Reservation Wages and the Wage Flexibility Puzzle*

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Abstract

Wages are weakly procyclical, implying that shocks to labor demand have a large short-run impact on unemployment, at odds with the quantitative predictions of the canonical job search model. We highlight the role of reservation wages in shaping wage cyclicality and propose that backward-looking reference-points in their determination can reconcile model predictions with the modest estimated cyclicality of both wages and reservation wages. The intuition is that reference dependence anchors reservation wages to backward-looking variables such as past earnings, which are typically less cyclical than the determinants of researvation wages in the canonical, forward-looking model. We provide evidence that reservation wages significantly respond to backward-looking reference points, as proxied by rents earned in previous jobs. Model calibrations based on the estimated degree of reference dependence deliver mildly cyclical wages and reservation wages for plausible value of all other model parameters.

Keywords: job search; reservation wages; wage cyclicality; reference dependence.

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1 Introduction

The currently dominant model of equilibrium unemployment – the search and matching framework developed by Diamond, Mortensen and Pissarides – offers valuable insights into labor market dynamics. However, the canonical version of the DMP model struggles to quantitatively match the relatively large unemployment fluctuations and mild cyclicality of wages. This point was highlighted by Shimer (2005), who noted that the canonical model is unable to deliver the observed unemployment volatility in response to productivity shocks of plausible magnitudes. A rich strand of work has addressed the ensuing unemployment volatility puzzle by emphasizing the role of wage rigidity in accounting for the volatility of unemployment and job vacancies. As wage stickiness is the main determinant of unemployment volatility in a large class of models with search frictions (Hall and Milgrom, 2008, p. 1657), unemployment volatility and wage stickiness are two sides of the same coin, and the unemployment volatility puzzle can be rephrased as the "wage flexibility puzzle."

Empirical evidence has shown that wages are only mildly procyclical. Blanchflower and Oswald (1994) suggest that the elasticity of wages with respect to the unemployment rate is -0.1, and most existing estimates are not far from this benchmark (Card, 1995; Nijkamp and Poot, 2005), including estimates presented in this paper. Using micro data from the British Household Panel Survey (BHPS) and the German Socio Economic Panel (SOEP), we obtain a wage elasticity estimate of -0.17 for the UK, and a much lower (in absolute value) and statistically insignificant estimate for Germany. Such modest degree of cyclicality implies that shocks to labor demand have a much larger short-run impact on unemployment than wages.

This paper suggests a novel solution to the wage flexibility puzzle, which builds on the role of reservation wages as a key determinant of actual wages and their cyclicality. In the canonical model, reservation wages are forward-looking, determined by current and future labor market conditions. We modify this framework by introducing backward-looking reference-dependence in the determination of reservation wages, for which we provide evidence on longitudinal data. The presence of reference points during search, shaped by workers' previous employment history, generates less cyclical reservation wages than the canonical model whenever reference points are less cyclical than labor market conditions. If a worker who lost her job at the start of a recession forms future wage aspirations based on her pre-recession earnings, she would set her reservation wage above the level implied by forward-looking preferences. Hence, reservation wages may not fall in a recession as much as the canonical model predicts, and such rigidity is in turn passed on actual wages via wage setting. Reference-dependent preferences have often featured in labor supply modelling (see, among others, Akerlof and Yellen, 1990, Farber, 2008, and Della Vigna, 2009), and in several contexts reference points are shaped by past experiences and peer influences. Closely related to our setting, Della Vigna et al. (2017; 2020) show that a search model with reference points represented by recent income fares better than conventional models at explaining the pattern of search effort and unemployment exits around the time of benefit exhaustion, and Falk et al. (2006) show that past minimum wages that are no longer in effect influence reservation wages, making them less cyclical than in the canonical model.

By shifting the focus of the wage flexibility puzzle onto reservation wages, this paper also contributes to their empirical analysis. Evidence on reservation wage determination has been typically limited by a scarcity of data.[1] In recent years, survey data for the US, analyzed by Krueger and Mueller (2011; 2012; 2016) and Mui and Schoefer (2020), as well as administrative data for France, analyzed by Le Barbanchon et al. (2019), have greatly added to knowledge on reservation wage determination, but they cover too short a time-span to investigate their cyclicality, which will be the focus of this paper. Our estimates are based on the BHPS and the SOEP, the only two known sources of information on reservation wages that cover more than one full business cycle. We estimate an unemployment elasticity of reservation wages of about -0.15 for the UK, and again obtain a smaller (in absolute value)

[1] Indeed their behavior has often been inferred from the relationship between changes in benefit entitlement, unemployment duration, and re-employment wages (see e.g. recent work by Schmieder et al., 2016, Nekoei and Weber, 2017, Jäger et al., 2020, and Marinescu and Skandalis, 2021).

and only borderline significant elasticity for Germany. Thus we conclude that both wages and reservation wages are characterized by moderate and very similar degrees of cyclicality.

We build a model that encompasses most of the existing proposed solutions to the wage flexibility puzzle and additionally allows for reference-dependent reservation wages. In particular, we incorporate weakly cyclical hiring costs (Pissarides, 2009), infrequent wage negotiations in ongoing job matches (Pissarides, 2009; Rudanko, 2009; Haefke et al. 2013; Kudlyak, 2014) and backward-looking elements in wage negotiations in new matches (Gertler et al., 2008, and Gertler and Trigari, 2009, introduce both innovations).[2] We show that the basic version of the model with forward-looking and continuous wage negotiations can only replicate the modest observed cyclicality of wages if replacement ratios are extremely high (as in Hagedorn and Manovskii, 2008). If one allows for infrequent wage renegotiation and a backward-looking element in wage setting, the model can only address the wage flexibility puzzle if unemployment and wage persistence is implausibly low, the duration of wage contracts is implausibly long or wages are almost entirely backward-looking.

In addition, existing solutions to the wage flexibility puzzle predict reservation wages to be more strongly cyclical than wages. The reason is that, even if wages were acyclical,[3] reservation wages in the canonical model would still be procyclical because workers would be prepared to accept lower wages in a recession when job opportunities are scarce. However, estimates for both the UK and Germany imply very similar degrees of cyclicality in wages and reservation wages – thus we detect a "reservation wage flexibility puzzle" alongside the better known wage flexibility puzzle. We argue that reference dependence in reservation wages can explain the low observed cyclicality in both wages and reservation wages for plausible values of all other model parameters. The intuition is that reference dependence anchors reservation wages to backward-looking variables such as past earnings, which are typically less cyclical than current and future labor market conditions. As supportive evidence, we

[2]See also Rogerson and Shimer (2011) for an overview.

[3]This might happen via a variety of channels, see e.g. Shimer (2005); Hall (2005); Hall and Milgrom (2008); Michaillat (2012).

show that reservation wages are partly shaped by past wages in the micro data, consistent with backward-looking reference points. Low reservation wage cyclicality then translates into low wage cyclicality, as wages in the model are a (roughly acyclical) mark-up on reservation wages.

Finally, this paper makes a methodological contribution. The standard approach simulates the impact of productivity shocks in calibrated DSGE models, and assesses the success of alternative models by comparing simulated outcomes to various data moments. Our alternative approach derives closed-form expressions for the unemployment elasticity of wages and reservation wages that are direct counterparts for the parameters we identify in the data. Predicted elasticities are a function of a small number of model parameters and variables, and transparently illustrate the role of each model element in driving (reservation) wage cyclicality. This approach is in the spirit of the Andrews et al. (2017) method to improve the transparency of structural models and of the sufficient statistic approach of Chetty (2009). We argue that our approach provides a (general) relationship between observed features of the data, which any candidate model that seeks to address the wage flexibility puzzle needs to be consistent with. A further advantage of our approach is that it is agnostic about the source and nature of underlying shocks.

The paper is organized as follows. Section 2 shows estimates of wage and reservation elasticities to unemployment for the UK and Germany. Section 3 lays out a job search model with infrequent wage negotiations and a backward-looking component in wage setting, allowing for reference-dependent reservation wages. Section 4 derives cyclicality predictions in the canonical model. Section 5 discusses cyclicality results under reference dependence and proposes a quantitative solution to the wage flexibility puzzle. Section 6 concludes.

2 Empirical wage and reservation wage curves

We first provide estimates of wage and reservation wage cyclicality, to which model predictions of the later sections will be benchmarked. We use micro data for the UK and West Germany (which, for simplicity, we will refer to as Germany), from the BHPS and the SOEP, respectively. Both are longitudinal studies, running from 1991-2009, and from 1984 onwards, respectively, and their main advantage lies in providing information on reservation wages over a long period of time.[4]

2.1 Estimates of the wage curve

We focus on the elasticity of hourly wages to unemployment, controlling for the usual demographics that influence wages. Our baseline specifications use national unemployment as a business cycle indicator, and include a quadratic trend to capture the effects of productivity growth. This differs from wage curve specifications usually estimated for the US, which control for state-level unemployment and both year and state effects (see, among others, Hines et al. 2001). In the UK and Germany, regional unemployment differentials are highly persistent, making it hard to identify wages cyclicality over and above unrestricted time and region effects. We also present estimates based on regional unemployment in an Appendix, which typically deliver lower (in absolute value) and less precise elasticities.[5]

Our sample period is 1991-2009 for the UK and 1984-2010 for Germany. Descriptive statistics for our samples are reported in Table A1 in the Appendix. Regression results for

[4] The BHPS successor, Understanding Society, started in 2016 and does not collect information on reservation wages.

[5] Our empirical specification is in line with double-log wage curves typically estimated in the literature. Blanchflower and Oswald (1994; 2005) provide estimates of the wage curve for several countries, and suggest an overarching elasticity of wages to unemployment of -0.1. For the UK, Bell, Nickell and Quintini (2002) obtain a short-run elasticity around -0.03, and long-run elasticities between -0.05 and -0.13. There is evidence that this elasticity has increased in the UK over recent decades (Faggio and Nickell, 2005; Gregg, Machin and Fernandez-Salgado, 2014), and that job movers' wages are more procyclical than stayers' (Devereux and Hart, 2006). For Germany, Blanchflower and Oswald (1994) provide estimates between -0.01 and -0.02 using data from the ISSP, and Wagner (1994) finds elasticities between 0 and -0.09 on the SOEP, and slightly higher estimates up to -0.13 on IAB data. Dynamic specifications on IAB data find elasticities consistently lower than -0.1 (Baltagi, Blien and Wolf, 2009). Ammermüller et al. (2010) use data from the German micro census and suggest a -0.03 upper bound for the elasticity in empirical specifications close to ours.

the UK are presented in Table 1.[6] The dependent variable is the log gross hourly 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 annual level. OLS estimates in Column 1 deliver an elasticity of wage to unemployment of -0.165 and highly significant. Column 2 introduces individual fixed-effects, and the unemployment elasticity stays roughly unchanged at -0.169. This is the benchmark estimate that we will compare to the predicted cyclicality of wages in our job search model.

Columns 3 and 4 distinguish between new and continuing jobs, including an interaction term between the unemployment rate and an indicator for the current job having started within the past year. In column 3, the associated coefficient implies that wages in new jobs are 50% more cyclical than on continuing jobs, in line with infrequent wage negotiations. 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. But when job fixed effects are included in column 4, the cyclicality differential is much smaller and borderline significant. As the excess cyclicality in column 4 is identified by unemployment fluctuations within a job spell, and unemployment is highly persistent, we likely lack power to identify an elasticity within job spells, which are on average only observed over 2.6 waves. The alternative explanation is that the (permanent) quality of newly-created jobs is procyclical, and once this is captured by job fixed-effects the excess cyclicality in new jobs is much reduced (see Gertler and Trigari, 2009 and Gertler et al., 2020, for a similar result for the US). Columns 5 and 6 control for lagged unemployment, with or without its current value, and column 7 controls for the lagged dependent variable. In all specifications the wage elasticity to unemployment is negative and significant, and does not fall below -0.17.

Corresponding results for 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

[6] Full estimation results corresponding to specification 2 of Table 1 are reported in Table A2.

the log of monthly hours worked.[7] The estimated wage cyclicality is markedly lower than in UK, in line with previous evidence for Germany, and is only significant for new matches (column 4) or when lagged unemployment is used (columns 7 and 8). Similarly as in the UK, the estimated cyclicality is higher for new hires than for continuing jobs, but such difference becomes statistically insignificant when controlling for job fixed-effects (column 5).[8]

In summary, we estimate elasticities of wages with respect to unemployment between -0.1 and -0.17 for the UK, and markedly higher values (often non statistically significant) for Germany. These results broadly replicate existing estimates (see for example Blanchflower and Oswald, 1994 for international evidence, Faggio and Nickell, 2005, for the UK and Ammermueller et al. 2010, for Germany), but they provide a useful context for estimates of the cyclicality of reservation wages, presented below.

2.2 Estimates of the reservation wage curve

The role of reservation wages in business cycle fluctuations is underexplored, and to the best of our knowledge there exist no estimates on their cyclicality. An obvious reason for this gap in the literature is the scarcity of reservation wage data. For the US, a few studies analyze reservation wage data occasionally collected (Feldstein and Poterba, 1984; Holzer, 1986; Petterson, 1998; Ryscavage, 1988) and early work for the UK has used cross-section survey data (Lancaster and Chesher, 1983; Jones, 1988). More recent survey data on job search and employment preferences for the US (Krueger and Mueller 2011; 2012; 2016; Hall and Mueller 2018; Mui and Schoefer, 2020), as well as rich administrative data for France (Le Barbanchon et al. 2019) have substantially advanced the empirical study of reservation wages, but the time series dimension available is too short to investigate their cyclical properties.

Both the BHPS and the SOEP provide micro data on reservation wages over long time

[7] The use of monthly, as opposed to hourly, wages is motivated by comparability with the reservation wage regressions of the next subsection, as information on reservation wages is only available at the monthly level.

[8] Specifications that control for regional rather than aggregate unemployment are shown in Table A3 for the UK and in Table A4 for Germany. For both countries, and across various specifications, the estimated wage cyclicality is lower than when using aggregate unemployment as a business cycle indicator.

horizons. 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. Combining answers to these questions we construct a measure of the hourly net reservation wage, and deflate it using the aggregate consumer price index. A similar question is asked of SOEP respondents in all waves since 1987, except 1990, 1991 and 1995. The reservation wage information is elicited in monthly terms and is not supplemented by information on expected hours, thus specifications for Germany use monthly reservation wages as the dependent variable, and control for whether an individual is looking for a full-time or part-time job, or a job of any duration. In the BHPS the question on reservation wages is asked of all individuals who are out of work in the survey week and are actively seeking work or, if not actively seeking, would like to have a regular job. In the SOEP the same question is asked of all individuals who are currently out of work but contemplate going back to work in the future. Descriptive statistics for the reservation wage samples are reported in Table A1.

As the reservation wage is predicted to respond to expected wage offers, reservation wage equations should control for factors featuring in wage curves, namely human capital components, regional and aggregate effects. Cyclical factors, as captured by the unemployment rate, are likely to affect the reservation wage via both the probability of receiving an offer and the expected wage offer conditional on human capital. The reservation wage is also expected to depend on the utility while out of work, which we proxy using available measures of welfare benefits and family composition.

The estimates for the UK reservation wage equation 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, and for the amount of benefit income received. Column 1 shows an elasticity of reservation wages to unemployment of -0.175, which rises slightly to -0.146 when individual fixed-effects are introduced in column 2. Columns 3 and

4 control for lagged unemployment, and the associated cyclicality is somewhat smaller than in specification that only control for current unemployment.

We estimate similar reservation wage specifications for Germany,[9] and the results are reported in Table 4. While the elasticity of reservation wages with respect to current unemployment is wrongly signed, the elasticity with respect to lagged unemployment is negative and significant.[10]

We conclude that there is fairly limited cyclicality in reservation wages. Specifications that control for individual fixed-effects deliver an elasticity of -0.146 in the UK, and about zero in Germany (or -0.082 when using lagged unemployment). Such elasticities are very close to the corresponding wage elasticities (-0.169, about zero, and -0.065, respectively). While there may be concerns about the quality of reservation wage data, Appendix A shows that their correlation with job search outcomes has the sign predicted by search theory. Ceteris paribus, higher reservation wages lead to longer job search spells and higher entry wages upon job finding. Hence we argue that reservation wage data, though likely noisy, embody meaningful information about job search behavior.

