Response to Reviewer 2

"A New Keynesian Model with Unemployment: The Effect of On-the-job Search" by Z. Kantur and K. Keskin (Discussion Paper No. 2017-99)

We would like to thank the reviewer for his/her careful reading, comments, and suggestions. Below we address each comment of the reviewer in an ordered fashion.

(1) The reviewer's major comment on the model

Response: First, also seeing from Reviewer 1's comments, we understand that we were not clear enough in motivating our study. This will be fixed in the revised version. Our claim is that we present the *first* business cycle model with *on-the-job* search which builds on the empirical finding that the levels of unemployment and productivity are *positively* correlated. We are the same as Gali (2010), Barnichon (2010), etc. in terms of positive correlation, but we distinguish from them by introducing on-the-job search (OJS); whereas we are closer to Krause and Lubik (2007), Van Zandweghe (2010), etc. in studying OJS, but differ from them in terms of correlation. We should also note that the source of wage dispersion in other papers (with OJS) is the different cost and productivity levels, however, in our model, the wage dispersion arises from different cost levels and bargaining powers (but not from productivity difference).

Reviewer: For me it is unclear what drives the positive co-movement of output and unemployment in the author's model. On-the-job search does not seem to matter for direction of the impact of the technology shock on unemployment (Figure 1). Without on-the-job search, the bargaining power of aggressive and passive firms as well as their hiring costs are the same.

Response: The source of positive co-movement of output and unemployment in our model is the New-Keynesian (NK) setup, but not the introduction of OJS. The literature on business cycle models with search frictions and price stickiness already reports that a positive technology shock leads to an increase in unemployment and a decrease in labor market tightness. What we emphasize is that the volatilities of these variables are not as high as their empirical counterparts; hence, we introduce a new dimension (namely, OJS) showing that the volatilities of unemployment and labor market tightness are amplified. The introduction of OJS does not affect the direction of the responses. In the revised version, we will clarify this point.

Reviewer: I understand that without OJS the model collapses to the model of Gali (2010) with sticky prices, search frictions, flexible wages and a simple interest rate rule. However, the results seem to be qualitatively different from Gali (2010) (see Figure 5b). Can the authors make a statement where this discrepancy comes from?

Response: It is true that without OJS, our model collapses to Gali (2010)'s model with sticky prices, search frictions, and flexible wages; but there is a single difference. Differently

from Gali (2010), we assume full participation of households meaning that all agents are either employed or unemployed. In that sense, we follow Blanchard and Gali (2010). Hence, we can claim that our baseline without OJS is in the intersection of the models analyzed by Blanchard and Gali (2010) and Gali (2010).

The full participation assumption implies that the fraction of unemployed agents is $u_t = 1 - N_t$. However, in Gali (2010), the same fraction is $u_t = F_t - N_t$ where F_t denotes the variable labor force. In his paper, after a positive technology shock, both labor force and employment decrease. Since the fall of labor force is higher than the fall of employment, we see that unemployment also decreases. This is why there is a discrepancy between our results and Gali's results (Figure 5b). If, on the other hand, he had assumed full participation, then after a technology shock, unemployment would increase to keep the labor force constant.

Reviewer: It seems that the paper's results also contradict other articles that introduced OJS in NK models. I think the authors should explain in greater detail where the difference between the present paper and others (e.g., Krause and Lubik, 2007) comes from.

Response: The novelty of our analysis does not lie in showing the positive co-movement of output and unemployment. In fact, Gali (2010) already showed this in a model without OJS. His results are different than the results in other studies (e.g., Krause and Lubik, 2007; Van Zandweghe, 2010), because

"In the standard NK model, firms are demand constrained so that an increase in productivity leads to a sluggish adjustment in aggregate demand to the new productivity level due to nominal rigidities. Accordingly, firms employ less labor during this process. Hence, a positive change in technology leads to an increase in unemployment."

The reason why our results differ from the others' results is exactly the same. What we introduce in our paper is OJS, and as a result, we find that unemployment and labor market tightness are more sensitive to a technology shock (in comparison to a model without OJS). We mention the other papers, because they are relevant to our study in the sense that they also contribute to "business cycle + OJS" literature.

