Discussion of: *Stubborn Beliefs in Search Equilibrium* by Guido Menzio
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**Summary.** Guido Menzio’s paper *Stubborn Beliefs in Search Equilibrium* provides a new and provocative approach to a set of long-standing questions in the macro-labor literature. What is the source of downward wage rigidity? And how can one of the workhorse models in this literature—the random search model pioneered by Diamond, Mortensen and Pissarides (DMP)—generate realistic cyclical fluctuations in vacancies and unemployment?

Menzio proposes a novel mechanism for wage rigidity, which relies on the presence of non-rational workers in an otherwise standard DMP model. These ‘stubborn’ workers do not have rational expectations but instead have biased beliefs about the aggregate state of the economy. More specifically, they believe that aggregate productivity is constant and equal to its unconditional mean of the productivity distribution, failing to recognize booms or recessions. In a downturn, workers who contemplate forming a match with a firm have therefore beliefs about their outside option—the value of search—that are too optimistic, which impacts the wages they bargain. In fact, wages are entirely pinned down by workers’ beliefs since firms have no choice but to accommodate these biased beliefs as they cannot be changed. Wages are therefore too high compared to what a recession would call for, i.e., they are downward sticky/rigid. As a result, firms’ incentives to post vacancies strongly diminish. In the presence of stubborn workers, aggregate productivity movements then translate into larger shifts in vacancies and unemployment, as well as in labor market tightness, which is the ratio between the two. On the normative side, the paper shows that these fluctuations are inefficiently large, which can be corrected by a countercyclical employment subsidy.

While in the baseline model, all workers are stubborn, the extension features a more realistic setting, in which some workers are stubborn (i.e., a fraction $\sigma$) and some are rational. Firms do not know the type of the particular worker that they bargain with. But they know the distribution of beliefs (i.e., they know $\sigma$), and they try to learn about the individual worker’s type they bargain with. In a recession, the focus is on a *pooling equilibrium*. Stubborn workers
are more optimistic about the economy’s state and their outside option compared to rational ones. Hence, they bargain wages that are too high compared to what is justified in a state of poor aggregate fundamentals. Rational workers understand this and have an incentive to mimic stubborn workers’ bargaining strategy to get paid higher wages. If the fraction of stubborn workers is relatively large and/or the negative productivity shock is relatively small, then screening is too costly and firms have no incentive to disentangle the two workers types. A pooling equilibrium results, in which both worker types obtain the wage that reflects stubborn beliefs. Conditional on pooling, this wage is independent of the amount of stubborn workers $\sigma$. In turn, the boom features a separating equilibrium. Rational workers are more optimistic about the state of the economy and their outside option than stubborn ones. As a result, they have an incentive to signal to firms their true rational type. Higher wages will be paid to rational than to stubborn workers, and the extent of upward sticky wages will depend on the fraction of stubborn workers $\sigma$.

**Contribution to the Literature.** The main contribution of this paper is to provide a new mechanism for rigid wages. This mechanism has the potential to generate large cyclical fluctuations of unemployment and vacancies in models that have struggled to do so.

As more accurate information on wages along with rich worker and job characteristics has become available, the empirical literature on wage rigidity has experienced a revival. Recent work tries to overcome the challenge posed by worker and job selection over the business cycle for the measurement of wage rigidities. Using administrative wage data from the largest US payroll processing company, [Grigsby et al. (2021)](Grigsby) find that wages of incumbent workers and new hires are similarly rigid. [Hazell and Taska (2020)](Hazell) measure the extent of wage rigidity of new hires based on job postings from the Burning Glass online vacancy platform. When controlling for cyclical changes in job composition, they also find that new hire wages are downward rigid (and flexible upward). While wage rigidity for incumbent workers may be natural, wage rigidity for new hires is more surprising and also more difficult to rationalize in models. Menzio contributes a new mechanism that generates (new hire) wage rigidity.

