), by identifying new jobs created each quarter and looking back at the previous quarter’s employment status of newly-hired workers. The average fraction of workers in new jobs who were previously employed in the UK is 61%. Figure B1 shows the relationship between this fraction, which we will denote by \( \zeta \), and unemployment, and Table B1 report the corresponding regression results. Both indicate that \( \zeta \) is pro-cyclical, with a slope coefficient on the unemployment rate of approximately 1.

We next consider the relationship between \( \zeta \) and \( \lambda^e / \lambda^u \) in a search model with permanent wage dispersion in which workers, when faced with a choice, accept the highest-wage job. Denote by \( f \) the position of a firm in the wage offer distribution. The fraction of workers who employed in firms at or below position \( f \) satisfies:

\[
\left[ s + \lambda^e (1-f) \right] G(f)(1-u) = \lambda^e u f, \tag{72}
\]

which simply equates flows into and out of firms paying \( f \) or below. Re-arranging and using \( u = s / \left( s + \lambda^u \right) \) gives:

\[
G(f) = \frac{sf}{s + \lambda^e (1-f)}. \tag{73}
\]

Total recruits to a firm at position \( f \), \( R(f) \), are given by:

\[
R(f) = \lambda^u u + \lambda^e (1-u) G(f) = \frac{s \lambda^u}{s + \lambda^u} \frac{s + \lambda^e}{s + \lambda^e (1-f)} \tag{74}
\]

and total recruits in the economy are given by:

\[
R = \int_0^1 R(f) \, df = \frac{s \lambda^u}{s + \lambda^u} \frac{s + \lambda^e}{s + \lambda^e (1-f)} = \frac{s \lambda^u}{s + \lambda^e} \frac{s + \lambda^e}{s + \lambda^e} \ln \left( \frac{s + \lambda^e}{s} \right). \tag{75}
\]

As the total recruits from unemployment are given by \( \lambda^u u \) this implies that the fraction of recruits from non-employment, \( 1 - \zeta \), is given by:

\[
1 - \zeta = \frac{\lambda^e}{(s + \lambda^e) \ln \left( \frac{s + \lambda^e}{s} \right) = \frac{\lambda^e / \lambda^u}{\left( \frac{u + \lambda^e}{1-u + \lambda^u} \right) \ln \left( \frac{1+ \lambda^e}{1-u} u \right)}. \tag{76}
\]

Using (76), an average unemployment rate in the UK over 1993-2012 of 6.8% and an average \( \zeta \) of 60.1% imply \( \lambda^e / \lambda^u \approx 0.612 \).

As expected, \( 1 - \zeta \) is increasing in the unemployment rate and decreasing in \( \lambda^e / \lambda^u \). Thus (76) implies an inverse relationship between \( \zeta \) and unemployment even if \( \lambda^e / \lambda^u \) does not.

---

23 We do not adjust this statistic for time aggregation, so it may be possible that a worker in employment this quarter and 3 quarters ago has had an intervening period of non-employment. Given the outflow rates from unemployment in the UK this makes little difference to the computations.
not vary with the cycle. But the strength of the relationship between $\zeta$ and unemployment shown in Table B1 is weaker than we would expect from (76) if $\lambda^e / \lambda^u$ were constant. This implies that, as unemployment rises, so does $\lambda^e / \lambda^u$. The estimates in Table B1 imply $\lambda^e / \lambda^u = 0.726$ for $u = 0.1$ and $\lambda^e / \lambda^u = 0.443$ for $u = 0.04$. According to (33), this mechanisms acts to make the reservation wage even more sensitive to the unemployment rate.

Figure B1

The Cyclicality in the Proportion of New Hires Who Were Previously Employed

Notes: Each point represents a year-region combination. Cells based on less than 50 observations are omitted.