3 The model

This section lays out a search and matching model to derive implications for the cyclicality of wages and reservation wages, as estimated in the previous section. Our set-up encompasses elements of wage rigidity proposed by previous work on the wage flexibility puzzle, namely acyclical hiring costs (Pissarides, 2000), infrequent wage negotiations in ongoing matches, and backward-looking elements in wage setting for new hires (Gertler et al., 2008; Gertler

[9]In Germany the duration of unemployment compensation is a nonlinear function of age and previous social security contributions, which are potentially correlated to individual characteristics that also determine wages. We exploit nonlinearites in entitlement rules to obtain the number of months to benefit expiry, which is used as an instrument for unemployment benefits in Table 4 (in which age and months of social security contributions feature linearly in all regressions). No instruments are required for the UK case, in which the duration of benefits is determined by job search behavior rather than previous employment history.

[10]As for wage cyclicality, estimates based on regional unemployment tend to deliver lower reservation wage cyclicality across various specifications, as shown in Table A5 for the UK and Table A6 for Germany.

and Trigari, 2009; Pissarides, 2000; Rudanko, 2009; Haefke et al., 2013; Kudlyak, 2014). In addition, we emphasize the role of reservation wages in wage cyclicality, and innovate on the canonical model by allowing for reference dependence in their determination, as captured by the influence of past wages.

For simplicity, we assume homogeneous workers and jobs, implying homogeneous wages and reservation wages in steady-state. Outside steady-state, there is heterogeneity across wages set at different times, due to infrequent negotiations, and heterogeneity across wages set at the same time, due to heterogeneity in reservation wages, in turn driven by reference-dependence.

3.1 Employers

Each firm has one job, which is either filled and producing or vacant and searching. We denote by $J(w_i; w_i^l, t)$ the value at time t of a filled job paying a wage w_i to worker i, whose wage in the previous job was w_i^l. The presence of backward-looking reference dependence makes the previous wage a state variable in the value of the current job, as it shapes the reservation wage and future wage negotiations. This is the only state variable that we need to keep track of; the impact of all other state variables, including the current and expected future labor market conditions can, without loss of generality, be subsumed within the general dependence of the value function on time. Wages are occasionally renegotiated and renegotiation opportunities are assumed to arrive at an exogenous rate ϕ,[11] leading to a staggered wage setting process à la Calvo (1983). We assume that, upon renegotiation, neither party has the option to continue the match at the current wage, which thus plays no role in wage bargaining. The renegotiated wage, denoted by $w_r(w_i^l, t)$, depends on the past wage as well as on other factors absorbed in time dependence.

[11] Renegotiation opportunities arrive exogenously, 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 introduce an extra source of cyclicality as it implies more frequent renegotiation in recessions.

Based on these assumptions, a job's value function is given by:

$$\begin{aligned} rJ(w_i; w_i^l, t) =& p(t) - w_i - s\big[J(w_i; w_i^l, t) - V(t)\big] \\ & + \phi\big[J(w_r(w_i^l, t); w_i^l, t) - J(w_i; w_i^l, t)\big] + E_t \frac{\partial J(w_i; w_i^l, t)}{\partial t}, \end{aligned} \tag{1}$$

where $V(t)$ is the value of a vacant job at time t, $p(t)$ is the productivity of a job-worker pair, and s is the separation rate, which is assumed to be exogenous (but we will consider a short extension with countercyclical separations in Subsection 4.1). The first term on the second line represents the change in job value resulting from renegotiation, which embodies the assumption that the past wage is not re-set upon renegotiation and stays equal to the wage in the previous job. Note that, conditional on the current wage, the lagged wage only affects the value function through its role in future renegotiations.

The value of a vacant job at time t is given by:

$$rV(t) = -c(t) + q(t)E_t[J(w_i; w_i^l, t) - V(t) - C(t)] + E_t \frac{\partial V(t)}{\partial t}. \tag{2}$$

Following Pissarides (2009) and Silva and Toledo (2009), hiring involves both a flow cost, $c(t)$, and a fixed cost, $C(t)$. $q(t)$ is the rate at which vacancies are filled, which varies over time via the impact of shocks on labor market tightness, and we can be agnostic about their nature. As is standard, we assume free entry of vacancies, thus $V(t) = 0$.

The $E_t[J(w_i; w_i^l, t)]$ term captures uncertainty about wages in future matches. When a firm and a worker match, they negotiate a wage with probability α, while with probability $1 - \alpha$ a pre-existing ("old") wage is paid, randomly drawn from the existing cross-section of wages. The extent of job creation at old wages (represented by $1 - \alpha$) is a backward-looking element in wage setting. The combinations of parameter values for α and ϕ determines the relative cyclicality of wages in new versus continuing matches. In Section 2.1 we found suggestive evidence that wages in new matches are more procyclical on than in continuing matches. This is predicted whenever the opportunity to renegotiate the wage in an ongoing job happens infrequently (low ϕ), relative to the chance to negotiate a new wage upon hiring (high α).

3.2 Workers

Workers can be either unemployed and searching or employed and producing. The value of being employed at time t at a wage w_i when one's previous wage was w_i^l is given by:

$$\begin{aligned} rW(w_i; w_i^l, t) = &w_i + \phi[W(w_r(w_i^l, t); w_{il}, t) - W(w_i; w_i^l, t)] \\ &- s\big[W(w_i; w_i^l, t) - W(\rho(w_i^l, t); w_i^l, t)\big] + E_t \frac{\partial W(w_i; w_i^l, t)}{\partial t}. \end{aligned} \tag{3}$$

The first term in (3) is the utility flow from working at the current wage w_i. The second term is the change in the value of employment when a renegotiation opportunity arises. The first term on the second line is the change resulting from job loss. We model the utility of unemployment as the utility of being in a job paying $\rho(w_i^l, t)$, which denotes the reservation wage at time t for a worker with a previous wage w_i^l.[12]

The value of being unemployed at time time t when one's previous wage was w_i^l is:

$$rU(w_i^l, t) = z + \lambda(t) E_t[W(w_i; w_i^l, t) - U(w_i^l, t)] + E_t \frac{\partial U(t)}{\partial t}, \tag{4}$$

where z is the flow utility when unemployed, assumed to be fixed in the short-run,[13] and $\lambda(t)$ is the rate at which the unemployed find jobs, which varies over time with labor market tightness. Note that, in contrast to the canonical search model, the value of being unemployed does not appear directly in the perceived consequence of job loss in (3); this is because we allow reservation wages to potentially differ from the level that makes a worker indifferent between working and not working.

[12] Similarly as in equation (1), equation (3) assumes that, when thinking about the capital loss from job separation, individuals keep using their current previous wage as the reference point.

[13] Chodorow-Reich and Karabarbounis (2016) argue in favor of pro-cyclical z, leading to more pro-cyclical wages, making it even harder for the canonical model to address the wage flexibility puzzle.

3.3 Wage determination

We assume Nash bargaining, whereby the wage negotiated at time $t, w^r(w_i^l, t)$, is such that:

$$w^r(w_i^l, t) = argmax_{w_i}[W(w_i; w_i^l, t) - W(\rho(w_i^l, t); w_i^l, t)]^\beta [J(w_i; w_i^l, t) - V(t)]^{1-\beta}, \quad (5)$$

where β denotes workers' relative bargaining power. Using value functions (1)-(3), the following result can be proved:

Proposition 1. *Newly-renegotiated wages are given by:*

$$\begin{aligned} w^r(w_i^l, t) = (1-\beta)\rho(w_i^l, t) + \beta \Big\{ & (r+s+\phi)\mu(t) + [\alpha w^{ru}(t) + (1-\alpha)w^a(t)] \\ & + \frac{\phi}{r+s+\phi}\frac{\partial w^r}{\partial w_i^l}[w^{lu}(t) - w_i^l] \Big\}, \end{aligned} \quad (6)$$

where $\mu(t) = C(t) + c(t)/q(t)$, $w^{ru}(t)$ is the average newly-negotiated wage for workers recruited from unemployment, $w^a(t)$ is the average wage in the economy and $w^{lu}(t)$ is the average lagged wage for the unemployed.

Proof. See Appendix B.1. □

The structure of equation (6) is intuitive. Negotiated wages are a weighted average of two terms, where weights are given by the firm's and worker's bargaining power, respectively. The first term is the reservation wage. The second term has three components. The first component, $(r + \phi + s)\mu(t)$, is related to hiring costs, which the firm would save by hiring the current worker instead of searching for a new one. These include the fixed cost $C(t)$ and the flow cost $c(t)$, multiplied by the expected duration of search, $1/q(t)$. The second component, $\alpha w^{ru}(t) + (1-\alpha)w^a(t)$, is the expected wage the firm would pay if they needed to hire another worker. The third component, $\frac{\phi}{r+s+\phi}\frac{\partial w^r}{\partial w_i^l}[w^{lu}(t) - w_i^l]$, is related to the difference in the lagged wage between the average and the current unemployed worker, capturing differences in the respective costs of future renegotiations (note that this component is multiplied by the renegotiation rate ϕ and by the sensitivity of negotiated wages to lagged wages, $\partial w^r/\partial w_i^l$). We show below that $\partial w^r/\partial w_i^l$ is just a function of model parameters, thus a constant. Collectively the second term in (6) can be thought of as the cost of replacing the current worker with another, part of which consists of hiring costs and part of which consists of expected differences in wages paid.

Despite the relatively unrestricted nature of the model assumptions, equation (6) gives a fairly simple expression for the negotiated wage, the wage curve. This is entirely expressed in terms of currently-dated variables, with the past and the future entering negotiations only to the extent that they affect the reservation wage and the average wage in the economy. Note further that the negotiated wage for an individual worker is a function of a set of average wages, implying that we do not need to keep track of higher moments of the wage distribution. This property follows from the linearity of value functions (1)-(3).[14]

The dependence of wages on the reservation wage in (6) is a key result in this model, as it implies that any element that makes reservation wages less cyclical will also make wages less cyclical. We next turn to the determination of reservation wages.

3.4 The reservation wage

In the canonical model without reference dependence, the reservation wage is set at the level that makes a worker indifferent between work and unemployment both now and in the future. We call this the optimal (i.e. forward-looking) reservation wage and denote it by $\rho^o(t)$. This is a function of time alone, and the lagged wage plays no role in its determination. The precise form of $\rho^o(t)$ is not needed as yet and will be derived later.

We contrast the optimal reservation wage model with one that deviates from purely forward-looking behavior by introducing backward-looking reference points, which we assume to be (partly) determined by recent earnings. The idea of backward-looking reference dependence is consistent with prospect theory, in which outcomes are evaluated against a

[14]This result differs from that of Krusell et al. (2010), whose assumption of risk-averse individuals introduces non-linearities in value functions.

natural benchmark represented by the status quo (Kahneman and Tversky, 1979). It is also consistent with the concept of aspiration-based references points whenever individuals expect to maintain the status quo with some probability (Loomes and Sugden, 1986; Koszegi and Rabin, 2006).[15] In the labor market context, the role of reference points in labor supply determination has been emphasized in seminal work by Akerlof and Yellen (1990) and more recent contributions by Farber (2008) and Della Vigna (2009), among others. Closely related to our approach, the experiment of Falk et al. (2006) shows that minimum wages have lasting effects on subjects' reservation wages, even after their removal; Della Vigna et al. (2017) show evidence on the role of past earnings as reference points during unemployment, causing the unemployment hazard to fall upon benefit exhaustion; Della Vigna et al. (2020) offer similar conclusions based on the time pattern of job search effort during unemployment; and Marinescu and Skandalis (2021) relate the fall in unemployment exit upon benefit exhaustion to a combination of reference dependence, dynamic selection and duration dependence. Finally, the presence of reference dependence in reservation would be consistent with limited impacts of potential benefit duration on reservation wages, as detected by recent papers that investigate the effects of UI reforms on the search process and its outcomes (Schmieder et al. 2016; Nekoei and Weber 2017; Le Barbanchon et al. 2019; Jäger et al. 2020).

Backward-looking reference points are introduced by modelling the deviation of the current reservation wage, $\rho(w_i^l, t)$, from its steady-state value, ρ^*, in two components. The first embodies the deviation of the optimal reservation wage, $\rho^o(t)$, from its steady-state value, ρ^*. The second embodies the deviation of the reference wage, w_i^l, from its steady-state value,

[15] Kahneman and Tversky (1979) provide evidence of backward-looking reference points for the retail market, in which firms and customers use past prices as benchmark for judging the fairness of a transaction, and Genesove and Mayer (2001) and Bracke and Tenreyro (2020) provide similar evidence for the housing market.

w^*. These assumptions lead to the following expression for the reservation wage:[16]

$$\rho(w_i^l, t) - \rho^* = \alpha_\rho(\rho^o(t) - \rho^*) + (1 - \alpha_\rho)\alpha_l(w_i^l - w^*), \tag{7}$$

where α_ρ captures the weight of forward-looking behavior in reservation wages, w_i^l is the last observed wage before job loss, and α_l captures its role in reference points. Lower α_ρ implies stronger reference dependence in reservation wages and lower α_l implies lower cyclicality in reference points. The special case $\alpha_\rho = 1$ represents the canonical model.

We can now solve for $\partial w_i^r / \partial w_i^l$, by combining (6) and (7):

$$\frac{\partial w_i^r}{\partial w_i^l} = \frac{(1-\beta)(1-\alpha_\rho)\alpha_l}{r + s + \beta\phi}. \tag{8}$$

The intuition is that the lagged wage affects the negotiated wage to the extent that it affects the reservation wage ($(1 - \alpha_\rho)\alpha_l$) and the extent to which the reservation wage affects the negotiated wage ($1 - \beta$), with a multiplier reflecting the direct impact of the lagged wage on the negotiated wage (from (6)), over and above its impact on the reservation wage.

3.5 From the Individual to the Aggregate

We can easily move from individual to aggregate-level relationships by taking averages, as the underlying relationships are linear. Taking averages of (7) gives the following expressions for the average reservation wage of the unemployed, $\rho^u(t)$, and the employed, $\rho^e(t)$, respectively:

$$\rho^u(t) - \rho^* = \alpha_\rho[\rho^o(t) - \rho^*] + (1 - \alpha_\rho)\alpha_l[w^{lu}(t) - w^*] \tag{9}$$

$$\rho^e(t) - \rho^* = \alpha_\rho[\rho^o(t) - \rho^*] + (1 - \alpha_\rho)\alpha_l[w^{le}(t) - w^*], \tag{10}$$

[16] This modelling choice for reference dependence is especially convenient for deriving tractable analytical results for the cyclicality of wages and reservation wages. Importantly, it delivers the same wage curve as a model that embodies reference dependence directy in the utility function (see e.g. Della Vigna et al., 2017). However, the latter model delivers less tractable analytical results for wage cyclicality.

where $w^{lu}(t)$ and $w^{le}(t)$ denote their respective average lagged wages. These expressions are identical functions of the average lagged wage, but this differs between the employed and the unemployed, implying that their negotiated wages will also differ.

Substituting (8) into (6) and taking averages leads to the following expressions for the average renegotiated wage for the unemployed and the employed, respectively:

$$w^{ru}(t) = (1-\beta)\rho^{u}(t) + \beta\left\{(r+\phi+s)\mu(t) + [\alpha w^{ru}(t) + (1-\alpha)w^{a}(t)]\right\} \tag{11}$$

$$\begin{aligned} w^{re}(t) = (1-\beta)\rho^{e}(t) + \beta\Bigg\{ & (r+\phi+s)\mu(t) + [\alpha w^{ru}(t) + (1-\alpha)w^{a}(t)] \\ & - \frac{\phi}{r+s}\frac{(1-\beta)(1-\alpha_{\rho})\alpha_{l}}{r+s+\beta\phi}\left[w^{le}(t) - w^{lu}(t)\right]\Bigg\}. \end{aligned} \tag{12}$$

4 The Predicted Cyclicality of Wages

To assess the performance of alternative models vis-à-vis the wage flexibility puzzle, we derive closed-form expressions for the linear projection of relevant (log) wage variables on (log) unemployment. We will compare this predicted elasticity to the estimates of Section 2, and in Section 4.4 we will compare our analytical results to those simulated from a standard model with productivity shocks. We first illustrate comparisons across steady states characterized by different unemployment rates, before considering the general case in which labor market conditions vary over time.

4.1 A comparison of steady states

In steady-state, labor market conditions are constant and all wages, whether pre-existing or newly-negotiated, are equal. From (6), steady-state wages can be written as:

$$w^{*} = \rho^{*} + \tilde{\beta}(r+\phi+s)\mu, \tag{13}$$

where $\tilde{\beta} = \beta/(1-\beta)$.