Understanding the sources and degree of rigid wages is especially important for the analysis of business cycle fluctuations in vacancies and unemployment. In fact, the most common way to generate realistic business cycle fluctuations in unemployment in the DMP model is through rigid wages. Under the standard assumption of period-by-period Nash bargained wages (and
under a standard calibration), this model features wages that are too flexible, absorbing a large chunk of aggregate productivity shifts. This excess volatility in wages is the main reason why the standard DMP model has failed to generate realistic fluctuations in quantities, a phenomenon that is known as the unemployment volatility puzzle (see Shimer (2005)).

Why do flexible wages dampen the cyclical fluctuations of unemployment, vacancies and market tightness in the standard DMP model? First note that what determines the amount of vacancies \( v \) and ultimately the labor market tightness \( \theta \) (which is the ratio of vacancies over unemployment \( u \)) as well as unemployment in this model is a free entry condition for firms. It says that firms (or vacancies) should enter the labor market up to the point where the cost \( k \) and benefit of posting a vacancy are equalized. This benefit is the expected value of filling the vacancy, given by the job filling rate \( q(\theta(y)) \) times the firm’s value of a filled job \( J(w(y), y) \), where both market tightness \( \theta \) and the wage \( w \) depend on the economy’s aggregate productivity \( y \):

\[
k = q(\theta(y))J(w(y), y) \approx q(\theta(y))(y - w(y)).
\]

The value of a filled job is an increasing function of flow profits \( y - w(y) \). Thus, if the wage \( w(y) \) is very responsive to aggregate productivity shocks to \( y \), then \( y - w(y) \) is roughly constant. As a result, the incentives to post vacancies do not vary over the business cycle, so that \( \theta = \theta(y) \) is approximately constant, and so is the unemployment rate.

What makes wages responsive to aggregate productivity \( y \) in this model in the first place? The standard way to pin down wages in the DMP model is through Nash bargaining. The axiomatic Nash solution maximizes the product of the worker and job surplus, with weights that are equal to the worker (firm) bargaining power \( \gamma (1 - \gamma) \). The resulting wage is given by a weighted average of productivity and the worker’s outside option:

\[
w(y) = \gamma y + (1 - \gamma)(1 - \beta)V_0(y),
\]

where \( \beta \) is the discount factor and \( V_0(y) \) is the value of search (i.e., the value of unemployment). The value of search is what the worker would get if the match did not happen, i.e., his outside option. It depends on the aggregate state because it is impacted by labor market tightness \( \theta \) (a
tight labor market increases the job-finding rate for workers and thus the value of search) and the wages in other jobs (higher wages lead to a higher value of search). This equation illustrates why in this type of model, wages strongly depend on aggregate productivity. There is a direct effect of aggregate productivity through surplus sharing, weighted by the worker’s bargaining power; and there is an indirect effect through the worker’s outside option, which is increasing in $y$ as well.

Much research has been dedicated to develop ways that make wages more rigid in this model. Some approaches focus on solutions that maintain the Nash bargaining assumption, while others abandon Nash bargaining altogether.

For instance, Hall (2005) lets go of Nash bargaining and makes wages rigid by assumption $w(y) = \bar{w}$, substantially increasing the cyclical fluctuations of firms’ profits and thus the incentives to post vacancies based on the free entry condition.

Hall and Milgrom (2008) also abandon Nash bargaining. They replace it by the alternating offer bargaining (Binmore et al. (1986)). One side of the market makes a wage offer. If accepted, this offer will be the agreed wage. If rejected by the other side, then a counter offer is made. If accepted, then the match will form at that wage. Workers and firms keep making alternative offers until they agree or the negotiations (exogenously) break down. The key difference with Nash bargaining is that this bargaining game puts the disagreement payoff (as opposed to the outside option) at its center stage. The disagreement payoff is what the two sides obtain while bargaining before the agreement is reached. The workers’ outside option is still in the picture but only becomes relevant in the unlikely case of a negotiation break-down. This loosens the connection between the wage and the value of search, and therefore the connection between wages and aggregate productivity. As a result, unemployment responds more strongly to aggregate shocks.

Gertler and Trigari (2009) replace the period-by-period Nash bargaining by staggered multi-period Nash-bargaining, according to which in each period only a subset of firms and workers negotiate wage contracts. Workers hired in between wage bargaining periods receive the same wage as the firm’s existing workers. As a result, wages are more rigid than in the baseline model, producing larger responses of unemployment to productivity shocks.

