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# The Unemployment Volatility Puzzle: a Note on the Role of Reference Points\*

Vincent Boitier<sup>†</sup>

## Abstract

This theoretical note aims at studying the role of reference points in generating unemployment volatility. For this purpose, I introduce the notion of reference points in a standard Mortensen-Pissarides model. I obtain two results. First, I find that the obtained model is similar to the one found by Pissarides (2009) with matching costs. Second, I show that the introduction of reference points can increase significantly unemployment volatility through a mechanism à la Hagedorn and Manovskii (2008).

JEL Classification: E24, J63, J64.

Keywords: Reference points, Unemployment volatility, Job matching.

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# 1 Introduction

Empirical studies and laboratory experiments clearly show that reference points play a fundamental role in (wage) negotiations.<sup>1</sup> Indeed, it is demonstrated that agents evaluate offers and outcomes as gains and losses relative to some reference points. Therefore, by affecting preferences, reference points impact both the process and the outcome of bilateral bargaining. Moreover, a pervasive challenge in macroeconomics is to understand why the standard Mortensen-Pissarides (hereafter MP) model cannot generate the volatility of the unemployment rate observed in US data. This is the so-called Shimer puzzle. Several solutions have been proposed to solve this puzzle: wage stickiness (Shimer (2004)), credible bargaining (Hall and Milgrom (2008)), low workers bargaining and very high unemployment benefits (Hagedorn and Manovskii (2008)), additional matching costs (Pissarides (2009))...

The aim of this theoretical note is to draw a link between reference points and the unemployment volatility puzzle. For this purpose, I consider a simple MP model with exogenous separations, reference points and where the partition of the surplus is no longer derived by a Nash bargaining game. It is determined by a sequential bargaining game where the outcome of this new negotiation process is evaluated relative to a reference point.<sup>2</sup> Assuming that preferences are linear, I then deduce the new wage equation and the new associated job creation. I find that the obtained model is equivalent to the one found by Pissarides (2009) with matching costs. This means that even if these two models do not tell the same story, they generate the same quantitative results. This also implies that Pissarides (2009) is a particular case of the present model. I also show that the presence of reference points raise considerably the unemployment volatility through a mechanism à la Hagedorn and Manovskii (2008). Indeed, I demonstrate that reference points can lower firm's profit and increase wage share by improving the outside option of the worker. Thus, this short article adds reference points to the list of solutions to the Shimer puzzle.

Finally, notice that this is not the first framework that integrates reference dependence in a MP model. In a recent working paper, Eliaz and Spiegler (2013) study the properties of a dynamical model with search and matching frictions and with a reference point in the productivity process of the firm. However, this model remains quite different than the one developed in this paper because, among others things, it does not aim at solving the Shimer puzzle.

This note is organized as follows. Section 2 describes the search and matching model with reference points. Section 3 concludes.

## 2 Search and matching model with reference points

The model considered hereafter is the standard Pissarides' (2000) model with reference points and sequential wage bargaining.

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<sup>1</sup>See among others Kahneman and Tversky (1978), Kahneman (1992), Lewicki *et al.* (2010).

<sup>2</sup>By doing so, I follow the game theory literature: see for example Muthoo (1999).

## 2.1 Pissarides' (2000) environment

Let  $U$  and  $W$  be the asset values of being unemployed and being employed. These asset values are given by

$$rU = z + f(\theta)(W - U) \quad (1)$$

and

$$rW = \omega + s(U - W) \quad (2)$$

with  $r$  the risk-free interest rate,  $z$  the unemployment benefits,  $s$  the separation rate and  $f(\theta)$  the job finding rate. Let  $V$  and  $J$  be the asset values of a vacancy and a filled job. These asset values are defined as

$$rV = -c + q(\theta)(J - V) \quad (3)$$

and

$$rJ = p - \omega - sJ \quad (4)$$

with  $c$  the cost of a vacancy,  $p$  the productivity of workers,  $\omega$  the wage and  $q(\theta)$  the job filling rate. Using equation (3), equation (4) and the free entry condition (i.e.  $V = 0$ ), the job creation equation is determined as

$$\frac{p - \omega}{r + s} = \frac{c}{q(\theta)} \quad (5)$$

Furthermore, notice that the unemployment rate of the economy is given by the following standard Beveridge curve