Table B1

Regression Analysis of the Cyclicality in the Proportion of New Hires Who Were Previously Employed

<table>
<thead>
<tr>
<th>Unemployment rate</th>
<th>-1.51**</th>
<th>-1.91**</th>
<th>-1.02</th>
<th>-0.97</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(0.065)</td>
<td>(0.076)</td>
<td>(0.081)</td>
<td>(0.195)</td>
</tr>
</tbody>
</table>

Region effects
Year effects
R squared
No. observations

Notes: Each observation is a region-cell year, and all regressions weighted by cell size. Cells based on less than 50 observations are omitted.
Appendix E

The reservation wage with hyperbolic discounting

Here we present a model of how the presence of hyperbolic discounting can affect the reservation wage. This is considered in Della Vigna and Paserman (2005) and Paserman (2008). In order not to change notation too much we use the version of hyperbolic discounting for continuous time developed by Harris and Laibson (2013) rather than the more familiar discrete time version. In this version there is an arrival rate of a shock – here denoted by \( \alpha \) - which turns one into a person (the future self) who one cares less about than one’s current self. Let us denote the weight one attaches to the future self by \( \gamma \). The expectation is that the future self is a straightforward exponential discounter\(^{24} \). The value function for being employed (5) is now modified to:

\[
\begin{align*}
    rW(w) &= w - s\left[ W(w) - U \right] + \alpha \left[ \psi \tilde{W}(w) - W(w) \right] \\
    &\tag{77}
\end{align*}
\]

where \( \tilde{W}(w) \) is the value of being employed for the future non-hyperbolic self. This value function is the same as (5) i.e. is given by:

\[
\begin{align*}
    r\tilde{W}(w) &= w - s\left[ \tilde{W}(w) - \tilde{U} \right] \\
    &\tag{78}
\end{align*}
\]

The value functions for the unemployed can similarly be written as:

\[
\begin{align*}
    rU &= z + \lambda \left[ W - U \right] + \alpha \left[ \psi \tilde{U} - U \right] \\
    r\tilde{U} &= z + \lambda \left[ \tilde{W} - \tilde{U} \right] \\
    &\tag{79} \text{(90)}
\end{align*}
\]

From (78) and (80) one can readily derive that:

\[
\tilde{W} - \tilde{U} = \frac{w - z}{r + s + \lambda} \\
\tag{81}
\]

and that:

\[
\begin{align*}
    r\tilde{U} &= z + \frac{\lambda [w - z]}{r + s + \lambda} \\
    &\tag{82}
\end{align*}
\]

From (77) and (79) one can then derive that:

\[
W - U = \frac{[w - z] + \alpha \psi (\tilde{W} - \tilde{U})}{r + s + \alpha} \\
&\tag{83}
\]

Using (83), (79) and (81) one can then, after some re-arrangement, derive:

\[
\begin{align*}
    rU &= \frac{r + \alpha \psi}{r + \alpha} \frac{z + \frac{\lambda [w - z]}{r + s + \lambda} \left[ r + s + \lambda + \alpha \psi \right] + \alpha \psi \left[ r + s + \lambda + \alpha \right]}{(r + s + \lambda)(r + s + \lambda + \alpha)(r + \alpha)} \\
    &\tag{84}
\end{align*}
\]

Now let us derive the reservation wage, \( \rho \). This is the wage that makes \( W \) equal to \( U \) i.e. from (77) it must satisfy:

\[^{24}\text{The alternative, sophisticated model, in which it is thought that the future self has hyperbolic preferences in isomorphic to the case where the interest rate is much higher than one would expect and is given by } \left[ r + \eta (1 - \gamma) \right]. \text{ This makes the reservation wage less sensitive to unemployment but just in the standard way of making the weight on the wage very low.} \]
\[ rU = \rho + \alpha \left[ \psi \tilde{W}(\rho) - U \right] \]  

(85)

Now from (78) we have that:

\[ \tilde{W}(\rho) = \frac{\rho + s \tilde{U}}{r + s} \]  

(86)

Combining (85) and (86) leads to the following expression for the reservation wage:

\[ \rho = \frac{(r + s)(r + \alpha)U - \alpha \psi s \tilde{U}}{(r + s + \lambda + \alpha \psi)} \]  