1A solution to the unemployment volatility puzzle that does not rely on wage rigidity is proposed by Hagedorn and Manovskii (2008) who maintain Nash bargaining in the DMP model, but choose a different calibration than Shimer (2005): They set a high level of unemployment flow income, which makes firms’ profit margin small. This implies that small productivity shocks have a relatively large proportional impact on profits, affecting the incentive to post vacancies even with relatively flexible wages.
Menzio’s solution to the problem of excessively flexible wages is different but can be understood within this framework as well. He assumes, similar to Hall and Milgrom (2008), that wages are set by the alternating offer bargaining. But contrary to Hall and Milgrom, he focuses on the limit case, in which the cost of delaying the agreement by one period becomes negligible. In this limit, the alternating bargaining solution becomes the axiomatic Nash solution, so in principle there is a strong transmission of aggregate productivity to wages through the workers’ outside option. Menzio’s twist to prevent this is to make the outside option of workers independent of the aggregate state, weakening the feedback effect from the current state of the economy to the current wage. Stubborn workers do not update their beliefs about the aggregate state of the economy; they think it is always the same, \( y = y^* \). As a result, the value of search does not depend on aggregate productivity \( V_0(y) = V_0 \) and wages are given by:

\[
w(y) = \gamma y + (1 - \gamma)(1 - \beta)V_0.
\]

This leads to a smaller transmission (or no transmission at all, if workers in addition do not observe the firm productivity realization \( y \), which is equal to the aggregate productivity) of aggregate shocks to wages, and thereby to larger fluctuations in vacancies and unemployment in response to these shocks.

**Discussion.** In this discussion, I will examine several of the model’s key ingredients that underlie the mechanism for wage rigidity. My main focus will be on the non-rational (stubborn) beliefs. What does the analyst need to know about the workers’ beliefs when applying this model and what do we actually know about individuals’ beliefs in the labor market context? I will also discuss the importance of two other assumptions, that of wage bargaining (versus posting) and of hiring from unemployment only (versus from employment also), for generating the desired wage rigidity. I base my discussion on the model extension that features a mix of stubborn and rational workers, as I believe it will be the main candidate for applications and quantitative analysis.

**Workers’ Biased Beliefs.** As a first comment, note that the information requirements for the analyst of this model are non-negligible. To apply this model both in a positive way (to understand the extent of business cycle fluctuations of unemployment and market tightness it can generate) and in a normative way (to design the optimal employment subsidy that corrects
the excess volatility of unemployment), the researcher needs to know the distribution of workers’ beliefs. She not only needs to know how the deviations from rationality look like, but also what the fraction of non-rational workers in the economy is.

For a start, I will take the particular deviations from rationality that the paper proposes as given and I will come back to this point below. Let me focus for now on the point that the researcher needs to know the share of stubborn workers, \( \sigma \), to work with this model. Consider the pooling equilibrium of a recession. The attractive feature of the model is that if pooling materializes, then the equilibrium wage will be downward rigid, independently of the level of \( \sigma \). But checking that the condition for pooling is satisfied, i.e., that firms have no incentive to screen rational and stubborn workers, requires knowledge of \( \sigma \). Using a slightly simplified model (with a two-point process for aggregate productivity) and a calibration that mimics the one in this paper, one can compute the (candidate) pooling equilibrium and check whether the condition for pooling holds.\(^2\)

I illustrate this condition for the calibrated (simplified) model in Figure 1, which graphs the fraction of stubborn workers \( \sigma \) as a function of the productivity realization in the recession \( y \) (the ‘normal’ state of the economy is \( y^* = 1 \)).\(^3\) Pooling happens in the parameter set that is north-east to the blue curve. For any given shock \( y \) with \( y < y^* \), the fraction of stubborn workers needs to be large enough so that screening out the rational workers is too costly for firms. But the larger is the negative productivity shock (i.e., the larger are the deviations of \( y \) from \( y^* = 1 \)), the more stubborn workers (higher \( \sigma \)) are needed to prevent firms from screening out rational workers and from paying them lower wages. Pooling makes wages particularly rigid in a recession, which amplifies the response of unemployment and vacancies to a negative shock. But whether pooling materializes depends on the distribution of stubborn/rational workers, captured by \( \sigma \).\(^4\)