The steady-state reservation wage is obtained in the following Proposition:

Proposition 2. *The steady-state reservation wage can be written as:*

$$\rho^* = z + \frac{\lambda^* - \phi}{r + \lambda^* + s}(w^* - z). \tag{14}$$

Proof. See Appendix B.2. □

Combining (13) and (14) leads to the steady-state wage equation:

$$w^* = z + \tilde{\beta}(r + \lambda^* + s)\mu, \tag{15}$$

which can be used to describe how wages and unemployment co-vary across steady-states. There are two reasons why wages may be procyclical. First, λ^* is negatively related to the steady-state unemployment rate, given by $u^* = s/(s + \lambda^*)$. Second, hiring costs μ may also vary with unemployment. If there is a flow component to the cost of filling vacancies ($c > 0$), hiring costs rise when unemployment is low, as vacancy duration rises (q falls). Moreover, vacancy costs themselves (c and C) may vary, and they are often indexed to productivity (Pissarides, 2009) or wages (Hagedorn and Manovskii, 2008, do both). In either case hiring costs are pro-cyclical, accentuating the pro-cyclicality of wages. To give the canonical model the best chance to match the data, we assume that hiring costs are acyclical, which in turn implies that the value of jobs to firms is also acyclical. In line with this assumption, most estimates of vacancy costs find the fixed cost component to be more important than the flow cost, so we assume $c = 0$ and that C does not vary with short-term fluctuations in productivity and/or wages. Thus μ is constant.[17] Using the steady-state relationship between λ^* and u^*, (15) can be written as:

$$w^* = z + \tilde{\beta}\mu\left(r + \frac{s}{u^*}\right). \tag{16}$$

[17] In the long-run, one has to assume that the vacancy cost is linked to productivity and/or wages; otherwise long-run growth would drive the relative cost of filling vacancies to zero.

One of the key features of the wage curve (16) is that productivity shocks (or other shocks to labor demand) only affect negotiated wages through their impact on unemployment. One can interpret the wage curve as akin to a labor supply curve that relates wages to the quantity of labor, proxied by the unemployment rate. The slope of the curve determines the relative cyclicality of wages and unemployment and is our parameter of interest, which we identify from (an estimable version of) the wage curve, without having to model labor demand shocks.

Differentiating (16) we obtain:

$$\epsilon_{w^*} = -\frac{\beta\mu}{1-\beta}\frac{s}{w^* u^*} = -\frac{w^* - z}{w^*}\frac{s}{ru^* + s} = -(1-\eta)\frac{s}{ru^* + s}, \tag{17}$$

where $\epsilon_x = \partial \ln x / \partial \ln u$ is used to denote the unemployment elasticity of any generic variable x and $\eta = z/w^*$ denotes the replacement ratio. According to (17), the steady-state elasticity of wages is a function of a small number of model parameters. As s is substantially larger than ru, the $s/(ru^* + s)$ ratio is close to 1. Based on UK labor market data, the monthly separation rate is 0.01 over our sample period, and $u^* = 0.067$. Using a standard monthly interest rate of 0.003, $s/(ru^* + s) = 0.98$. Corresponding values for Germany give almost exactly the same result. Equation (17) then implies that the elasticity of wages should be almost exactly equal to one minus the replacement ratio. The Blanchflower and Oswald (1994) benchmark estimate of -0.1 would require a replacement ratio of 0.9, very close to the 0.95 calibration used by Hagedorn and Manovskii (2008). Our -0.169 estimate for the UK (column 2 in Table 1) requires a replacement ratio of 0.83, and our -0.028 estimate for Germany (column 2 in Table 2) requires a replacement ratio of 0.97.[18]

[18] As in most related work, we assume that variation in unemployment is associated with variation in job-finding rates, at constant job separation rates. However, countercyclical separations would amplify the impact of shocks on unemployment, as in recessions unemployment increases both because it is harder to find a job and it is easier to be made redundant (Fujita and Ramey, 2009, Elsby and Michaels, 2013, Robin, 2011). If we allow for countercyclical separations, differentiating (16) gives $\epsilon_{w^*} = -(1-\eta)(\frac{s}{ru+s} - \frac{su}{r+su}\epsilon_s)$, implying that a lower replacement ratio is necessary to match a given elasticity of wages to unemployment, as $\epsilon_s > 0$. But the role of countercyclical separations is quantitatively very small. Using the estimate of Elsby and Michaels (2013), ϵ_s is about 0.17 in the UK and 0.47 in Germany, and the required replacement ratio to match a -0.169 (-0.028) elasticity in the UK (Germany) is 0.82 (0.97).

These values seem implausibly high. The OECD Social Policy Database[19] computes 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 UK and Germany was 0.60 and 0.66, respectively. These estimates do not assign a value to the increase in home time for the unemployed, and there is no definitive evidence on the size of this component. Krueger and Summers (1988) report that home production and leisure activities increase during unemployment, but at the same time the unemployed enjoy these activities less than the employed.

We propose an approach to calibrate the replacement ratio that does not require assumptions about the value of home time. Rearranging (14), one can obtain the steady-state relationship between the replacement ratio and the ratio of reservation wages to wages, ρ^*/w^*:

$$1 - \frac{\rho^*}{w^*} = (1-\eta)\frac{r+\phi+s}{r+\lambda^*+s}. \tag{18}$$

In the BHPS, unemployed workers are asked about their reservation wage and their expected wage upon re-employment, and the answers to these questions can be used to estimate ρ^*/w^*, whose median value is 0.80. As the duration of a wage contract, $1/\phi$, is typically longer than the duration of an unemployment spell, $1/\lambda$, equation (18) implies an upper bound for the replacement ratio of 0.80. And for realistic values of λ and ϕ (see Table 5 below), this will be markedly lower. If wages are renegotiated on average once a year ($\phi = 0.083$ on monthly data) and the job finding rate is set to its average level observed during our sample period for the UK ($\lambda = 0.139$ monthly), the replacement ratio equals 0.69. This value is somewhat higher than the benefit replacement ratio estimated from the OECD data, but well below the level required to match the estimated wage elasticity.

The prediction of the canonical model for the cyclicality of reservation wage presents an additional challenge, which has been under appreciated in the literature. In steady state,

[19] http://www.oecd.org/els/soc/$NRR_Over5years_EN$.xlsx

equation (13) and the assumption of acyclical hiring costs deliver the followng expression:

$$\epsilon_w = \frac{\rho^*}{w^*}\epsilon_\rho > \epsilon_\rho, \tag{19}$$

i.e. wages are less cyclical than reservation wages, and the ratio between the respective elasticities is given by $\rho^*/w^* = 0.80$. This prediction is not satisfied in the data. Estimates for the UK reveal very similar degrees of cyclicality in wages and reservation wages ($\epsilon_w/\epsilon_\rho = 0.169/0.146 = 1.16$), and estimates for Germany give a near zero elasticity for the reservation wage. The model prediction of "excess" reservation wage cyclicality also holds outside steady state in a model without reference dependence, as will be shown in Section 4.3, and reference dependence will be necessary to break this result, as shown in Section 5.

4.2 Model dynamics: Building blocks.

We next consider an economy outside steady-state. Our parameter of interest, the unemployment elasticity of wages, is defined as the coefficient on log unemployment in a linear projection of log wages on log unemployment. For any variable x, we define the parameter θ_x, indicating the linear projection of $x(t)$ on $u(t)$:

$$E_t\left[(x(t) - x^*) \mid (u(t) - u^*)\right] = \theta_x(u(t) - u^*), \tag{20}$$

where x^* and u^* indicate steady-state values. Given θ_x, one can obtain the elasticity of $x(t)$ with respect to $u(t)$, evaluated at the steady state, as $\epsilon_x = u^*\theta_x/x^*$.

Outside steady-state, the persistence of variables is also relevant. We thus define, for any variable $x(t)$:

$$E_t\left[\frac{dx(t)}{dt} \mid (u(t) - u^*)\right] = -\xi_x E_t\left[(x(t) - x^*) \mid (u(t) - u^*)\right] = -\xi_x\theta_x, \tag{21}$$

where ξ_x can be interpreted as the speed at which $x(t)$ converges to its steady state, which is inversely related to its degree of persistence. ξ_x is positive for backward-looking variables and negative for forward-looking ones.

4.3 Model dynamics without reference-dependence.

We first describe model dynamics in an economy without reference-dependence ($\alpha_\rho = 1$), in which reservation wages are at their optimal value and lagged wages are irrelevant. Newly-negotiated wages and average wages may differ due to the backward-looking component in wage determination ($\alpha < 1$) and occasional renegotiation ($\phi < \infty$). This exercise is valuable for two reasons. First, it provides a natural benchmark for the general case with reference dependence (shown in Section 5). Second, it shows that our analytical results for the elasticity of wages and reservation wages are nearly identical to simulated elasticities obtained assuming a standard stochastic process for labor productivity (see Section 4.4 below).

Using the notation of Section 4.2 we can prove:

Proposition 3. *With no reference dependence and a constant mark-up*

(a) the elasticity of newly-negotiated wages with respect to unemployment is given by:

$$\epsilon_r = -(1-\eta)\frac{s - u^*\xi_u}{ru^* + s}\,\frac{r+\phi+s}{(r+\phi+s+\xi_\rho)(1+\widetilde{\beta}\Gamma) + \Gamma\left[\lambda^*(1+\widetilde{\beta}) - \widetilde{\beta}\phi\right]}, \tag{22}$$

where:

$$\Gamma = \frac{(1-\alpha)\xi_w}{\alpha s + \phi + \xi_w}; \tag{23}$$

(b) the elasticity of average wages is given by:

$$\epsilon_w = \frac{\alpha s + \phi}{\alpha s + \phi + \xi_w}\epsilon_r; \tag{24}$$

(c) the elasticity of reservation wages is given by:

$$\epsilon_\rho = (1 + \widetilde{\beta}\Gamma)\frac{w^*}{\rho^*}\epsilon_r. \tag{25}$$

Proof. See Appendix B.4. □

Results (22), (24) and (25) provide closed-form elasticities of newly-negotiated, average and reservation wages, respectively. To understand their quantitative implications, we evaluate them at benchmark parameter values, described below.

4.3.1 Benchmark parameters

We adopt a monthly calibration. For the UK, we use the Quarterly Labor Force Survey (LFS) to obtain the average unemployment rate and monthly separation rate over the sample period used in Section 2 (1991-2009). This gives $u = 0.067$ and $s = 0.010$, implying $\lambda = s(1-u)/u = 0.139$. For Germany, we obtain $u = 0.078$ and $s = 0.012$ on the SOEP for 1984-2010, yielding $\lambda = 0.142$. We set the bargaining power of workers at 0.05 (see estimates reported by Manning, 2003, Table 4) and the monthly interest rate at 0.003.

To pin down the value of the replacement ratio, we use (18) to combine BHPS data on reservation wages and expected wages ($\rho/w \simeq 0.80$) and benchmark values for other parameters, which yield $\eta = 0.69$ in the UK. For Germany, there is no available information on expected wages during unemployment, thus we calibrate the replacement ratio assuming that it exceeds the unemployment benefit ratio by the same amount as in the UK, i.e. 9 percentage points. This is equivalent to assuming that the extra utility of leisure enjoyed during unemployment is the same in both countries, giving $\eta = 0.75$ in Germany.

We assume an expected contract length of 12 months, corresponding to $\phi = 0.083$. This is the mode among medium and large firms according to the review of wage setting practices in the US by Taylor (1999). Gottschalk (2005) estimates that in the US the hazard of a change in wages peaks 12 months after the previous change and Fabiani et al. (2010) find that 60% of firms in a number of European countries change base wages once a year. While $\phi = 0.083$ is our benchmark value, we will show predictions for a range of ϕ values.

We estimate $\xi_u = 0.003$ for the UK by fitting an AR(1) model on the monthly, seasonally adjusted, time series for the unemployment rate, available from the Office for National Statistics for 1971 onwards. For Germany, a harmonised, seasonally adjusted, series for the unemployment rate is available from the Bundesbank, from 1991 onwards, on which we obtain $\xi_u = 0.004$.[20] As long, high-frequency, time series are not available for wages and reservation wages, we cannot obtain corresponding estimates for ξ_w and ξ_ρ and we therefore consider predictions for a range of values. Similarly, we have no information on the share of new hires that negotiate their wage, and we let α vary between 0 and 1. All parameters and their sources are summarized in Table 5.

Before showing full calibrations in Subsection 4.3.3, to give further intuition on the model's working, the next two Subsections illustrate some special cases.

4.3.2 Special cases

Continuous wage negotiation ($\phi = \infty$). In this case α plays no role, as wages are constantly being renegotiated and there is no distinction between average and newly-negotiated wages. The final term in (22) is equal to 1, so that the difference between the elasticity of newly-negotiated wages (22) and its steady-state equivalent (17) boils down to a term $(u^* \xi_u)$, which is related to unemployment persistence. Higher ξ_u makes negotiated wages less cyclical, thus in principle it helps resolve the wage flexibility puzzle. But, using benchmark values of other parameters from Table 5, the implied difference is small, with a predicted wage elasticity in the UK of -0.303 in steady state (equation (17)) and -0.298 outside steady (equation (22)). In Germany, corresponding elasticities are -0.241 in steady state and -0.235 outside

[20] We also use HP filtered series (with a conventional smoothing parameters of 129600 on monthly data), giving $\xi_u = 0.004$ for the UK and $\xi_u = 0.018$ for Germany, but the resulting trend component of unemployment for Germany retains some degree of cyclicality. This trend becomes less cyclical with higher smoothing parameters, delivering higher persistence estimates on the resulting filtered series. For both the UK and Germany, estimates on log unemploymet and/or quarterly series give very similar results to those obtained on the level of monthly unemployment.

steady state. Turning to reservation wages, equation (25) predicts an elasticity of -0.374 for the UK and an elasticity of -0.295 for Germany. All predicted values are markedly higher in absolute value than their respective empirical targets discussed in Section 2. Thus a model with continuous wage negotiation can only deliver relatively low wage cyclicality if the replacement rate is implausibly high (as we noted in Section 4.1) and/or unemployment has implausibly low persistence.

Occasional wage negotiation ($\phi < \infty$) and no backward-looking component in wage determination ($\alpha = 1$). When $\alpha = 1$, $\Gamma = 0$ and, using (22):

$$\epsilon_r = -(1-\eta)\frac{s - u^*\xi_u}{ru^* + s}\,\frac{r+\phi+s}{r+\phi+s+\xi_\rho}. \tag{26}$$

The last term in (26) is different from 1 to the extent that ξ_ρ is different from zero. As the reservation wage is forward-looking in a model without reference dependence, $\xi_\rho < 0$, and infrequent negotiations (lower ϕ) make the wage cyclicality puzzle worse for newly-negotiated wages. For average wages, there is an additional effect that goes in the opposite direction, because only a fraction of wages are being negotiated each period. According to (24), ε_w is proportional to ε_r by a term that rises with ϕ whenever $\xi_w > 0$. Lower ϕ hence implies that the elasticity of average wages falls further below the elasticity of negotiated wages, but again this difference will only be large under low persistence (high ξ_w).

4.3.3 Occasional wage negotiation ($\phi < \infty$) and backward-looking wages ($\alpha < 1$)

When we allow for wage rigidities among new hires ($\alpha < 1$), the model can deliver arbitrarily low wage cyclicality for small enough values of α and ϕ. In the limit, if all new jobs are filled at existing wages, and these are never re-negotiated, average wages cannot change and are hence completely acyclical. By continuity, there must exist small enough values of α and ϕ that deliver sufficiently low elasticities. In this sense, backward-looking wages can solve the wage flexibility puzzle, although we will argue below that the required values of ϕ are implausibly low. Moreover, a problem with this solution is that reservation wages are still predicted to be cyclical in this case. As $\alpha, \phi \to 0$, equations (22) and (25) imply:

$$\begin{aligned}\epsilon_\rho \to & -\frac{w^*}{\rho^*}(1-\eta)\frac{s-u^*\xi_u}{ru^*+s}\frac{(r+s)\left(1+\widetilde{\beta}\Gamma\right)}{(r+s+\xi_\rho)(1+\widetilde{\beta}\Gamma)+\Gamma\lambda^*(1+\widetilde{\beta})} \\ &= -\frac{w^*}{\rho^*}(1-\eta)\frac{s-u^*\xi_u}{ru^*+s}\frac{r+s}{r+s+\xi_\rho+\lambda^*} < 0 \qquad (27)\end{aligned}$$

so that reservation wages retain some cyclicality even when other wages are completely acyclical. Evaluated at baseline parameter values, this ranges between -0.032 and -0.034 for ξ_ρ ranging between 0 and -0.01. The intuition is that, even when wages are completely acyclical, workers' outside options are cyclical via the effect of the unemployment rate on the probability of receiving a job offer.