(87)

Substituting in (84) and (82) and re-arranging leads to the following expression:

\[ \rho = z + \frac{\lambda [w - z]}{(r + s + \lambda)} \left[ \frac{(r + s)}{(r + s + \lambda + \alpha)} + \frac{\alpha \psi}{(r + s + \lambda + \alpha \psi)} \right] \leq z + \frac{\lambda [w - z]}{(r + s + \lambda)} \]  

(88)

The inequality shows that the effect of hyperbolic discounting is to reduce the reservation wage. It should also be apparent from (88) that hyperbolic discounting reduces the weight on the wage in the determination of the reservation wage. This is what one would expect as hyperbolic discounting makes the individual more present-oriented. This reduced weight on the wage makes the reservation wage less sensitive to the unemployment rate but also makes the weight on the wage lower. So hyperbolic discounting does not really solve the basic problem.

The calibration used by Harris and Laibson (2012) is (at annual level) \( \alpha = \frac{2}{3} \) and that the arrival rate of a change of self is at least 12. In this case the reservation wage is almost the same as \( z \). This obviously has the potential to increase dramatically the effective interest rate used by workers and this will make the reservation wage very insensitive to unemployment but at the cost of making it insensitive to the expected wage. These calibrations may be plausible for the application they consider (consumption) but do not seem plausible for our application.

**Appendix F**

The model with backward-looking wages and reservation wages

In this section, we sketch a very simple model that incorporates some backward-looking elements in both wage-setting and the determination of reservation wages.

We do not assume that new jobs are automatically at a newly-renegotiated wage- we assume that a fraction \( \beta \) are and the others are, on average, at the average wage that we denote by \( w_a \) so we have:

\[ w_n = \alpha_n w_r + (1 - \alpha_n) w_a \]  

(89)

Here a lower \( \beta \) represents a greater backward-looking component to wages. We assume, as before, that all wages are re-negotiated at rate \( \phi \) which leads to the following equation of motion for average wages:
\[ \dot{w}_a = \frac{\lambda u}{1-u} (w_n - w_a) + \phi (w_r - w_a) \]  

(90)

The first term is the inflow of new jobs (equal to \( s \) in steady-state) and the second term the renegotiation of all jobs. Linearizing about the steady-state we can write (90) as:

\[ \dot{w}_a = s (w_n - w_a^* - w_a + w_a^*) + \phi (w_r^* - w_a - w_a^*) \]  

(91)

Where the terms in \( \lambda \) and \( u \) drop out because \( w_r^* = w_a^* \) in steady-state. The average wage is a backward-looking variable and this can be solved to give:

\[ w_a(t) - w_a^* = (\alpha_s + \phi) \int_{-\infty}^{t} e^{-\alpha_s(t-i)} (w_r(i) - w_r^*) \, di \]  

(92)

Assume – as will be shown to be the case – that we can write newly-renegotiated wages as a function of labour market tightness as:

\[ w_a(t) - w_a^* = (\alpha_s + \phi) \int_{-\infty}^{t} e^{-\alpha_s(t-i)} (w_r(i) - w_r^*) \, di \]  

(93)

Then using:

\[ E\left[ (w_r(t) - w_r^*) \right] = \theta, \quad E\left[ (\lambda(t) - \lambda^*) \right] \]  

(94)

(92) can then be written as:

\[ E\left[ (w_a(t) - w_a^*) \right] = \frac{\theta (\lambda(t) - \lambda^*)}{\alpha_s + \phi + \phi} \]  

(95)

Note that this as an expectation conditional on current labour market tightness.