Knowledge of the distribution of beliefs is also required for assessing the qualitative and, especially, the quantitative implications of the boom equilibrium. In the boom, stubborn workers

\[ \sigma(y - (1 - \beta)\hat{V}_{S,0}) \geq (1 - \sigma)(1 - \beta)(\hat{V}_{S,0} - V_{R,0}(y)), \]

where \( \hat{V}_{S,0} \) is the perceived value of search of unemployed workers, which is independent of the aggregate productivity \( y \), and \( V_{R,0}(y) \) is the value of search of rational workers, which depends on \( y \). See equation (5.14) in Menzio (2022).

\(^2\)Formally, the condition for pooling is given by:

\[^{3}\]The figure is based on a model with two-point productivity process, with \( y^* = 1, \gamma = 0.5, \delta = 0.02, b = 0.5, \phi_R = 0.98, \phi_S = 0.95, \) and \( k \) is chosen such that the average monthly job finding rate is around 30%.

\[^{4}\]Menzio (2022) makes the plausible conjecture that even when the equilibrium is separating in the recession, rational workers’ wages will be close to the wages of stubborn workers. But even in this case, \( \sigma \) needs to be known for grasping the extent of wage rigidity in the boom, see below.
are relatively pessimistic and therefore bargain a wage that is lower than what the state of the economy calls for. Rational workers have therefore no incentive to mimic stubborn workers’ wage bargaining strategy. Instead, they signal their rational type to firms in order to obtain higher wages. Rational workers’ wages therefore reflect the favorable aggregate state. The extent of wage rigidity (and the extent of fluctuations of labor market tightness in response to productivity shocks) will thus depend on the fraction of stubborn workers, $\sigma$.

Figure 2 illustrates this point by graphing the model-implied elasticity of labor market tightness w.r.t. aggregate productivity as a function of the fraction of stubborn workers, $\sigma$. The more stubborn workers there are, the more rigid wages will be in a boom, translating into a larger elasticity of labor market tightness with respect to aggregate productivity. The horizontal dashed line indicates the empirical elasticity, which is around 20\textsuperscript{5}. In order to achieve realistic fluctuations of tightness (and unemployment) w.r.t. aggregate productivity, this simple calibration suggests that what is required is that the majority of workers ( $\sim$70\%) is ignorant of the aggregate state.

Given that the level of $\sigma$ is central to whether the model can generate a sufficient degree of wage rigidity that renders realistic business cycle fluctuations in tightness, it is important to discipline these beliefs in a credible way. Otherwise, anything goes: If $\sigma$ is a free parameter, one can always choose it such that the model matches the observed volatility. Can the data help us

\textsuperscript{5}This is in between the targets of \textcite{Shimer2005} who uses 17 and \textcite{Hornsteinetal2005} who use 27.
discipline those beliefs? This is the question I will turn to next.

Figure 2: Boom: Elasticity of Market Tightness w.r.t. Aggregate Productivity as a Function of $\sigma$

Data on workers’ beliefs about labor market prospects is still rare. Up to date, only a few surveys elicit individuals’ beliefs in the labor market context. Among the best data sources for this purpose is the Survey of Consumer Expectations (SCE), administered by the Federal Reserve Bank of New York. This is a monthly panel, interviewing 1000-2000 workers about their perceived probabilities of job loss and job finding. The survey seeks answers from around 200-300 unemployed workers per year. Data collection started in 2012 and is ongoing (data from 2012 to the beginning of 2022 is publicly available here).

Apart from issues with small sample size and (so far) limited time dimension, this survey—like any survey that elicits beliefs of individuals—wrestles with a few known challenges. As discussed in detail in Mueller and Spinnewijn (2022), it is intrinsically difficult to elicit beliefs about the economy’s primitives. This is because the respondents’ answers reflect both beliefs about primitives and behavioral responses. A respondent may be optimistic about his job finding rate because he expects the economy to be in a good aggregate state going forward; or because he expects to search hard for a job in the coming months. Furthermore, not every deviation between elicited belief and actual outcome is a sign of a bias. The reason is that the object of elicitation may not perfectly coincide with the realized outcome; and moreover, unexpected aggregate shocks
can drive a wedge between beliefs and outcomes without any bias.