We next move beyond this limiting case and graphically summarize predictions for alternative combinations of α, ϕ and persistence parameters. These are shown in Figure 1, where Panel A shows predictions for the elasticity of the average wage, Panel B shows predictions for the elasticity of the reservation wage and Panel C shows predictions for the ratio between the two.[21] There are three persistence parameters in the model, ξ_u, ξ_w, and ξ_ρ. The reservation wage is forward-looking in this version of the model, and we consider the conservative case $\xi_\rho = 0$ (as we have noted that $\xi_\rho < 0$ would increase wage cyclicality). For ξ_u and ξ_w, we consider three alternative values (0.001, 0.01 and 0.1), whose range is far wider than most existing estimates and calibrations. We let ϕ vary along the horizontal axis, report elasticities on the vertical axis, and capture variation in α between 0 and 1 along the thickness of each

[21] While we can compare ϵ_w and ϵ_ρ to the estimates of Section 2, we have no empirical counterpart for ϵ_r because the data contain no information on the timing of negotiations, i.e. on which wage observations are newly-negotiated. We can observe, however, wages in new job matches, and we have estimated their elasticity as an excess sensitivity to unemployment, relative to the sensitivity of average wages. As average wages in new matches are a weighted average of average wages and average newly-negotiated wages with weights α and $1-\alpha$, respectively, using Proposition 1 we can obtain their predicted elasticity as $\epsilon_n = \frac{\alpha s+\phi+\alpha\xi_w}{\alpha s+\phi}\epsilon_w$, i.e. wages in new matches are more cyclical than average wages, with the difference in their respective cyclicality rising in α and ξ_w. Estimates of Tables 1 and 2 show that wages in new matches are indeed more cyclical than average wages (column 4), but this difference is hardly significant when job fixed-effects are included (column 5). This finding is consistent with high wage persistence (low ξ_w) or a large backward-looking component in wage negotiations (low α).

shaded band, such that, for a given ϕ and ξ_x ($x = u, w$) higher α delivers higher cyclicality. All other parameter values are set as in column 3 of Table 5. As it is clear from the plots, variation in α is less important for quantitative predictions than variation in ϕ or ξ_x.

The horizontal line in Panel A represents the target wage elasticity for the UK, $\epsilon_w = -0.169$ (from column 2 in Table 1) and the vertical line represents annual renegotiations, $\phi = 0.083$. The Figure shows that, under very high persistence ($\xi_x = 0.001$), only implausibly low values of ϕ (corresponding to wage renegotiations every 8 years or more), can match the target elasticity. At the other extreme, under very low persistence ($\xi_x = 0.1$), one can achieve almost acyclical wages with any combination of α and ϕ. Under intermediate values of persistence ($\xi_x = 0.01$), one can match the target elasticity with values of ϕ in the range 0.01-0.05: this range does not contain the benchmark value $\phi = 0.083$, but is getting closer to it. In order to match the corresponding wage elasticity for Germany (-0.028), one would need much lower persistence (higher ξ_x) than in the UK.

Panel B shows predictions for the cyclicality of reservation wages, whose target value for the UK is $\epsilon_\rho = -0.146$ (from column 2 in Table 3). The model fails even worse at matching this target. For example, under $\xi_x = 0.01$, the target elasticity can only be matched by setting $\phi < 0.025$. In general, lower persistence has a larger impact on the cyclicality of wages than reservation wages. Therefore, as one could match wage cyclicality with low values of persistence, these values would badly overpredict the excess reservation wage cyclicality.

This is shown in Panel C, which plots on the vertical axis the target ratio between the elasticity of wages and reservation wages for the UK ($0.169/0.146 \cong 1.16$). For example, under $\xi_x = 0.01$, a value of ϕ between 0.01-0.05 can match the wage elasticity in Panel A, but these ϕ values would predict a ratio between the wage and reservation wage elasticity between 0.6-0.75, while this ratio is 1.16 in reality. If one lowers persistence to match the wage elasticity with a higher (more realistic) value of ϕ, moving from the red towards the blue plot in Panel A, this would imply an even lower ratio between the wage and reservation wage elasticity in Panel C, thus further overstating the excess elasticity of reservation wages.

The conclusion is that one cannot find a combination of α, ϕ and ξ_x parameters that would match both the wage and reservation wage elasticities.

4.4 Analytical results vs. simulations

The results obtained allow us to assess the ability of alternative models of wage determination to match empirical wage elasticities and address the wage flexibility puzzle.[22] The advantage of our approach is to deliver analytical results for the parameters of interest, showing transparently the role of various model elements in driving wage cyclicality. While we obtain analytical results without relying on numerical simulations or imposing a specific source and nature of shocks, we show in this section that these results perform very well when compared to predictions from numerical model simulations, obtained assuming an underlying stochastic process for labor productivity with standard characteristics.

We have used a continuous-time formulation in the model above because it leads to simpler notation. However, we need a discrete-time formulation to compare results to those of a simulated model. This is presented in Appendix C, leading to the discrete time versions of our main elasticity results. In the simulated model, the source of shocks is given by productivity fluctuations, which directly impact the job creation condition (83). We assume an autoregressive productivity process with a monthly persistence parameter of 0.983 and a standard deviation of 0.007 (Gertler and Trigari, 2009, and Gertler et al., 2020). We also normalize steady state productivity to 1.[23] Panel A in Figure 2 plots analytical against

[22] The use of wage elasticities differs from a more standard approach, based on the relative standard deviation of wages and unemployment. The two approaches coincide if the only shock to wages and unemployment is the one-dimensional productivity shock considered, but our approach is more robust whenever there exist other sources of shocks. Suppose the relationship between wages and unemployment is $\ln w = \beta_0 + \beta \ln u + \varepsilon$, where β is a regression coefficient (i.e. the estimated elasticity), and for simplicity we omit other regressors. One can write $\beta = cov(\ln w, \ln u)/var(\ln u) = r\ stdev(\ln w)/stdev(\ln u)$, where r is the correlation coefficient between $\ln w$ and $\ln u$. Thus the regression coefficient and the ratio of standard deviations are identical whenever $r = 1$ or, equivalently, the R^2 from the regression is 1, as implicitly assumed in one-factor models in which variation in unemployment and wages is only generated by TFP shocks. However, if $r \neq 1$, the elasticity and relative standard deviations differ, and the elasticity is preferable for our purposes as we are interested in the variation in wages driven by unemployment, not their total variation (see Mortensen and Nagypál, 2007 for a discussion on this).

[23] We simulate 10,000 months and discard the first 500.

simulated elasticities for alternative combinations of $\alpha \in [0.2, 1]$ and $\phi \in [0.03, 0.3]$, keeping all other parameters at benchmark values. For the analytical results, as we do not have estimates for ξ_w and ξ_ρ, we calibrate all persistence parameters (including ξ_u) to those predicted by the simulated model. For the simulated results, elasticities are obtained from regressions of log (simulated) wages and reservation wages on log (simulated) unemployment. The two methods produce near identical results. Panel A of Figure 2 plots simulated against analytical results and shows a near perfect fit, illustrating that our closed-form expression can closely replicate results from simulated models based on productivity shocks.

5 Reference dependence in reservation wages

We finally allow for backward-looking reference points in reservation wages. To derive analytical results, we follow similar steps to those outlined above and derive expressions for elasticities in terms of model parameters. The main difference with respect to the forward-looking model is that past wages now matter for wage negotiation – both for the unemployed, upon hiring, and for the employed, whenever renegotiation opportunities arise. We therefore need to keep track of past wages and distinguish between past employment and unemployment status. The analytical results are less insightful than those summarized in Proposition 3 for the case without reference dependence, because there are ten endogenous variables[24] (and as many persistence parameters), leading to a system of ten equations in ten unknowns. The analytical results for the continuous and discrete time cases are presented in Appendix B.5 and Appendix C, respectively. Similarly as for the canonical model, analytical results closely mirror the predictions of numerical simulations (Panel B of Figure 2).

In this more general model, backward-looking behavior in reservation wages, as measured by $(1 - \alpha_\rho)\alpha_l$, can deliver arbitrarily low cyclicality in *both* wages and reservation wages. Consider the extreme case in which $\alpha_\rho = \alpha_l = 0$: according to (7), reservation wages are

[24] These are: the negotiated wage for those previously employed, for those previously unemployed, and for forward-looking individuals; the reservation wage for the same three categories of workers; the past wage for the employed and the unemployed; the overall average wage in the economy; the arrival rate of job offers.

always identical to their steady state value, hence completely acyclical. By continuity, there exists some combination of α_ρ and α_l that would be able to match the low observed cyclicality of reservation wages (and hence wages). The key issue is whether combinations of α_ρ and α_l that match estimated cyclicalities are also empirically plausible. The next section estimates the degree of reference dependence in reservation wages from the empirical relationship between reservation wages and lagged wages and tests whether the estimated amount of backward-looking reference dependence can quantitatively explain the observed wage and reservation wage behavior.

5.1 Estimation

If past wages shape reference points, our model predicts that they are positively correlated to reservation wages. But while such correlation is consistent with the existence of reference points, it is also consistent with alternative mechanisms. One possible confounding factor is a direct link between unemployment benefits and past wages, as unemployment income is a component of reservation wages in the canonical model. This is the case for Germany, where benefit entitlement is a function of age and previous social security contributions, which are 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 only varies (coarsely) with 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 would not use past rents in forming their current reservation wage (absent wealth effects, which we do not find to be important), whereas a worker who uses past wages as a reference point might do so.

Consider a simple empirical model for the reservation wage:

$$\ln \rho_{it} = \beta_1 X_{it} + \beta_2 w_i^* + \beta_3 R_{it-d} + \varepsilon_{it}, \tag{28}$$

where X_{it} denotes observable characteristics, w_i^* denotes worker ability, and R_{it-d} denotes rents in the last job observed (d periods ago). The coefficient of interest is β_3, indicating whether rents lost with past jobs influence current reservation wages.

Assume the following model for the last observed wage:

$$\ln w_{it-d} = \gamma_1 X_{it-d} + w_i^* + R_{it-d} + u_{it-d}. \tag{29}$$

If one regresses the reservation wage on the last observed wage as in:

$$\ln \rho_{it} = \delta_1 X_{it} + \delta_2 \ln w_{it-d} + \varepsilon_{it}, \tag{30}$$

the OLS estimate for δ_2 would capture the effect of both unobserved heterogeneity and rents on the reservation wage, and is possibly attenuated by the presence of measurement error in past wages. Identification of the effect of interest requires an instrument that represents a 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 structure reflects rents (see Krueger and Summers, 1988, and Gibbons and Katz, 1992, for classic references, and Benito, 2000, and Carruth et al., 2004, for UK evidence). Specifically, we instrument previous wages using the predicted, inter-industry wage differential obtained on administrative data from 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 equation for 1982-2009 on ASHE, controlling for 4-digit industry effects, unrestricted age effects, region, and individual fixed effects. These capture the component of inter-industry wage differentials that is uncorrelated to individual unobservables, which is important for our exclusion restriction. We match the estimated industry effects to individual records in the BHPS, and use them 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 if rents in previous jobs would contribute to savings, in turn affecting utility during unemployment and reservation wages (see for example Shimer and Werning, 2007, for a model of job search with asset accumulation). 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 we control for wealth effects, if any, by including indicators for household assets and housing tenure in the estimated reservation wage equations.

Column 1 in Table 6 reports OLS estimates of the reservation wage equation (30). The sample is smaller than the original sample of Table 3, as for about 45% of the reservation wage sample no previous jobs are recorded. The coefficient on the wage in the last job is positive and highly significant. Column 2 introduces individual fixed-effects, and the coefficient on the lagged wage is reduced, as part of the observed association between reservation wages and past wages is driven by unobserved worker quality.

Column 3 instruments the previous wage with its rent component, as proxied by the 4-digit industry level differential, and shows that this has a positive and significant impact on the reservation wage, implying that 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, (classical) measurement error, and unobserved compensating differentials in the last observed wage (see also Manning, 2003, chapter 6). Column 4 introduces individual fixed-effects, and the coefficient of interest is now identified by the sub-sample of individuals with multiple unemployment spells originating from different 4-digit industries. Unlike in the OLS model, the coefficient on the lagged wage remains very close to the one obtained without fixed-effects in column 3. Once lagged wages are instrumented, their impact on reservation wages is no longer confounded by unobserved ability. This signals that unobserved ability is not driving the (very disaggregate) industry allocation of individuals, indirectly confirming the validity of the instrument. In summary, the finding that rents in previous jobs affect reservation wages is not consistent with the determination of reservation wages in the canonical model, but is instead consistent with a model in which reference wages influence reservation wages, and these reference wages are shaped by past wages.

5.2 Quantitative results

We finally assess whether a model with reference dependence can quantitatively match estimated targets. We consider combinations of backward-looking behavior in wages, $1-\alpha$, and backward-looking behavior in reservation wages, $(1-\alpha_\rho)\alpha_l$, that yield model predictions close to our elasticity estimates. The data moments we use to pin down the values of these three parameters are: (i) the elasticity of reservation wages to lagged wages (0.149, from column 4 in Table 6); (ii) the elasticity of wages with respect to unemployment (-0.169, from column 2 in Table 1); (iii) the elasticity of reservation wages with respect to unemployment (-0.146, from column 2 in Table 3). Specifically, as 0.149 is obtained in a regression of log reservation wages on log lagged wages, we impose $(1-\alpha_\rho)\alpha_l = 0.149\frac{\rho^*}{w^*}$, as $(1-\alpha_\rho)\alpha_l$ is the coefficient in the relationship between their levels in equation (7). Then we select combinations of (α, α_ρ) that produce, in correspondence of baseline parameters of Table 5, an elasticity of wages and reservation wages with respect to unemployment within 0.04 of -0.169, and -0.146, respectively. The error margin 0.04 corresponds almost exactly to the standard error on each parameter estimate, from Tables 1 and 3, respectively.

Parameter combinations that satisfy these criteria are represented in Figure 3. Note that backward-looking components in reservation wages are necessary to fit the estimates, as there is no overlap between the shaded area and the vertical line $\alpha_\rho = 1$. Hence it is not possible for a model with fully forward-looking reservation wages to match estimated elasticities, independent of the degree of backward-looking behavior in wage setting ($0 \leq \alpha \leq 1$). On the contrary, it is possible for a model with fully forward-looking wage setting ($\alpha = 1$) to match estimated elasticities, provided there is some degree of reference dependence in reservation wages. More in general, for any value of α above 0.43, there exist values of α_ρ between (about) 0.55 and 0.8 that can match target wage and reservation wage elasticities and therefore solve the wage flexibility puzzle.

6 Conclusions

Based on micro data for the UK and Germany, we find that wages and reservation wages display very similar degrees of cyclicality, substantially lower than those predicted by the canonical model search model with forward-looking reservation wages. We then propose a search model with reference dependence in reservation wages to derive a relationship between wages and unemployment – the wage curve – whose slope gives an estimate of the relative variability of wages and unemployment in response to demand shocks.

Absent reference dependence, we show that the model can only explain the modest procyclicality of wages if replacement ratios are implausibly high, unemployment and wage persistence implausibly low, or labor contracts implausibly long. A further model prediction is that reservation wages should be more strongly cyclical than wages because they embody cyclicality from both expected wage offers and the probability of receiving an offer.

We show that the introduction of reference dependence in reservation wages, based on backward-looking reference points, can instead deliver mildly cyclical wages and reservation wages for plausible value of model parameters, and provide evidence that reservation wages significantly respond to backward-looking reference points, as proxied by rents earned in previous jobs. We conclude that accounting for reference points markedly reduces the predicted cyclicality of both wages and reservation wages and reconciles theoretical predictions of search models with their observed cyclicality.

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Tables and Figures

Table 1: **Estimates of a Wage Equation for the UK, 1991-2009**

	Dependent variable: log hourly wage						
	1	2	3	4	5	6	7
Log wage, lagged							0.102
							(0.046)
Log unemployment rate	-0.165	-0.169	-0.147	-0.109	-0.022		-0.150
	(0.044)	(0.044)	(0.042)	(0.029)	(0.070)		(0.009)
Log unemployment rate			-0.075	-0.019			
* new job			(0.013)	(0.011)			
Log unemployment rate,					-0.113	-0.126	
lagged					(0.050)	(0.032)	
Individual fixed effects		✓	✓		✓	✓	✓
Job fixed effects				✓			
Observations	96,270	92,380	92,380	77,854	92,380	92,380	53,054
R-squared	0.397	0.810	0.810	0.889	0.778	0.778	

Notes. The sample includes employees aged 18-65 with non-missing wage information. The dependent variable is the log gross hourly wage, deflated by the aggregate consumer price index. Estimation method: OLS in columns 1-6; Arellano Bond (1991) estimator for dynamic panel data models in column 7. The unemployment concept is national. All regressions include a quadratic time trend, 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. Regressions in columns 3 and 4 also include a dummy for the job having started in the previous 12 months. Standard errors are clustered at the year level in column 1, and using 2-way cluster-robust variance (Cameron and Miller, 2015) in columns 2-7. Source: BHPS.