$$u = \frac{s}{s + f(\theta)} \quad (6)$$

## 2.2 The role of reference points

Once the match is made, employer and employee have to negotiate over the partition of the surplus defined as  $S = W - U + J - V$  according to a sequential bargaining game. In the first stage of the game, one player is randomly chosen to make a take-it or leave-it offer. The probability for the worker to be drawn is assumed to be  $\beta$  while the probability for the firm is  $1 - \beta$ . If the offer is accepted by the opponent, the game ends. Conversely, if the offer is rejected, the game goes on to the next period where a player is again randomly selected and bargaining begins again. If players agree on a partition of the surplus, they enjoy the following standard utility function<sup>3</sup>

$$u_i(x_i, \phi_i) = x_i - \eta\phi_i \quad (7)$$

with  $i \in \{W, F\}$  and where  $W$  is the index of the worker such that  $x_W = W - U$ ,  $F$  is the index of the firm such that  $x_F = J - V$ ,  $0 < \eta \leq 1$  is a constant and  $\phi_i$  is the reference point of player  $i$ . Equation (7) states that the utility of agents depends on the deviation of the value of the agreement from the reference point. The parameter  $\eta$  weights the relative importance of this deviation. In line with prospect

<sup>3</sup>See within a large literature Compte and Jehiel (2003) and Hyndan (2011).

theory, this means that outcomes are compared to a reference point that splits the agent preferences into gains and losses. However, contrary to prospect theory and for the sake of simplicity, the valuation of gains and losses are symmetric (*i.e.* no loss aversion).<sup>4</sup> If players disagree forever, their payoffs are equal to zero. Using the subgame perfect equilibrium concept introduced by Rubinstein and Wolinsky (1985), there exists a unique agreement given by

$$\begin{cases} x_W = \eta\phi_W + \beta(S - \eta\phi_W - \eta\phi_F) \\ x_F = \eta\phi_F + (1 - \beta)(S - \eta\phi_W - \eta\phi_F) \end{cases} \quad (8)$$

if and only if  $\eta\phi_W + \eta\phi_F \leq S$ . This standard result in the game theory literature (see for example Kambe (1999)) is straightforward to analyze. An agreement is a situation where each agent gets the utility value of its reference point and the remaining fraction of the surplus according to his bargaining power. Reducing system (8) gives the following new sharing rule

$$(1 - \beta)(W - U - \eta\phi_W) = \beta(J - V - \eta\phi_F) \quad (9)$$

Using the above sharing rule, the wage satisfies

$$\omega = rU + \beta(p - rU) + (r + s)\eta[(1 - \beta)\phi_W - \beta\phi_F] \quad (10)$$

Likewise, using equation (1), the job creation equation and the sharing rule, I obtain

$$rU = z + \frac{\beta}{1 - \beta}c\theta - \frac{\beta}{1 - \beta}f(\theta)\eta\phi_F + f(\theta)\eta\phi_W \quad (11)$$

Plugging equation (11) in equation (10) yields

$$\omega = (1 - \beta)\{z + [r + s + f(\theta)]\eta\phi_W\} + \beta\{p + c\theta - [r + s + f(\theta)]\eta\phi_F\} \quad (12)$$

Equation (12) shows that the worker's reference point increases the wage by raising the reservation wage while the firm's reference point decreases the wage by lowering the expected return of the match. Moreover, observe that if the bargaining game is symmetric (*i.e.*  $\gamma = 0.5$ ) and reference points are equal (*i.e.*  $\phi_W = \phi_F$ ), I end up with the standard wage equation derived from a generalized Nash bargaining game. Finally, the wage equation can be rewritten as

$$\omega = (1 - \beta)z + \beta(p + c\theta) + [r + s + f(\theta)]H \quad (13)$$

where  $H = (1 - \beta)\eta\phi_W - \beta\eta\phi_F$  can be viewed as an index measuring the relative importance of the worker's reference point. Integrating equation (13) in equation (5), I find

$$\frac{p - (1 - \beta)z - \beta(p + c\theta) - f(\theta)H}{r + s} = \frac{c}{q(\theta)} + H \quad (14)$$

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<sup>4</sup>It is possible to consider a general utility function such that  $u_i(x_i, \phi_i) = f(x_i - \eta\phi_i)$  where  $f$  could exhibit loss aversion. Nonetheless, I assume a linear utility to show that the Pissarides' (2009) model with matching costs is a particular case of this general model.