Bearing these limitations in mind, let’s take a look at the evidence on elicited beliefs in the labor market context, based on the SCE. I am interested in (a) whether workers adjust their beliefs to the aggregate state and (b) what we can learn about the nature of their biases and the distribution of the biased beliefs from these data.

A first look at the data suggest that workers do adjust their beliefs to the aggregate state of the economy, at least to some extent. The left panel in Figure 3 plots the expected rise in unemployment one year ahead, while the right panel plots the expected job finding rate during the next three months if the worker becomes unemployed. Beliefs about both statistics become more optimistic as the U.S. leaves the Great Recession further behind, with more respondents expecting a decline/no shift in the future unemployment rate and an increase in the future job finding rate. In turn, both trends are disrupted by the pandemic recession, with beliefs about future unemployment spiking and beliefs about future job finding plummeting. As the pandemic recession is waning, beliefs about unemployment and the job finding rate quickly approach pre-recession levels.

![Figure 3: Workers Beliefs about Unemployment and Job Finding](image)

In a second step, to get a sense of whether beliefs are biased and of the nature of this bias (i.e., too optimistic or too pessimistic), I am comparing elicited beliefs about job finding to

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6The unemployment beliefs reflect the mean probability that U.S. unemployment rate will be higher one year from the interview date among respondents in a given year. Respondents are asked for the percent chance that within the next 12 months the U.S. unemployment rate will be higher than it is now. In turn, the beliefs about the job finding probability give the mean probability of finding and accepting a job among the respondents in a given year. Respondents who report not being self-employed but working full time, part time, being temporarily laid off or on sick leave are asked for the percent chance that within the following 3 months they will find a new job they will accept (considering the pay and type of work), if they were to lose their job this month.
actual outcomes, replicating the findings from Mueller and Spinnewijn (2022) (see their Figure 1, left panel), but focusing on a sample of unemployed workers to make it comparable with the figure that follows below. Figure 4 plots the expected and realized job-finding rate from 2013 to 2019. There is co-movement between expectation and realization but throughout, the expected job-finding rate is higher than the realized one, suggesting that unemployed workers are overly optimistic about their prospects (but this bias is imprecisely estimated). Interestingly, individuals appear to be overly optimistic throughout the entire period 2013-2019, which was characterized by an economic boom.

![Figure 4: Expectation and Realization of Job Finding](image)

Source: Author’s replication of Mueller and Spinnewijn (2022), Figure 1a, based on a sample of only unemployed workers in the Survey of Consumer Expectations, Federal Reserve Bank of New York, 2013-2019.

Zooming further into these biased beliefs of unemployed workers suggests that only long-term unemployed workers, who make up around 25% of the U.S. unemployment pool, are overly optimistic. In turn, short-term unemployed workers have accurate beliefs about job-finding probabilities. Figure 5 plots the expected and realized job finding rate by different unemployment durations and highlights this point.

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7 Over-optimism of unemployed workers has also been documented by Spinnewijn (2015).
Figure 5: Expectation and Realization of Job Finding, by Unemployment Duration

Source: Author’s replication of Mueller et al. [2021], Figure 3, based on the Survey of Consumer Expectations, Federal Reserve Bank of New York, 2013-2019.

This evidence suggests some discrepancy between the observed biases in workers’ beliefs (long-term unemployed workers tend to be overly optimistic during a boom while short-term unemployed workers have accurate beliefs) and the model’s specification of stubborn beliefs, according to which all those unemployed workers that are stubborn are overly optimistic in a recession and overly pessimistic in a boom. But, due to the small sample and short time horizon, the evidence is not sufficiently sharp to draw strong conclusions either in support of or against the model’s assumptions on the nature of the bias. What this analysis suggests, however, is that it may be difficult to infer the value of the model’s central parameter, namely the level of $\sigma$ that indicates the fraction of stubborn workers, from these data on workers’ expectations.