Table 2: **Estimates of a Wage Equation for Germany, 1984-2010**

	Dependent variable: Log monthly wage						
	1	2	3	4	5	6	7
Log wage, lagged							0.390
							(0.027)
Log unemployment rate	0.002	-0.028	-0.015	-0.005	0.070		-0.015
	(0.025)	(0.019)	(0.018)	(0.015)	(0.025)		(0.030)
Log unemployment rate			-0.096	0.034			
* new job			(0.026)	(0.022)			
Log unemployment rate,					-0.120	-0.065	
lagged					(0.024)	(0.018)	
Individual fixed effects		✓	✓		✓	✓	✓
Job fixed effects				✓			
Observations	166,614	161,075	160,865	149,617	161,075	161,075	101,526
R-squared	0.651	0.415	0.415	0.199	0.415	0.415	

Notes. The sample includes employees aged 18-65 with non-missing wage information. The dependent variable is the log gross monthly wage, deflated by the aggregate consumer price index. Estimation method: OLS in columns 1-6; Arellano Bond (1991) estimator for dynamic panel data models in column 7. The unemployment concept is national. All regressions include a quadratic time trend, 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. Regressions in columns 3 and 4 also include a dummy for the job having started in the previous 12 months. Standard errors are clustered at the year level in column 1, and using 2-way cluster-robust variance (Cameron and Miller, 2015) in columns 2-7. Source: SOEP.

Table 3: **Estimates of a Reservation Wage Equation for the UK, 1991-2009**

Dependent variable: log hourly reservation wage	1	2	3	4
Log unemployment rate	-0.175	-0.146	0.010	
	(0.058)	(0.042)	(0.146)	
Log unemployment rate, lagged			-0.119	-0.112
			(0.096)	(0.026)
Individual fixed effects		✓	✓	✓
Observations	14,874	10,774	10,774	10,774
R-squared	0.249	0.614	0.614	0.614

Notes. The sample includes unemployed jobseekers with non-missing reservation wage information. The dependent variable is the log net hourly reservation wage, deflated by the aggregate consumer price index. Estimation method: OLS. The unemployment concept is national. All regressions also include a quadratic time trend, 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 column 1, and using 2-way cluster-robust variance (Cameron and Miller, 2015) in columns 2-4. Source: BHPS.

Table 4: **Estimates of a reservation wage equation for Germany, 1987-2010**

Dependent variable: log monthly reservation wage	1	2	3	4
Log unemployment rate	0.001	0.038	0.175	
	(0.065)	(0.054)	(0.070)	
Log unemployment rate, lagged			-0.196	-0.082
			(0.064)	(0.045)
Individual fixed effects		✓	✓	✓
Observations	11,221	7,911	7,911	7,911
R-squared	0.418	0.123	0.125	0.123

Notes. The sample includes unemployed jobseekers with non-missing reservation wage information. The dependent variable is the log net monthly reservation wage, deflated by the aggregate consumer price index. Estimation method: IV. All regressions also include a quadratic time trend, 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 eleven 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 column 1, and using 2-way cluster-robust variance (Cameron and Miller, 2015) in columns 2-4. Source: SOEP.

Table 5: **Benchmark Parameters for the UK and Germany**

Variable	**Symbol**	**UK**	**Germany**	**Source**
Unemployment rate	u	0.067	0.078	Official unemployment rate
Separation rate	s	0.010	0.012	Quarterly LFP (UK) SOEP (Germany)
Job-finding rate	λ	0.139	0.142	Separation rate and unemployment rate ($\lambda = s(1-u)/u$)
Frequency of wage negotiations	ϕ	0.083	0.083	Annual frequency (Taylor, 1999)
Interest rate	r	0.003	0.003	Conventional value
Replacement rate	η	0.690	0.754	For UK: equation (18), using $\rho^*/w^* = 0.8$ (from BHPS) For Germany: benefit replacement ratio + extra utility of leisure during unemployment as implied by UK estimates
Bargaining power of workers	β	0.05	0.05	Manning (2001, Table 4)
Unempl. convergence parameter	ξ_u	0.003	0.004	AR(1) estimates on monthly series for unemployment rate
AR(1) term in productivity		0.983		Gertler and Trigari (2009) Gertler et al (2020)
St. dev. productivity		0.007		Gertler and Trigari (2009) Gertler et al (2020)

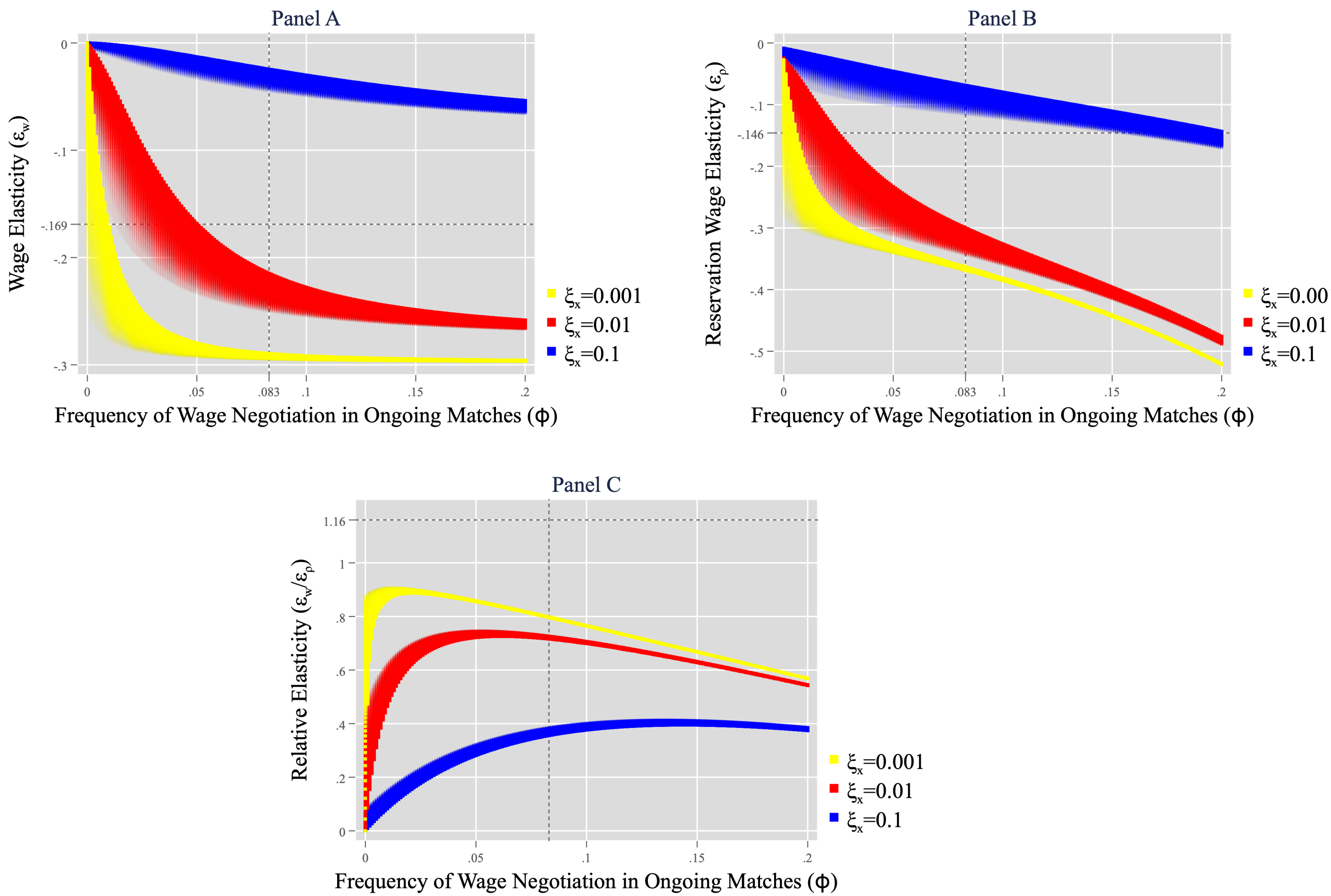
Notes: s, λ, ϕ and ξ_u are expressed in monthly terms.

Table 6: **Reservation Wages and Rents in Previous Jobs: UK, 1991-2009**

Dependent variable: log hourly reservation wage				
	1	2	3	4
Estimation method	OLS	OLS	IV	IV
Last observed log wage	0.083	0.033	0.133	0.149
	(0.005)	(0.010)	(0.018)	(0.063)
Log unemployment rate	-0.183	-0.173	-0.159	-0.177
	(0.081)	(0.075)	(0.084)	(0.067)
Individual fixed effects		✓		✓
Observations	8,091	5,737	7,732	5,520
R-squared	0.284	0.098		
First stage, F-test$^{(a)}$			908.9	908.9

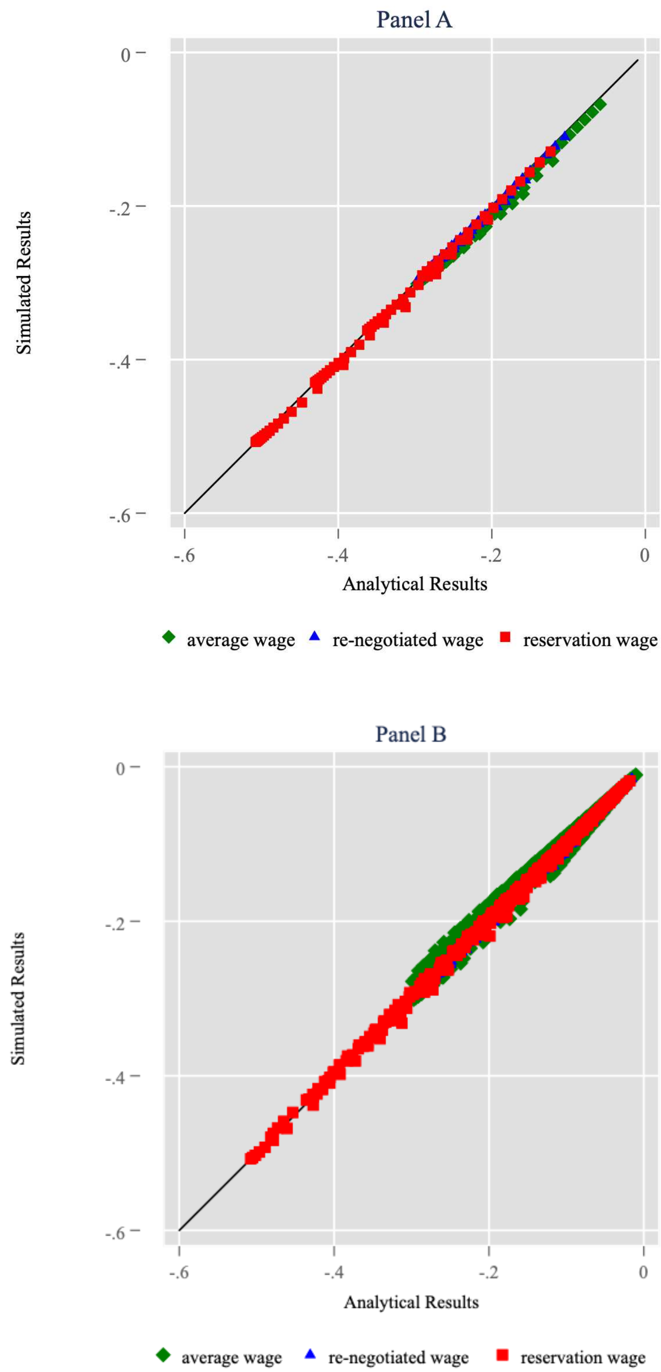
Notes. See notes to Table 3 for the sample used. All regressions also include a quadratic time trend, a gender dummy, age and its square, three education dummies, a cubic trend in the number of years since the last job was observed, a dummy for married, the number of children in the household, the log 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 for last observed wage: predicted industry wage (4-digit) for previous job. (a) denotes Sanderson and Windmeijer (2016) first-stage F-statistic. Standard errors are clustered at the year level. Source: BHPS.

Figure 1: **Predictions of the Canonical Model**



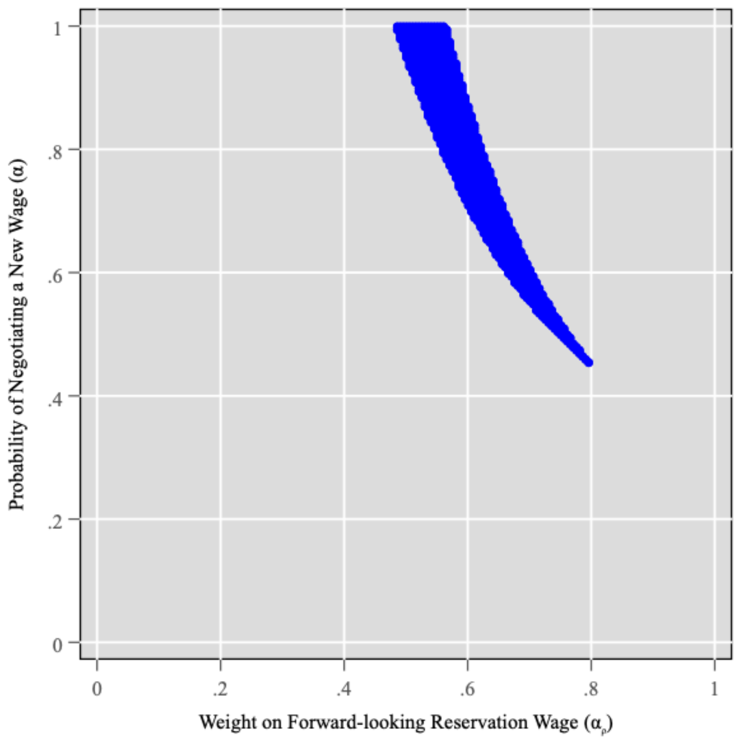
The Figure shows predicted wage elasticities in the canonical model under alternative combinations of parameters. Panels A, B and C plots the predicted wage elasticity, reservation wage elasticity and the ratio between the two, respectively. Variation in the frequency of renegotiations, ϕ, is represented on the horizontal axis. Alternative values of persistence parameters ξ_x, $x = w, u$ are represented by different colors, having set $\xi_\rho = 0$. Variation in the share of matches that negotiated a new wage, α, is represented by shade intensity, with darker shades corresponding to lower values of α.

Figure 2: **Analytical and Simulated Results**



Panel A plots simulated against analytical elasticity results for the forward-looking model, for 68 parameter combinations and 204 elasticity estimates, covering parameter values $\alpha \in [0.2, 1]$ and $\phi \in [0.05, 0.2]$. Panel B plots corresponding results for the model with reference dependence, for 324 parameter combinations and 972 elasticity estimates, covering parameter values $\alpha \in [0.2, 1]$, $\alpha_\rho \in [0.2, 1]$ and $\phi \in [0.05, 0.2]$, having imposed $\alpha_l(1-\alpha_\rho) = 0.15\frac{\rho*}{w*}$. The correlation coefficient between simulated and analytical results is 0.999 in Panel A and 0.997 in Panel B.

Figure 3: **Parameter Values that Explain the Observed Cyclicality of Wages and Reservation Wages**



Notes. The shaded region shows the combinations of α, the probability of negotiating a wage on a new match, and α_ρ, the weight on the forward-looking reservation wage, that predict a wage elasticity and a reservation wage elasticity within 0.04 of -0.169 and -0.146, respectively, having imposed $\alpha_l(1-\alpha_\rho) = 0.15\frac{\rho*}{w^*}$. The persistence parameters ξ_x are obtained from the simulated data. All other parameter are set at baseline values reported in Table 5.

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A Appendix: The quality of reservation wage data

While there may be concerns about the quality of reservation wage data, and hence on the interpretation of their low correlation with unemployment, we note that the impact of most covariates considered on reservation wages (e.g. age, education and gender) has the expected sign and is precisely estimated, as shown in Table A2. Here we further address concerns about the informative content of reservation wage data by testing whether their correlation with job search outcomes has the sign predicted by search theory. Ceteris paribus, a higher reservation wage should cause a longer remaining duration in unemployment and higher entry wages upon job finding.

Table A7 illustrates the effect of reservation wages on each outcome for the UK. Column 1 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, but this estimate is likely to be upward biased due to omitted controls for worker ability, as more able workers have both higher reservation wages and are more likely to find employment. Column 2 controls for the usual individual covariates and the national unemployment rate, and shows that, conditional on these, workers with higher reservation wages tend to experience significantly longer unemployment spells. Column 3 shows that this results is robust to the introduction of individual fixed-effects.