(2) The reviewer's major comment on steady state and calibration

Reviewer: I would like to know more about the steady state results. I am particularly interested in the case when aggressive firms have maximum bargaining power. How do wages and vacancies in aggressive and passive firms differ in steady state?

Response: In fact, we already investigate the case when aggressive firms have maximum bargaining power in our calibration. We prefer not to report all steady state values, because it might distract the reader from the main focus of the paper. To answer the reviewer's question,

in our calibration, wage in aggressive firms is 0.45, wage in passive firms is 0.5, vacancy in aggressive firms is 0.033, and vacancy in passive firms is 0.008.

Reviewer: Why do the authors calibrate the ratio of aggressive firms to 0.5? If the authors think that the aggressive and passive firm assumption is a good approximation for labor unions, why do they not use the ratio from the data (union coverage etc)? How crucial is this assumption for the amplification effect (which could be an interesting story by itself)?

Response: We agree with the reviewer that it would be better if the ratio of aggressive firms is obtained from the data (union coverage, etc.). However, one should be careful doing this. The definition of aggressive and passive firms might be vague, if one considers a real-life implication. For instance, one would need firm-level data from an economy with company unions including information about firms' relative bargaining powers over workers. This is why it might be misleading to refer to the data for N^A . In our calibration, when there is no *clear* way of identifying a parameter, we acknowledge this and opt for symmetry. Thus, we consider $N^A = 0.475$. We believe that an asymmetric value would raise bigger concerns. Yet, as for the asymmetry in favor of aggressive firms. If there is such a strong asymmetry, the steady state fails to exist.

(3) The reviewer's major comment on the presentation of results

Reviewer: It would helpful if the authors provided some tables showing simulated absolute and relative volatilities and compare them with UK labor market data. The authors should also provide cross-correlations, which would make it easier for the reader to inspect the mechanisms at play and see what is the reason for the increase in unemployment volatility and how important in magnitudes this increase is.

Response: As we emphasize in several places within our paper, this is a *theoretical* study, which finds that the model with OJS induces a *higher* volatility in unemployment and labor market tightness in response to a positive technology shock. The suggested data analysis would require data-supported calibration values for some of the model parameters, such as the ratio of aggressive firms, the bargaining powers, and the productivity levels. And to achieve this, one would need firm-level data including the relevant information. Otherwise, we believe that a data-fitting analysis would not be sufficiently well-practiced. That is the reason why we are being cautious about such a data analysis. Instead of following such a path, we choose to stay in the theory side and propose OJS as a realistic extension to the model, which is revealed to be a forward step in the right direction.

Reviewer: Some of the important impulse response function are missing. Can the authors show the impulse response functions of vacancies and wages for each of the firm types?

Response: Following the reviewer's suggestion, we agree to report impulse responses of other variables, especially wages and vacancies in aggressive and passive firms.

(4) The reviewer's minor comment about page 4

Response: We agree with the reviewer that the sentence was misleading. Shimer (2005) works on a model in which unemployment decreases as a response to technology shock and further argues that the canonical SM model is not able to generate the observed fluctuations in response to shocks of a plausible magnitude. On the other hand, Barnichon (2014) argues that "the Mortensen-Pissarides model is confronted with not one but two challenges: it needs to match the magnitude as well as the sign of the labor market tightness-productivity elasticity. In other words, the Shimer puzzle needs to be discussed conditionally on the nature of the shock and in the context of a model that can reproduce the conditional elasticities." A similar challenge is present in the relationship between unemployment and productivity.

The challenge regarding the sign of the responses is already addressed by Gali (2010) and Barnichon (2010). Furthermore, the amplification problem (for unemployment) is already addressed by Barnichon (2010). In this paper, utilizing a model similar to Gali (2010), we also aim to increase the magnitude of unemployment and labor market tightness in response to a positive technology shock.

(5) The reviewer's minor comment about units in figures

Response: We thank the reviewer for this comment. We should, in fact, add units into the figures. All variables are in log deviations (percentage deviations) from their steady state values, except the unemployment rate. Since the unemployment rate is already in percentage units, we prefer to report its level deviations.

We thank the reviewer once again for his/her comments and suggestions. We hope that we have managed to address all the issues in his/her report.