Apart from the presence of non-rational workers whose beliefs do not vary with the aggregate state, there are a couple of additional model ingredients that support the proposed mechanism behind wage rigidity and that I would like to discuss.

*Wage Bargaining.* One of them is the assumption of wage bargaining. Menzio’s model relies on the alternating wage bargaining game ([Binmore et al. (1986)](#)), which in the limit—when the negotiation intervals become very small—converges to the axiomatic Nash bargaining solution. As discussed above, the Nash solution yields wages that generally show a strong co-movement with aggregate productivity. One reason for this is their dependence on workers’ outside option that

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varies significantly with the aggregate state in standard models. This makes profits and, thus, the incentive to create vacancies inelastic with respect to aggregate productivity. Menzio obtains rigid wages despite his focus on the Nash limit of the bargaining game by making (stubborn) workers’ outside option sticky. The sticky outside option translates into sticky wages, by breaking an important channel through which aggregate productivity impacts wages. What seems important for this mechanism is that there is a strong impact of the outside option on wages, and the assumed wage bargaining protocol delivers this.

Overall, there is not much evidence on how wages are set. Existing findings give a mixed picture. Hall and Krueger (2012) collect data on this issue and find that around a third of all workers bargain over their wages. More recently, Lachowska et al. (2022) document that only 25% of workers bargain over their wages, based on a clever identification strategy that uses dual jobholders in administrative data from Washington State. Moreover, those who bargain tend to be educated, high-income individuals that are employed.

It is therefore worth asking whether the model mechanism would be robust to replacing wage bargaining by the common alternative of wage posting. How would the model implications for wage rigidity change if firms made take-it-or-leave-it-offers, leaving little if any of the match surplus to the worker? In this scenario, firms adjust their wages in each period optimally to the aggregate state of the economy, dampening the effect of individual workers’ outside options on wages (and thus, leaving less room for biased beliefs to generate rigid wages and strong responses of tightness to productivity shocks). It would still be true that workers’ believes impact their reservation wages, which firms take into account in their wage-posting strategies. But one conjecture is that individual workers’ outside options impact wages less compared to the current setting, potentially weakening the proposed mechanism for wage rigidity.

*Search Only From Unemployment.* A second assumption that amplifies the role of workers’ beliefs in wage setting is that only the unemployed search for jobs. When unemployed workers bargain for wages, their outside option—the value of search—strongly depends on their beliefs about the economy’s aggregate state. This gives a prominent role to workers’ beliefs in wage bargaining and thus in aggregate fluctuations of unemployment.

When it comes to the evidence, it is well-known that hiring from employment is as important as hiring from unemployment. The average poaching share (i.e., the fraction of hires that are
made from employment) is almost 50% in the U.S. (Haltiwanger et al. (2014)).

For employed workers, the role of beliefs in wage outcomes is potentially smaller. Employed workers’ outside option is the current wage, which, at that stage, does not depend on their beliefs about the aggregate state. I conjecture that additional features, such as a mobility cost for job switchers or endogenous search intensity, could restore the important role of beliefs for employed job seekers’ outcomes. But adding employed workers’ search to the current model would likely dampen the impact of stubborn beliefs on wage rigidity and aggregate fluctuations.

**Conclusion.** This paper provides a new and provocative take on a set of long-standing questions that have shaped the macro-labor literature in important ways. First, what underlies (downward) wage rigidity? Second, and related, how can the DMP model produce realistic fluctuations in labor market tightness and unemployment?

Existing literature has offered several answers over the years. However, none of them seems perfectly satisfactory. Depending on the approach, the proposed models implied a labor share that is too high and/or too strongly counter-cyclical; and unemployment that is too responsive to flow unemployment benefits. It therefore seems worthwhile to revisit these important questions with a fresh perspective.

This is what Menzio’s paper is about. He proposes an intriguing, novel mechanism for wage rigidity, which hinges on workers’ biased beliefs about the aggregate economy. One could check in a quantitative application of his model whether it can overcome some of the mentioned challenges of existing approaches. But to do so, one would need to discipline the agents’ beliefs in the model in a data-driven way. The agenda of relaxing the rational expectations assumption will likely hinge on how well and convincingly this can be done.

**References**