Columns 4-6 show the impact of reservation wages on wages for those who find jobs. In column 4, which does not control for individual characteristics, the estimated elasticity of reemployment wages with respect to reservation wages is positive and highly significant, but likely to be upward biased by unobserved individual factors that are associated to both higher reservation wages and higher reemployment wages. The elasticity falls by about a quarter in column 5, which controls for individual characteristics, and is further halved in column 6, which controls for individual fixed-effects, but remains statistically significant.

Similar results for Germany are presented in Table A8, and they are in line with the UK results, with the qualification that the negative impact of reservation wages on job-finding rates is stronger for Germany than for the UK. The conclusion from this analysis is that the reservation wage data, though undoubtedly noisy, embody meaningful information about job search behavior, and there is no particular reason to think that their cyclicality is systematically under-estimated.

B Appendix: Derivation of model results

B.1 Proof of Proposition 1: The wage equation

Maximizing the Nash maximand (5) with respect to $w^r(w_i^l, t)$ implies the first-order condition:

$$\begin{aligned}&(1-\beta)\frac{\partial J(w_r(w_i^l,t);w_i^l,t)}{\partial w^r}[W(w^r(w_i^l,t);w_{il},t) - W(\rho(w_i^l,t);w_i^l,t)]\\ &+\beta\frac{\partial W(w_r(w_i^l,t);w_i^l,t)}{\partial w^r}J(w^r(w_i^l,t);w_i^l,t) = 0,\end{aligned} \tag{31}$$

where $V(t) = 0$ has been imposed.

The following result will be useful:

Lemma. *If $\partial w^r/\partial w_i^l$ is a constant, $J(w_i; w_i^l, t)$ and $W(w_i; w_i^l, t)$ are separable and linear in w_i and w_i^l and separable in t.*

Proof. Equations (1) and (3) imply:

$$\frac{\partial W(w_i; w_i^l, t)}{\partial w_i} = -\frac{\partial J(w_i; w_i^l, t)}{\partial w_i} = \frac{1}{r + \phi + s}. \tag{32}$$

As (r, ϕ, s) are constant, (32) implies that $W(w_i; w_i^l, t)$ and $J(w_i; w_i^l, t)$ are separable and linear in w_i. The derivative of the value functions with respect to w_i^l can be written as:

$$\frac{\partial J(w_i; w_i^l, t)}{\partial w_i^l} = \frac{\phi}{r + \phi + s} \frac{\partial J(w^r(w_i^l, t); w_i^l, t)}{\partial w^r} \frac{\partial w^r}{\partial w_i^l} = -\frac{\phi}{(r + \phi + s)^2} \frac{\partial w^r}{\partial w_i^l}. \tag{33}$$

This shows that lagged wages only affect the value functions through their impact on wage negotiation. If $\partial w^r / \partial w_i^l$ is constant, (33) and (32) imply that $J(w_i; w_i^l, t)$ is separable and linear in w_i and w_i^l and separable in t, and similarly for $W(w_i; w_i^l, t)$. This in turn implies that $\partial J(w_i; w_i^l, t)/\partial t$ and $\partial W(w_i; w_i^l, t)/\partial t$ do not depend on $(w_i; w_i^l)$. The derivative $\partial w^r / \partial w_i^l$ is not known at this stage but turns out to be a constant (using an 'assume and verify' approach).

Given (32), one can write

$$W(w^r(w_i^l, t); w_i^l, t) - W(\rho(w_i^l, t); w_i^l, t) = \frac{w^r(w_i^l, t) - \rho(w_i^l, t)}{r + \phi + s}. \tag{34}$$

As the value function (1) is linear in both current and lagged wages (from the Lemma), the first expectation term in the value function of a vacant job (2) can be replaced by averages, i.e. $E_t[J(w_i; w_i^l, t)] = \alpha J(w^{ru}(t); w^{lu}(t), t) + (1 - \alpha) J(w^a(t); w^{lu}(t), t)$, where $w^{ru}(t)$ and $w^{lu}(t)$ are the average newly-negotiated wage and lagged wage, respectively, for workers hired from unemployment and $w^a(t)$ is the average wage among all employed workers. Using this and imposing $V(t) = 0$, (2) can be rearranged to give:

$$\alpha J(w^{ru}(t); w^{lu}(t), t) + (1-\alpha)J(w^{a}(t); w^{lu}(t), t) = C(t) + \frac{c(t)}{q(t)} = \mu(t), \tag{35}$$

i.e. the expected value of a newly-filled job equals the total expected cost of filling a vacancy, $\mu(t)$. Using (34) and (35), and imposing $\frac{\partial W(w_i; w_i^l, t)}{\partial w_i} = -\frac{\partial J(w_i; w_i^l, t)}{\partial w_i}$, (31) can be written as:

$$\begin{aligned}(1-\beta)\frac{w^r(w_i^l, t) - \rho(w_i^l, t)}{r+\phi+s} = \beta \Big\{ & J(w^r(w_i^l, t); w_i^l, t) - \alpha J(w^{ru}(t); w^{lu}(t), t) \\ & - (1-\alpha)J(w^a(t); w^{lu}(t), t) + \mu(t) \Big\}. \end{aligned} \tag{36}$$

Using (32) and (33) to evaluate value functions in (36) gives

$$\begin{aligned}(1-\beta)[w^r(w_i^l, t) - \rho(w_i^l, t)] = \beta \Big\{ & [\alpha w^{ru}(t) + (1-\alpha)w^a(t) - w_i^r(w_i^l, t)] \\ & - \frac{\phi}{r+\phi+s}\frac{\partial w^r}{\partial w_i^l}[w_i^l - w^{lu}(t)] + (r+\phi+s)\mu(t) \Big\}, \end{aligned}$$

which can be rearranged to give the wage equation (6). This proves the Proposition. □

B.2 Proof of Proposition 2: Steady-state reservation wages

In steady-state, all wages are equal to w^* and the value of being employed at a wage w (possibly different from w^*) is given by:

$$rW(w) = w - s[W(w) - U] + \phi[W(w^*) - W(w)]. \tag{37}$$

The value of being unemployed is given by:

$$rU = z + \lambda[W(w^*) - U], \tag{38}$$

where z is the flow utility from being unemployed. The steady-state reservation wage ρ^* satisfies $W(\rho^*) = U$. Using (37) and (38), this can be written as:

$$\rho^* + \phi[W(w^*) - U] = z + \lambda[W(w^*) - U] \tag{39}$$

and rearranged as:

$$\rho^* = z + (\lambda - \phi)[W(w^*) - U] = z + \frac{\lambda - \phi}{r + \lambda + s}(w^* - z), \tag{40}$$

where the second equality comes from comparison of (37) and (38). This proves the Proposition.

B.3 The forward-looking reservation wage

If workers have an optimal reservation wage, the value of a job paying w is the following modification of equation (3):

$$rW^o(w_i, t) = w_i + \phi[W^o(w^{ro}(t), t) - W^o(w_i, t)] - s\big[W^o(w_i, t) - U^o(t)\big] + E_t\frac{\partial W^o(w_i, t)}{\partial t}, \tag{41}$$

where $w^{ro}(t)$ is the wage negotiated by a worker with an optimal reservation wage. This differs from (3) as it does not depend on the lagged wage, and the value of being unemployed replaces the value of being employed at the reservation wage. The value of being unemployed for a worker with the optimal reservation wage is given by:

$$rU^o(t) = z + \lambda(t)[\alpha W^o(w^{ro}(t), t) + (1-\alpha)W^o(w^a(t), t) - U^o(t)] + E_t \frac{\partial U^o(t)}{\partial t}, \tag{42}$$

where $W^o(w_i, t)$ is the value of being employed at a wage w_i for a worker whose reservation wage is the optimal reservation wage. The optimal reservation wage $\rho^o(t)$ satisfies:

$$W^o(\rho^o(t); t) = U^o(t) \tag{43}$$

which, using (41) and (42), can be written as:

$$\rho^o(t) + \frac{\phi[w^{ro}(t) - \rho^o(t)]}{r+\phi+s} = z + \frac{\lambda(t)[\alpha w^{ro}(t) + (1-\alpha)w^a(t) - \rho^o(t)]}{r+\phi+s} + E_t \frac{\partial U^o(t)}{\partial t} - E_t \frac{\partial W^o(\rho^o(t), t)}{\partial t}. \tag{44}$$

Equation (43) implies:

$$\frac{\partial U(t)}{\partial t} = \frac{\partial W(\rho^o(t); t)}{\partial t} + \frac{\partial W(\rho^o(t); t)}{\partial w_i} \frac{\partial \rho^o(t)}{\partial t}, \tag{45}$$

so that (44) becomes:

$$\rho^o(t) + \frac{\phi[w^{ro}(t) - \rho^o(t)]}{r+\phi+s} = z + \frac{\lambda(t)[\alpha w^{ro}(t) + (1-\alpha)w^a(t) - \rho^o(t)]}{r+\phi+s} + \frac{1}{r+\phi+s} E_t \frac{\partial \rho^o(t)}{\partial t}. \tag{46}$$

Re-arranging (46) leads to the following differential equation for the optimal reservation wage:

$$[r + \lambda(t) + s]\, \rho^o(t) = (r + \phi + s)z + \lambda(t)[\alpha w^{ro}(t) + (1-\alpha)w^a(t)] - \phi w^{ro}(t) + E_t \frac{\partial \rho^o(t)}{\partial t}. \qquad (47)$$

We now need to determine $w^{ro}(t)$. To this purpose, we assume that employers can observe the worker's reservation wage, but not whether such reservation wage is the optimal one or the result of reference dependence on a certain lagged wage. If all workers have reference-dependent reservation wages, it is rational for employers to assume they have a lagged wage $w^{lo}(t)$, which, given (7), must satisfy:

$$\rho^o(t) - \rho^* = \alpha_\rho(\rho^o(t) - \rho^*) + (1-\alpha_\rho)(w^{lo}(t) - w^*), \qquad (48)$$

which can be re-arranged to give:

$$w^{lo}(t) = w^* + (\rho^o(t) - \rho^*). \qquad (49)$$

Working through similar steps as in the proof of Proposition 1, we obtain an expression similar to (6) for the negotiated wage, with an extra term that captures the difference between the optimal reservation wage and its steady state value:

$$\begin{aligned} w^{ro}(t) = (1-\beta)\rho^o(t) + \beta\Big\{ &(r+\phi+s)\mu(t) + [\alpha w^{ru}(t) + (1-\alpha)w^a(t)] \\ &- \frac{\phi}{r+\phi+s}\frac{\partial w^r}{\partial w_i^l}\big[(\rho^o(t) - \rho^*) - (w^{lu}(t) - w^*)\big]\Big\}. \end{aligned} \qquad (50)$$

B.4 Proof of Proposition 3.

Without reference dependence, lagged wages are irrelevant in negotiations and the negotiated wage does not vary with previous employment status. In this case the wage equation (6) can be written as:

$$w^r(t) = (1-\beta)\rho(t) + \beta\left\{(r+\phi+s)\mu + [\alpha w^r(t) + (1-\alpha)w(t)]\right\}, \tag{51}$$

Taking the linear projection, (51) can be written as:

$$\theta_r = (1-\beta)\theta_\rho + \beta[\alpha\theta_r + (1-\alpha)\theta_w], \tag{52}$$

where θ_x has been defined in equation (20).

Average wages follow the following differential equation:

$$\frac{dw^a(t)}{dt} = \frac{\lambda(t)u(t)}{1-u(t)}\alpha\left[w^{ru}(t) - w^a(t)\right] + \phi\left[w^{re}(t) - w^a(t)\right], \tag{53}$$

i.e. $w^a(t)$ changes through wage renegotiation for the employed (at a rate ϕ) and through new hires, some of whom negotiate a new wage (this happens at rate $\lambda(t)u(t)\alpha$). Without reference dependence, $w^{ru}(t) = w^{re}(t)$. Hence, linearising (53) around steady-state leads to:

$$\xi_w\theta_w = (\alpha s + \phi)(\theta_r - \theta_w), \tag{54}$$

where ξ_x has been defined in equation (21). This can be re-arranged as:

$$\theta_w = \frac{\alpha s + \phi}{\alpha s + \phi + \xi_w}\theta_r \tag{55}$$

and

$$\alpha\theta_r + (1-\alpha)\theta_w = (1-\Gamma)\theta_r, \tag{56}$$

where $\Gamma = (1-\alpha)\xi_w/(\alpha s + \phi + \xi_w)$.

Unemployment follows the differential equation:

$$\frac{du(t)}{dt} = s\,[1-u(t)] - \lambda(t)u(t). \tag{57}$$

Linearizing and taking the linear projection gives

$$\theta_\lambda = -(s + \lambda^* - \xi_u)/u^*. \tag{58}$$

Substituting (56) into (52) gives:

$$\theta_r = \theta_\rho - \widetilde{\beta}\Gamma\theta_r. \tag{59}$$

Linearizing and taking the linear projection of (47) leads to the following expression for the sensitivity of the optimal reservation wage:

$$(r + \lambda^* + s + \xi_\rho)\theta_\rho = \lambda^*[\alpha\theta_r + (1-\alpha)\theta_w] - \phi\theta_r + \theta_\lambda(w^* - \rho^*). \tag{60}$$

Substituting (56) and (59) into (60) gives:

$$[(r + \lambda^* + s + \xi_\rho)(1 + \widetilde{\beta}\Gamma) - \lambda^*(1-\Gamma) + \phi]\theta_r = \theta_\lambda(w^* - \rho^*). \tag{61}$$

Using (58) and converting to an elasticity we obtain:

$$\epsilon_r = -\frac{w^* - \rho^*}{w^*} \frac{\lambda^* + s - \xi_u}{(r + \lambda^* + s + \xi_\rho)(1 + \widetilde{\beta}\Gamma) - \lambda^*(1 - \Gamma) + \phi}. \tag{62}$$

Using (18), (62) can be rearranged to give the elasticity of the negotiated wage in equation (22). The elasticity of the average wage can be obtained as a function of ϵ_r using (55), which gives equation (24). Finally, the elasticity of the reservation wage can be expressed as a function of ϵ_r using (59), which gives equation (25).

B.5 The model with reference dependence

This sub-section derives results akin to those presented in Proposition 3 for the model with reference dependence. Taking linear projections of the reservation wage equations for the unemployed and the employed, (9) and (10) respectively, we obtain:

$$\theta_{\rho u} = \alpha_\rho \theta_{\rho o} + (1 - \alpha_\rho)\alpha_l \theta_{lu} \tag{63}$$

$$\theta_{\rho e} = \alpha_\rho \theta_{\rho o} + (1 - \alpha_\rho)\alpha_l \theta_{le}, \tag{64}$$

where $\theta_{\rho o}$ refers to the optimal reservation wage. Linearizing and taking the linear projection of (47) leads, after some re-arrangement to

$$\left[r + \lambda^*(1 - \alpha) + \phi\frac{\alpha}{\alpha_l} + s + \xi_\rho\right]\theta_{\rho o} = \lambda^*(1 - \alpha)\theta_w + \theta_\lambda(w^* - \rho^*). \tag{65}$$

For newly-negotiated wages, taking averages of (6) for those coming from unemployment and employment, respectively, gives

$$\theta_{ru} = (1-\beta)\theta_{\rho u} + \beta\left[\alpha\theta_{ru} + (1-\alpha)\theta_w\right] \tag{66}$$

$$\theta_{re} = (1-\beta)\theta_{\rho e}\frac{\rho^*}{w^*} + \beta\Bigg\{\left[\alpha\theta_{ru} + (1-\alpha)\theta_w\right] - \frac{\phi}{r+s}\frac{(1-\beta)(1-\alpha_\rho)\alpha_l}{r+s+\beta\phi}\left[\theta_{le} - \theta_{lu}\right]\Bigg\}. \tag{67}$$

Using (50), we obtain the corresponding expression for those with forward-looking reservation wages:

$$\theta_{ro} = (1-\beta)\theta_{\rho o}\frac{\rho^*}{w^*} + \beta\Bigg\{\left[\alpha\theta_{ru} + (1-\alpha)\theta_w\right] - \frac{\phi}{r+s}\frac{(1-\beta)(1-\alpha_\rho)}{r+s+\beta\phi}\left[\theta_{\rho o}\frac{\rho^*}{w^*} - \theta_{lu}\right]\Bigg\}. \tag{68}$$

The next set of equations are related to wage dynamics. Average wages follow the differential equation (53). Linearizing and taking the linear projection this becomes:

$$\xi_w\theta_w = \alpha s(\theta_{ru} - \theta_w) + \phi(\theta_{re} - \theta_w). \tag{69}$$

The lagged wage for the unemployed follows the differential equation:

$$\frac{dw^{lu}(t)}{dt} = \frac{s(1-u(t))}{u(t)}(w_a(t) - w_l^u(t)), \tag{70}$$

as it changes only with the inflow of workers from employment, who have an average wage $w_a(t)$.