Now consider the following equation for the surplus (over unemployment) of a job that pays \( w \):

\[ r\left[ W(t;w) - U(t) \right] = w - z + \phi \left[ W(t;w_t(t)) - W(t;w) \right] - s \left[ W(t;w) - U(t) \right] \]

(96)

\[ -\lambda(t) \left[ W(t;w_a(t)) - U(t) \right] + E \frac{\partial [W(t;w) - U(t)]}{\partial t} \]

\[ -(1-\alpha_n) \lambda(t) \left[ W(t;w_a(t)) - U(t) \right] + E \frac{\partial [W(t;w) - U(t)]}{\partial t} \]  

(97)
Using the notation that $S(t; w) = W(t; w) - U(t)$ (this is the surplus of a job that pays wage $w$), this has as a solution:

$$S(t; w) = \frac{w - z}{r + \phi + s}$$

\[+ E \int e^{-(r + \phi + s)(r - t)} \left\{ \left( \frac{1 - \alpha_w}{r + \phi + s} \right) \lambda \left( \frac{w - w_0}{r + \phi + s} \right) - \lambda \right\} \right] d\tau \tag{98}\]

Inspection of (98) shows that $S$ is linear in $w$ so that the difference in the surplus between a newly-renegotiated job and the average job can be written as:

$$S(t; w_1(t)) = S(t; w_0(t)) + \frac{w_1(t) - w_0(t)}{r + \phi + s} \tag{99}$$

So that (98), evaluated at a newly-renegotiated wage can be written as:

$$S(t; w_1(t)) = \frac{w_1(t) - z}{r + \phi + s}$$

\[+ E \int e^{-(r + \phi + s)(r - t)} \left\{ \left( \frac{1 - \alpha_w}{r + \phi + s} \right) \lambda \left( \frac{w_1(t) - w_0(t)}{r + \phi + s} \right) \right] d\tau \tag{100}\]

Differentiating (100) we have that:

$$\frac{dS_r}{dt} = \frac{dw_r}{dt} - \left\{ (\phi - \lambda \lambda + (1 - \alpha_w) \lambda \left( \frac{w_r - w_0}{r + \phi + s} \right) \right\} + (r + \phi + s) \left\{ S_r - \frac{w_r - z}{r + \phi + s} \right\} \tag{101}\]

Where we use the short-hand notation $S_r(t) = S(t; w_r(t))$. Linearizing about the steady-state we can write (101) as:

$$\frac{dS_r}{dt} = \frac{dw_r}{dt} - \left\{ (\phi - \lambda \lambda * + (1 - \alpha_w) \lambda * \left( w_r - w_0 * - w_r + w_0 * \right) \right\} + (r + \phi + s) \left\{ S_r - \frac{w_r - w_0 *}{r + \phi + s} \right\} \tag{102}\]

Again, using the fact that average and re-negotiated wages are the same in steady-state. Now consider taking expectations of (102) conditional on the current level of labour market tightness, $\lambda$. Suppose – as can be verified – that we have:

$$E \left[ (S_r(t) - S_r *) | \lambda(t) \right] = \theta_r \left[ \lambda(t) - \lambda * \right] \tag{103}\]
Solving this we have:

\[
(r + \lambda^* + s + \xi)\theta_R = \frac{(r + \phi + s + \xi) + \frac{1 - \alpha_u}{\alpha_s + \phi + \xi}}{(r + \phi + s)} \theta_R - S_r^* - S_r^* \tag{105}
\]

Now let us consider the reservation wage. First consider the optimal reservation wage i.e. the wage that makes the surplus from a job equal to zero – denote this by \( \rho_o \). From (98) we have

\[
\rho_o(t) = z - (r + \phi + s) E \int_{t}^{\infty} e^{(r + \phi + s)(t - \tau)} \left\{ \left( \phi - \lambda(\tau) \right) S(\tau, w_{r}(\tau)\right\} + \frac{1 - \alpha_u}{r + \phi + s} \left( w_{r}(\tau) - w_{a}(\tau) \right) \right\} d\tau
\]

(106)

Differentiating this we have that:

\[
\frac{d\rho_o}{dt} = (r + \phi + s) \left\{ (\phi - \lambda) S_r + \frac{1 - \alpha_u}{r + \phi + s} \left( w_{r} - w_{a} \right) \right\} + (r + \phi + s) (\rho_o - z) \tag{107}
\]