Linearizing and taking the linear projection, (70) gives:

$$\xi_{lu}\theta_{lu} = \lambda^*(\theta_w - \theta_{lu}). \tag{71}$$

The lagged wage for the employed follows the differential equation:

$$\frac{dw^{le}(t)}{dt} = \frac{\lambda(t)u(t)}{1-u(t)}(w^{lu}(t) - w^{le}(t)), \tag{72}$$

as it changes only with the inflow of workers from unemployment, who have a lagged wage $w^{lu}(t)$. Linearizing and taking the linear projection, (72) gives:

$$\xi_{le}\theta_{le} = s(\theta_{lu} - \theta_{lu}). \tag{73}$$

Finally, there is the linear projection of the expression for unemployment dynamics (58) obtained above:

$$\theta_\lambda = -(s + \lambda^* - \xi_u)/u^* \tag{74}$$

Equations (63)-(69), (71), (73) and (74) form a system of ten linear equations that can be solved for the unknowns $\theta = (\theta_w, \theta_{\rho o}, \theta_{\rho e}, \theta_{\rho u}, \theta_{ro}, \theta_{re}, \theta_{ru}, \theta_{le}, \theta_{lu}, \theta_\lambda)$, in terms of the model parameters. The elements of the θ vector can be converted into elasticities using $\epsilon_x = u^*\theta_x/x^*$.

C The model with reference dependence in discrete time

C.1 Employers

The value at time t of a filled job that pays a wage w_{it} to worker i with lagged wage w_i^l is given by

$$J_t(w_{it}, w_i^l) = p_t - w_{it} + \frac{1}{1+r}\left\{(1-s)\left[(1-\phi)E_t J_{t+1}(w_{it}, w_i^l) + \phi E_t J_{t+1}(w_{t+1}^r(w_i^l), w_i^l)\right] + sE_t V_{t+1}\right\}. \tag{75}$$

From (75) two results follow, which will be used in later derivations:

$$\frac{\partial J_t(w_{it}, w_i^l)}{\partial w_{it}} = -\frac{1+r}{(1+r)-(1-s)(1-\phi)} = -\psi \tag{76}$$

and:

$$\begin{aligned}\frac{\partial J_t(w_{it}, w_i^l)}{\partial w_l} =& \frac{1-s}{1+r}\left[(1-\phi)\frac{\partial E_t J_{t+1}(w_{it}, w_i^l)}{\partial w_l}\right.\\ &\left.+\phi\left(\frac{\partial E_t J_{t+1}(w_{t+1}^r(w_i^l), w_i^l)}{\partial w_{t+1}^r}\,\frac{\partial w_{t+1}^r(w_i^l)}{\partial w_i^l} + \frac{\partial E_t J_{t+1}(w_{t+1}^r(w_i^l), w_i^l)}{\partial w_i^l}\right)\right],\end{aligned} \tag{77}$$

which, using (76), can be rewritten as:

$$\frac{\partial J_t(w_{it}, w_i^l)}{\partial w_i^l} = -\frac{(1-s)\phi\psi}{r+s}\frac{\partial w^r(w_i^l)}{\partial w_i^l} = -\chi. \tag{78}$$

The value of a vacant job is given by:

$$V_t = -c_t + \frac{1}{1+r}\left\{q_t E_t[\alpha J_{t+1}(w_{t+1}^{ru}, w_{t+1}^{lu}) + (1-\alpha)J_{t+1}(w_t^a, w_{t+1}^{lu}) - C_t] + (1-q_t)E_t V_{t+1}\right\}. \tag{79}$$

Imposing free entry and $\mu_t = \mu$, (79) can be re-arranged to give:

$$E_t[\alpha J_{t+1}(w^{ru}_{t+1}, w^{lu}_{t+1}) + (1-\alpha) J_{t+1}(w^a_t, w^{lu}_{t+1})] = \mu \tag{80}$$

which, using (76), can be rewritten as:

$$E_t J_{t+1}(w^{ru}_{t+1}, w^{lu}_{t+1}) = \mu - (1-\alpha)\psi(w^{ru}_{t+1} - w^a_t). \tag{81}$$

Evaluating (75) at the expected newly-negotiated wage and the expected lagged wage for the unemployed yields

$$\begin{aligned} J_t(w^{ru}_t, w^{lu}_t) = p_t - w^{ru}_t + \frac{1}{1+r} \big\{ (1-s) \big[(1-\phi) E_t J_{t+1}(w^{ru}_t(w^{lu}_t), w^{lu}_t) \\ + \ \phi E_t J_{t+1}(w^{ru}_{t+1}(w^{lu}_{t+1}), w^{lu}_{t+1}) + s E_t V_{t+1} \big] \big\}. \end{aligned} \tag{82}$$

Using (76), (78) and (81), (82) can be rewritten as:

$$\begin{aligned} (1+r)\left[\mu - (1-\alpha)\psi(w^{ru}_t - w^a_{t-1})\right] = (1+r)(p_t - w^{ru}_t) \\ \big\{ (1-s) \big[(1-\phi) \left[\psi(w^{ru}_{t+1} - w^{ru}_t) + (\psi\omega + \chi)(w^{lu}_{t+1} - w^{lu}_t) \right] \\ + \left[\mu - (1-\alpha)\psi(w^{ru}_{t+1} - w^a_t) \right] \big] \big\}, \end{aligned} \tag{83}$$

also using the fact that $E_t J_{t+1}(w^{ru}_{t+1}, w^{lu}_{t+1}) = E_t J_{t+1}(w^{ru}_{t+1}(w^{lu}_{t+1}), w^{lu}_{t+1})$. Equation (83) represents the job creation curve, relating negotiated wages w^{ru}_t to labor productivity p_t.

C.2 Workers

The value at time t to worker i, with a lagged wage w_i^l, of being employed at a wage w_{it} is given by:

$$
\begin{aligned}
W_t(w_{it}, w_i^l) =& w + \frac{1}{1+r}\left\{sE_tW_{t+1}(\rho_{t+1}(w_i^l), w_i^l)\right. \\
&\left. + (1-s)\left[\phi E_tW_{t+1}(w_{t+1}^r(w_i^l), w_i^l) + (1-\phi)E_tW_{t+1}(w_{it}, w_i^l)\right]\right\}, \qquad (84)
\end{aligned}
$$

where the utility of unemployment is represented by the utility of working at the reservation wage, which may depend on the lagged wage. The following result will be useful:

$$
\frac{\partial W_t(w_{it}, w_i^l)}{\partial w_{it}} = \frac{1+r}{1+r-(1-s)(1-\phi)} = \psi. \qquad (85)
$$

C.3 Wage determination

Nash bargaining implies:

$$
(1-\beta)[W_t(w_t^r(w_i^l), w_i^l) - W_t(\rho_t(w_i^l), w_i^l)] = \beta J_t(w_t^r(w_i^l), w_i^l). \qquad (86)
$$

Adding and subtracting $\beta E_t J_t(w_t^{ru}, w_t^{lu})$ on the right hand side of (86), and using (78), (81) and (85), (86) can be written as:

$$
\psi w_t^r(w_i^l) = (1-\beta)\psi\rho_t(w_i^l) + \beta\left\{\psi w_t^{ru} - \chi(w_i^l - w_t^{lu}) + \mu - (1-\alpha)\psi(w_t^{ru} - w_{t-1}^a)\right\}. \qquad (87)
$$

We take averages of (87) for those coming from unemployment and employment, respectively, to give:

$$\psi w_t^{ru} =(1-\beta)\psi\rho_t^u + \beta\left\{\psi w_t^{ru} + \mu - (1-\alpha)\psi(w_t^{ru} - w_{t-1}^a)\right\}, \tag{88}$$

$$\psi w_t^{re} =(1-\beta)\psi\rho_t^e + \beta\left\{\psi w_t^{ru} - \chi(w_t^{le} - w_t^{lu}) + \mu - (1-\alpha)\psi(w_t^{ru} - w_{t-1}^a)\right\}. \tag{89}$$

C.4 Reservation wage determination

The reservation wage is given by:

$$\rho_t(w_i^l) - \rho^* = \alpha_\rho(\rho_t^o - \rho^*) + (1-\alpha_\rho)\alpha_l(w_i^l - w^*). \tag{90}$$

Taking averages for the employed and unemployed gives, respectively:

$$\rho_t^u - \rho^* =\alpha_\rho(\rho_t^o - \rho^*) + (1-\alpha_\rho)\alpha_l(w_t^{lu} - w^*), \tag{91}$$

$$\rho_t^e - \rho^* =\alpha_\rho(\rho_t^o - \rho^*) + (1-\alpha_\rho)\alpha_l(w_t^{le} - w^*). \tag{92}$$

This leaves the foward-looking reservation wage to be determined. The value of being unemployed for the forward-looking case can be written as:

$$U_t = z + \frac{1}{1+r}\left\{(1-\lambda_t)E_tU_{t+1} + \lambda_t\left[\alpha E_tW_{t+1}(w_{t+1}^r) + (1-\alpha)E_tW_{t+1}(w_t^a)\right]\right\}. \tag{93}$$

The optimal reservation wage satisfies $W_t(\rho_t^o) = U_t$. Using this, the value functions (84) and (93) can be combined as:

$$
\begin{aligned}
&(1+r)\rho_t^o + \psi\left\{(1-s)E_t\left[\phi(w_{t+1}^r - \rho_{t+1}^o) + (1-\phi)(\rho_t^o - \rho_{t+1}^o)\right]\right\} \\
=&(1+r)z + \psi E_t\left\{\lambda_t\left[\alpha(w_{t+1}^r - \rho_{t+1}^o) + (1-\alpha)(w_t^a - \rho_{t+1}^o)\right]\right\}.
\end{aligned} \tag{94}
$$

Recall that prospective employers infer the worker's lagged wage, based on their observed reservation wage. Taking expectations of (90) for someone with $\rho_t(w^l) = \rho_t^o$ gives $E(w_i^l|\rho_t^o) = w^* + (\rho_t^o - \rho^*)/\alpha_l$. Substituting this into (87) gives the average negotiated wage for forward-looking workers, which is conditional on the optimal reservation wage:

$$
\psi w_t^{ro} = (1-\beta)\psi\rho_t^o + \beta\left\{\psi w_t^{ru} - \chi[w^* + \frac{1}{\alpha_l}(\rho_t^o - \rho^*) - w_t^{lu}] + \mu - (1-\alpha)\psi(w_t^{ru} - w_{t-1}^a)]\right\}. \tag{95}
$$

C.5 Lagged wages and average wages

Average lagged wage for the unemployed and the employed, are given by the following dynamic equations, respectively:

$$
w_t^{lu} = \frac{(1-\lambda_{t-1})u_{t-1}w_{t-1}^{lu} + s(1-u_{t-1})w_{t-1}^a}{(1-\lambda_{t-1})u_{t-1} + s(1-u_{t-1})} \tag{96}
$$

$$
w_t^{le} = \frac{\lambda_{t-1}u_{t-1}w_{t-1}^{lu} + (1-s)(1-u_{t-1})w_{t-1}^{le}}{\lambda_{t-1}u_{t-1} + (1-s)(1-u_{t-1})}. \tag{97}
$$

The average wage is given by:

$$
w_t^a = \frac{(1-s)(1-u_{t-1})\left[\phi w_t^{re} + (1-\phi)w_{t-1}^a\right] + \lambda_{t-1}u_{t-1}\left[\alpha w_t^{ru} + (1-\alpha)w_{t-1}^a\right]}{\lambda_{t-1}u_{t-1} + (1-s)(1-u_{t-1})}. \tag{98}
$$

C.6 Elasticities

The wage setting process is captured by nine equations: the three Nash bargaining solutions (88), (89) and (95); the three reservation wage equations (91), (92) and (94); and the three laws of motion for average wages (lagged and current) (96), (97), (98). These can be jointly solved for the nine endogenous wage variables w_t^a, w_t^{ro}, ρ_t^o, w_t^{re}, w_t^{ru}, w_t^{le}, w_t^{lu}, ρ_t^e and ρ_t^u. These conditions are conditional on the market tightness λ_t and the model is closed by the job creation curve (equation (83)), which gives λ_t as a function of the exogenous productivity process p_t.

To study how the system responds to shocks, we use the linear projection definition for a hypothetical variable x on the unemployment rate (as in Section 4.3):

$$E(x_t - x^*|u_t - u^*) = \theta_x(u_t - u^*)$$
$$E(x_{t+1} - x_t|u_t - u^*) = \xi_x E(x_t - x^*|u_t - u^*) = \xi_x \theta_x (u_t - u^*).$$

Starting with negotiated wages, we apply the linear projection to equation (88) to obtain:

$$(1 - \alpha\beta)\theta_{ru} = (1 - \beta)\theta_{\rho u} + \beta(1 - \alpha)(1 - \xi_a)\theta_w. \tag{99}$$

Similarly for equation (89):

$$\theta_{re} = (1 - \beta)\theta_{\rho e} + \beta \left[(1 - \alpha)(1 - \xi_w)\theta_w + \alpha\theta_{ru} - \frac{\chi}{\psi}(\theta_{le} - \theta_{lu}) \right] \tag{100}$$

and (95):

$$\theta_{ro} = (1 - \beta)\theta_{\rho o} + \beta \left[(1 - \alpha)(1 - \xi_w)\theta_w + \alpha\theta_{ru} - \frac{\chi}{\psi}(\theta_{\rho o} - \theta_{lu}) \right]. \tag{101}$$

For reservation wages, we apply the linear projection to equations (91) and (92):

$$\theta_{\rho u} = \alpha_\rho \theta_{\rho o} + (1-\alpha_\rho)\alpha_l \theta_{lu} \tag{102}$$

$$\theta_{\rho e} = \alpha_\rho \theta_{\rho o} + (1-\alpha_\rho)\alpha_l \theta_{le}. \tag{103}$$

All equations used so far are linear in the model variables. Equations (94) and (96)-(98) are instead nonlinear, because they involve the product between various wage concepts and λ_t. We first linearise the corresponding expressions around steady state and then apply the linear projection. Let's define $\frac{\partial f(x)}{\partial x} \mid_{ss} = R_x$ the derivative of a function $f(x)$ evaluated at the steady state value of x, x^*. Starting with (94), and using $w^* - \rho^* = \mu\tilde{\beta}/\psi$, we obtain:

$$\theta_{\rho o} R_{\rho o} = \tilde{\beta}\mu\theta_\lambda + (1+\xi_{ro})R_{ro}\theta_{ro} + R_w \theta_w, \tag{104}$$

where $R_w = \psi\lambda^*(1-\alpha)$, $R_{ro} = \psi\lambda^*\alpha - (1-s)\phi\psi$, $R_{\rho o} = \psi\{1 + r + [\lambda^* - (1-s)](1+\xi_{\rho o})\}$.