Linearized about the steady-state this leads to:

\[
\frac{1}{(r + \phi + s)} \frac{d\rho_o}{dt} = (\phi - \lambda^*) (S_r - S_r^*) - S_r^* (\lambda - \lambda^*) + (1 - \alpha_u) \frac{\lambda^*}{r + \phi + s} \left( w_{r} - w_{a} \right) - (w_{r} - w_{a}^*) \tag{108}
\]

If we denote that:

\[
E \left[ (\rho_o(t) - \rho_o^*) \right] \lambda(t) = \theta_{\rho_o} \lambda(t) - \lambda^* \tag{109}
\]

Then, taking expectations of (108) conditional on \( \lambda(t) \) and eliminating all the terms in \( \lambda(t) \) we can derive:

\[
-\xi \theta_{\rho_o} = \frac{(r + \phi + s)}{\theta_R} - S_r^* + \frac{(1 - \alpha_u) \lambda^*}{(r + \phi + s)} \xi \theta_R + \theta_{\rho_o} \tag{110}
\]

Which can be re-arranged to yield:

\[
(r + \phi + s + \xi) \theta_{\rho_o} = (r + \phi + s) \left( \theta_R \right) - \frac{(1 - \alpha_u) \lambda^*}{(r + \phi + s)} \xi \theta_R \tag{111}
\]

Using (105) this can be written as:
\[ \theta_{\rho_b} = \left( \lambda^* - \phi \right) \left( 1 - \alpha_w \right) \lambda^* \xi \right] \left( \alpha_w s + \phi + \xi \right) \left( r + \lambda^* s + \xi \right) \jmath \theta + \left( r + \phi + s \right) S_r^* \left( r + \lambda^* s + \xi \right) \] (112)

For the actual reservation wage we use two models. The first assumes that the reference point in reservation wages is acyclical so that we have:

\[ \rho = \alpha_\rho \rho_o + \left( 1 - \alpha_\rho \right) k \] (113)

so that the actual reservation wage is a weighted average of the optimal reservation wage and the constant reference wage. Here a lower \( \alpha_\rho \) represents a greater reference component to reservation wages. From (113) we have that:

\[ \rho - \rho^* = \alpha_\rho \left( \rho_o - \rho_o^* \right) \] (114)

Taking expectations with respect to current labour market conditions we have that:

\[ \theta_\rho = \alpha_\rho \theta_{\rho_o} \] (115)

As an alternative model we assume the reference point is linked to average wages so will have some cyclicality i.e.:

\[ \rho = \alpha_\rho \rho_o + \left( 1 - \alpha_\rho \right) \left( w_a - k \right) \] (116)

From (116) we have that:

\[ \rho - \rho^* = \alpha_\rho \left( \rho_o - \rho_o^* \right) + \left( 1 - \alpha_\rho \right) \left( w_a - w_a^* \right) \] (117)

Taking expectations with respect to current labour market conditions we have that:

\[ \theta_\rho = \alpha_\rho \theta_{\rho_o} + \left( 1 - \alpha_\rho \right) \left( \frac{w_a + \phi}{\alpha_w s + \phi + \xi} \right) \theta_r \] (118)

Finally, we retain the model in (25) for the determination of wages when they are renegotiated – wages in newly-renegotiated jobs, denoted by \( w_r \) are given by:

\[ w_r = \rho + \mu \] (119)

From which we can derive:

\[ \theta_r = \theta_\rho + \theta_\mu \] (120)

Combining (120) and (118) we have that:
The equations (112) and (121) give us two linear equations in two unknowns that can be solved to give the equilibrium.

\[
\theta_r = \frac{(\alpha_n s + \phi + \xi)(\alpha_r \theta_{rs} + \theta_{r})}{\alpha_r \left(\alpha_n s + \phi + \xi\right)}
\]  

(121)
References


http://www.stanford.edu/~rehall/WageDispersion2013