Linearising (98) gives:

$$w_t = f_{ru}(w_t^{ru} - w^*) + f_{re}(w_t^{re} - w^*) + f_u(u_{t-1} - u^*) + f_\lambda(\lambda_{t-1} - \lambda^*) + f_w(w_{t-1}^a - w^*),$$

where $f_x = \frac{\partial w}{\partial x}|_{ss}$, with $f_u = f_\lambda = 0$, $f_{ru} = \alpha s$, $f_{re} = (1-s)\phi$ and $f_w = (1-\alpha)s + (1-s)(1-\phi)$. Taking the linear projection gives:

$$\theta_w(1 + \xi_w - f_w) = \theta_{ru}(1+\xi_{ru})f_{w^{ru}} + \theta_{re}(1+\xi_{re})f_{w^{re}} \tag{105}$$

Using a similar approach for (96) gives:

$$\theta_{lu}(1+\xi_{lu}) = \frac{(1-\lambda^*)u^*\theta_{lu} + s(1-u^*)\theta_w}{(1-\lambda^*)u^* + s(1-u^*)}.$$

Imposing the steady state condition $s(1-u^*) = \lambda^* u^*$ and re-arranging gives:

$$\theta_{lu} = \frac{\lambda^*\theta_w}{\xi_{lu} + \lambda^*}. \tag{106}$$

Finally, repeating the same steps for (97) gives:

$$\theta_{lu} = \frac{s\theta_w}{\xi_{le} + s}. \tag{107}$$

We next derive elasticities with respect to unemployment, defined as $\epsilon_x = \theta_x u^*/x^*$. We start with unemployed workers first. The elasticity of negotiated wages for those previously unemployed, ϵ_{ru}, follows from (99):

$$(1-\alpha\beta)\epsilon_{ru} = (1-\beta)\epsilon_{\rho u}\frac{\rho^*}{w^*} + \beta\,(1-\alpha)\,(1-\xi_w)\epsilon_w. \tag{108}$$

The elasticity of reservation wages for the unemployed, $\epsilon_{\rho u}$, follows from (102):

$$\epsilon_{\rho u} = \alpha_\rho \epsilon_{\rho o} + (1-\alpha_\rho)\alpha_l \epsilon_{lu}\frac{w^*}{\rho^*} \tag{109}$$

and the elasticity of lagged wages for the unemployed, ϵ_{lu}, follows from (106):

$$\epsilon_{lu}(\xi_{lu} + \lambda^*) = \lambda^*\epsilon_w.$$

The elasticity of the optimal reservation wage can be derived by combining equations (74), (105), and the steady state version of (94):

$$\epsilon_{\rho o} R_{\rho o} \frac{\rho^*}{w^*} = -(1-\eta)\frac{1+r}{ru^*+s}(s - \xi_u u^*) + (1+\xi_{ro}) R_{ro}\epsilon_{ro} + R_w \epsilon_w. \tag{110}$$

Turning to employed workers, the elasticity of newly-negotiated wages, newly-negotiated wages for those with forward-looking reservation wages, lagged wages and reservation wages can be derived respectively from (100):

$$\epsilon_{re} = (1-\beta)\epsilon_{\rho e}\frac{\rho^*}{w^*} + \beta\left[(1-\alpha)(1-\xi_w)\epsilon_w + \alpha\epsilon_{ru} - \frac{\chi}{\psi}(\epsilon_{le} - \epsilon_{lu})\right], \tag{111}$$

from (101):

$$\epsilon_{ro} = \left[1 - \beta\left(1 + \frac{\chi}{\psi\alpha_l}\right)\right]\epsilon_{\rho o}\frac{\rho^*}{w^*} + \beta\left[(1-\alpha)(1-\xi_w)\epsilon_w + \alpha\epsilon_{ru} + \frac{\chi}{\psi}\epsilon_{lu}\right], \tag{112}$$

from (107):

$$\epsilon_{le} = \frac{s}{\xi_{le} + s}\epsilon_{lu},$$

and from (103):

$$\epsilon_{\rho e} = \alpha_\rho \epsilon_{\rho o} + (1-\alpha_\rho)\alpha_l \epsilon_{le}\frac{w^*}{\rho^*}. \tag{113}$$

Finally, the elasticity of the average wage in the economy follows from (105):

$$\epsilon_w(1 + \xi_w - f_w) = \epsilon_{ru}(1+\xi_{ru}) f_{ru} + \epsilon_{re}(1+\xi_{re}) f_{re}. \tag{114}$$

C.7 The special case without reference dependence

The elasticity of average wages can be obtained from (114) as a function of the elasticity of negotiated wages, having set $\epsilon_{re} = \epsilon_{ru} = \epsilon_r$ and $\xi_{re} = \xi_{ru} = \xi_r$:

$$\epsilon_w = \frac{\alpha s + (1-s)\phi}{\alpha s + (1-s)\phi + \xi_w}(1+\xi_r)\epsilon_r. \tag{115}$$

The elasticity of reservation wages can be obtained from (108) as a function of the elasticity of negotiated wages, using (115) and setting $\epsilon_{ru} = \epsilon_r$ and $\epsilon_{\rho u} = \epsilon_\rho$:

$$\epsilon_\rho = \left[\frac{1-\beta\alpha}{1-\beta} - \tilde{\beta}\,(1-\alpha)\,\frac{\alpha s + (1-s)\phi}{\alpha s + \phi + \xi_w}(1-\xi_w)(1+\xi_r)\right]\frac{w^*}{\rho^*}\epsilon_r. \tag{116}$$

The condition that closes the system, and provides the elasticity of the negotiated wage as a function of the previous two elasticities, can be obtained from (110), having set $\epsilon_{\rho 0} = \epsilon_\rho$:

$$\epsilon_\rho R_\rho \frac{\rho^*}{w^*} = -(1-\eta)\frac{1+r}{ru^*+s}(s - \xi_u u^*) + (1+\xi_r)R_r\epsilon_r + R_w\epsilon_w, \tag{117}$$

where $R_w = \psi\lambda^*(1-\alpha)$, $R_r = \psi\lambda^*\alpha - (1-s)\phi\psi$, and $R_\rho = \psi[1 + r + \{\lambda^* - (1-s)\}(1+\xi_\rho)]$. Substituting (115) and (116) into (117) finally gives the elasticity of the negotiated wage as a function of parameters only:

$$\varepsilon_r(R_\rho\Omega_\rho - (1+\xi_r)R_r - R_w\Omega_w) = -(1-\eta)\frac{s - \xi_u u^*}{ru^*+s}\psi[r + \phi + s(1-\phi)]. \tag{118}$$

D Additional Tables and Figures

Table A1: **Summary Statistics**

	United Kingdom				Germany			
	Wage sample		Res. wage sample		Wage sample		Res. wage sample	
Variables:	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
Reservation wage			5.226	6.206			1180.366	703.219
Wage	9.866	6.203			2387.666	1898.023		
Female	0.526	0.500	0.546	0.498	0.430	0.495	0.616	0.486
Age	38.106	11.691	34.666	14.024	39.039	11.644	33.289	11.316
Higher education	0.117	0.321	0.247	0.431	0.254	0.435	0.143	0.350
Upper secondary education	0.269	0.443	0.353	0.478	0.528	0.499	0.549	0.498
Lower secondary education	0.405	0.491	0.314	0.464	0.178	0.382	0.211	0.408
No qualifications	0.209	0.407	0.085	0.280	0.040	0.040	0.097	0.086
Married	0.717	0.451	0.514	0.500	0.657	0.475	0.559	0.497
No. Kids	0.686	0.965	0.917	1.168	0.730	0.990	1.027	1.120
Duration in current status (years)	4.880	5.969	4.387	5.748	10.464	9.653	2.962	3.902
Benefits			276.414	318.201			255.835	448.710
Looking for full-time work							0.482	0.500
Looking for part-time work							0.382	0.486
Looking for either							0.109	0.312
Unsure about working hours							0.027	0.161
Social insurance contributions (months)							5.242	6.878
Months to benefit expiry							1.109	3.679
Entitled to unemployment benefits							0.196	0.397
Hours worked					38.495	12.680		
Number of observations	96,270		14,874		166,614		11,221	

Notes. Samples include employees aged 16-65 with non-missing wage information (wage sample); unemployed jobseekers aged 18-65 with non-missing reservation wage information (reservation wage sample). Source: BHPS 1991-2009 and SOEP 1984-2010.

Table A2: **Detailed Results on Wage and Reservation Wage Equations for the UK and Germany**

	United Kingdom		Germany	
Dependent variable	log wage	log res wage	log wage	log res wage
Log national unemployment rate	-0.165	-0.175	0.002	0.001
	(0.044)	(0.058)	(0.025)	(0.065)
Female	-0.263	-0.102	-0.265	-0.188
	(0.009)	(0.011)	(0.015)	(0.018)
Age	0.073	0.033	0.082	0.018
	(0.002)	(0.002)	(0.002)	(0.003)
Age^2 (/100)	-0.084	-0.034	-0.009	-0.003
	(0.002)	(0.002)	(0.000)	(0.000)
Lower secondary qualification	0.193	0.068	0.023	-0.016
	(0.008)	(0.009)	(0.011)	(0.024)
Upper secondary qualification	0.361	0.157	0.230	0.093
	(0.007)	(0.011)	(0.015)	(0.023)
Higher education	0.710	0.352	0.562	0.276
	(0.004)	(0.013)	(0.019)	(0.029)
Married	0.092	0.042	0.032	-0.038
	(0.006)	(0.006)	(0.003)	(0.010)
No. kids in household	-0.019	0.018	-0.020	-0.006
	(0.003)	(0.004)	(0.004)	(0.005)
Duration in current status (years)	0.018	-0.002	0.037	0.013
	(0.001)	(0.002)	(0.002)	(0.005)
Duration in current $status^2$ (/10)	-0.010	-0.001	-0.012	-0.014
	(0.001)	(0.002)	(0.001)	(0.006)
Duration in current $status^3$ (/100)	0.017	0.003	0.002	0.003
	(0.002)	(0.003)	(0.000)	(0.002)
Log(Unemp benefits + 1)		0.004		0.004
		(0.001)		(0.003)
Receives housing benefits		0.017		-0.075
		(0.008)		(0.026)
Social insurance contributions (years)				0.005
				(0.001)
Looking for full-time work				0.151
				(0.036)
Looking for part-time work				-0.507
				(0.033)
Looking for any hours				-0.051
				(0.031)
Log hours worked			0.912	
			(0.042)	
Year	-0.009	0.004	0.022	0.027
	(0.007)	(0.007)	(0.002)	(0.008)
$(Year-1990)^2$	0.001	0.001	-0.696	-1.003
	(0.000)	(0.000)	(0.078)	(0.253)
Observations	96,270	14,847	166,614	11,221
R-squared	0.397	0.249	0.605	0.359

Notes. See notes to Table A1 for samples used. The wage measure is hourly for the UK and monthly for Germany. All regressions include region dummies. Standard errors are clustered at the year level. Source: BHPS 1991-2009 and SOEP 1984-2010

Table A3: **Estimates of a Wage Equation for the UK, 1991-2009. Further Estimates with Regional Controls.**

	Dependent variable: Log monthly wage								
	1	2	3	4	5	6	7	8	9
Log hourly wage, lagged									0.073
									(0.052)
Log regional unemployment rate	0.010	-0.009	-0.036	-0.053	-0.044	-0.042	-0.010		-0.058
	(0.010)	(0.022)	(0.019)	(0.017)	(0.017)	(0.010)	(0.022)		(0.022)
Log regional unemployment rate					-0.032	-0.011			
* new job					(0.005)	(0.006)			
Log regional unemployment rate,							-0.060	-0.065	
lagged							(0.017)	(0.013)	
Trend	no	linear	quadratic	quadratic	quadratic	quadratic	quadratic	quadratic	quadratic
Year dummies	✓								
Individual fixed effects				✓	✓		✓	✓	✓
Job fixed effects						✓			
Observations	96,269	96,269	96,269	92,380	92,380	77,854	92,380	92,380	53,054
R-squared	0.399	0.397	0.397	0.809	0.810	0.889	0.810	0.810	

Notes. See notes to Table A1 for sample. The dependent variable is the log gross hourly wage, deflated by the aggregate consumer price index. Estimation method: OLS in columns 1-8; Arellano Bond (1991) estimator for dynamic panel data models in column 9. 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. Standard errors are clustered at the region*year level in column 1; at the year level in columns 2 and 3; and using 2-way cluster-robust variance (Cameron and Miller, 2015) in columns 4-9. Source: BHPS.

Table A4: **Estimates of a Wage Equation for Germany, 1984-2010. Further Estimates with Regional Controls**

	Dependent variable: Log monthly wage								
	1	2	3	4	5	6	7	8	9
Log monthly wage, lagged									0.390
									(0.027)
Log regional unemployment rate	-0.033	0.015	0.006	-0.008	-0.003	0.001	0.049		-0.004
	(0.016)	(0.026)	(0.023)	(0.015)	(0.014)	(0.011)	(0.016)		(0.016)
Log regional unemployment rate					-0.039	-0.011			
* new job					(0.013)	(0.011)			
Log regional unemployment rate,							-0.079	-0.044	
lagged							(0.013)	(0.014)	
Trend	no	linear	quadratic	quadratic	quadratic	quadratic	quadratic	quadratic	quadratic
Year dummies	✓								
Individual fixed effects				✓	✓		✓	✓	✓
Job fixed effects						✓			
Observations	166,614	166,614	166,614	161,075	160,865	149,617	161,075	161,075	101,526
R-squared	0.652	0.649	0.651	0.414	0.415	0.199	0.415	0.415	

Notes. See notes to Table A1 for sample. The dependent variable is the log gross monthly wage, deflated by the aggregate consumer price index. Estimation method: OLS in columns 1-8; Arellano Bond (1991) estimator for dynamic panel data models in column 9. 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. Standard errors are clustered at the region*year level in column 1; at the year level in columns 2 and 3; and using 2-way cluster-robust variance (Cameron and Miller, 2015) in columns 4-9. Source: SOEP.

Table A5: **Estimates of a Reservation Wage Equation for the UK, 1991-2009: Further Estimates with Regional Controls**

	Dependent variable: Log hourly reservation wage					
	1	2	3	4	5	6
Log regional unemployment rate	0.007	-0.047	-0.054	-0.034	0.048	
	(0.025)	(0.031)	(0.028)	(0.030)	(0.037)	
Log regional unemployment rate, lagged					-0.106	-0.078
					(0.030)	(0.024)
Trend	no	linear	quadratic	quadratic	quadratic	quadratic
Year dummies	✓					
Individual fixed effects				✓	✓	✓
Observations	14,873	14,873	14,873	10,774	10,774	10,774
R-squared	0.252	0.247	0.247	0.613	0.614	0.614

Notes. See notes to Table A1 for sample. The dependent variable is the log net hourly reservation wage, deflated by the aggregate consumer price index. Estimation method: OLS. 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*region level in column 1, at the year level in columns 2 and 3, and using 2-way cluster-robust variance (Cameron and Miller, 2015) in columns 4-6. Source: BHPS.

Table A6: **Estimates of a Eeservation Wage Equation for Germany, 1987-2010: Further Estimates with Regional Controls**

	Dependent variable: Log monthly reservation wage					
	1	2	3	4	5	6
Log regional unemployment rate	-0.079	0.028	0.018	0.034	0.116	
	(0.043)	(0.044)	(0.028)	(0.023)	(0.029)	
Log regional unemployment rate, lagged					-0.113	-0.031
					(0.032)	(0.023)
Trend	no	linear	quadratic	quadratic	quadratic	quadratic
Year dummies	✓					
Individual fixed effects				✓	✓	✓
Observations	11,221	11,221	11,221	7,911	7,911	7,911
R-squared	0.421	0.413	0.418	0.124	0.125	0.123

Notes. See notes to Table A1 for sample. The dependent variable is the log net monthly reservation wage, deflated by the aggregate consumer price index. Estimation method: IV. 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 eleven region dummies. Unemployment benefits are instrumented, see notes to Table 4. Standard errors are clustered at the year) level in columns 1-3, and using 2-way cluster-robust variance (Cameron and Miller, 2015) in columns 4-6. Source: SOEP.

Table A7: **Reservation Wages, Post-unemployment Wages and Job Finding Probabilities in the UK, 1991-2009**

	Whether found job			Log post-unemployment wage		
	1	2	3	4	5	6
Log reservation wage	-0.001	-0.020	-0.020	0.436	0.312	0.157
	(0.008)	(0.008)	(0.011)	(0.021)	(0.036)	(0.080)
Year dummies	✓			✓		
Trend	no	quadratic	quadratic	no	quadratic	quadratic
Further controls		✓	✓		✓	✓
Individual fixed-effects			✓			✓
Observations	15,278	14,701	10,642	2,685	2,594	602
R-squared	0.018	0.078	0.039	0.217	0.299	0.290

Notes. See notes to Table 3 for the sample used. Estimation method: OLS. All specifications include eleven region dummies. 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 and the number of children in the household. Standard errors are clustered at the year level in columns 1, 2, 4 and 5; and using 2-way cluster-robust variance (Cameron and Miller, 2015) in columns 3 and 6. Source: BHPS.

Table A8: **Reservation Wages, Post-unemployment Wages and Job Finding Probabilities in Germany, 1987-2010**

	Whether found job			Log post-unemployment wage		
	1	2	3	4	5	6
Log reservation wage	0.033	-0.081	-0.100	0.737	0.391	0.123
	(0.007)	(0.011)	(0.016)	(0.023)	(0.034)	(0.106)
Year dummies	✓			✓		
Trend	no	quadratic	quadratic	no	quadratic	quadratic
Further controls		✓	✓		✓	✓
Individual fixed-effects			✓			✓
Observations	11,534	11,534	8,156	2,984	2,984	755
R-squared	0.007	0.071	0.033	0.244	0.348	0.127

Notes. See notes to Table 4 for the sample used. Estimation method: OLS. All specifications include eleven region dummies. 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"). Standard errors are clustered at the year level in columns 1, 2, 4 and 5; and using 2-way cluster-robust variance (Cameron and Miller, 2015) in columns 3 and 6. Source: SOEP.