Using the following job creation equation in Pissarides (2009)

$$\frac{p - \omega'}{r + s} = \frac{c}{q(\theta)} + H' \quad (15)$$

and the following wage equation in Pissarides (2009)

$$\omega' = (1 - \beta)z + \beta(p + c\theta) + \beta f(\theta)H' \quad (16)$$

yields the following job creation equation

$$\frac{p - (1 - \beta)z - \beta(p + c\theta) - \beta f(\theta)H'}{r + s} = \frac{c}{q(\theta)} + H' \quad (17)$$

with  $H'$  a constant. Notice that the Beveridge curve in Pissarides (2009) is identical to the one in equation (6). Also observe that I can assume that  $H = H'$  since  $H$  and  $H'$  are exogenous parameters. Thus, up to a coefficient  $\beta$ , the job creation equation determined by a MP model with reference points is the same as the one determined by a MP model with matching costs. This indicates that these two models generate the same quantitative results. Indeed, I solve the job creation equation (14) for the unknown  $\theta$  with Pissarides' (2009) calibration and  $\eta = 1$ . I then study the effect of a 1 % productivity shock on the model's unknown by computing the elasticity  $\epsilon_\theta$  of the tightness index with respect to productivity and the elasticity  $\epsilon_\omega$  of the wage with respect to productivity. Table 1 gives the results for different values of  $H$  (*i.e.*  $H = 0.25$   $H = 0.75$  and  $H = 1.25$ ) and  $\beta$ .<sup>5</sup> For a given level of bargaining

$\beta$	$\epsilon_\omega$			$\epsilon_\theta$			$\epsilon_\theta^{MP}$
	$H = 0.25$	$H = 0.75$	$H = 1.25$	$H = 0.25$	$H = 0.75$	$H = 1.25$	$H = 0$
0.1	0.95	0.97	0.98	6.07	7.58	8.40	3.81
0.2	0.96	0.97	0.98	5.52	7.32	8.28	3.72
0.3	0.97	0.97	0.98	5.18	7.06	8.15	3.68
0.4	0.97	0.98	0.98	4.93	6.80	7.99	3.67
0.5	0.98	0.98	0.98	4.74	6.53	7.80	3.66
0.6	0.98	0.98	0.98	4.58	6.25	7.57	3.67
0.7	0.98	0.98	0.98	4.45	5.96	7.28	3.68
0.8	0.99	0.99	0.99	4.34	5.64	6.91	3.72
0.9	0.99	0.99	0.99	4.27	5.29	6.40	3.81

**Table 1:** Simulations results at different H

power, as in Pissarides (2009), the model generates persistent high wage elasticities and an increase in  $H$  raises dramatically the volatility of job creation. Especially,

<sup>5</sup>So far, there is no calibration for  $H$  because of lack of empirical evidence. This limit is in line with Pissarides (2009) and the calibration of parameter  $H'$ : "*Since we do not have information about how the job creation costs are split between the costs that depend on the duration of vacancies and the costs that do not, we cannot choose one combination over another on the basis of independent evidence*" (p.1375).

$\epsilon_\theta^{MP}$  is the elasticity of the tightness index with respect to productivity generated by the standard MP model with Nash bargaining game.

the model is able to match the observed volatility of labor market tightness (*i.e.*  $\epsilon_\theta^* = 7.56$ ). Since wage stickiness does not matter here and  $\eta = 1$ , the amplification mechanism is driven by the relative role of workers' reference point. Indeed, for high  $H$ , the reference point of the worker is larger than the reference point of the firm. This leads to an increase in the wage set by firms because the reservation wage (or the outside option of the worker) is very high. This lowers the firm's surplus and so increases the effect of the productivity shock. Namely, the introduction of reference points in a standard MP model can increase the unemployment volatility through a mechanism à la Hagedorn and Manovskii (2008). Furthermore, note that, an increase in the bargaining power of the worker decreases the volatility generated by the model because it lowers the impact of  $H$  on the worker's wage. Finally, contrary to Pissarides (2009) where matching costs are always assumed to be exogenous, it is easy to endogenize reference points in this setting. Indeed, in this stationary framework, a natural candidate for the worker's reference point is the partition of the surplus received by a worker in the standard MP model.<sup>6</sup> Assuming that the firm has no reference point, I perform the same analysis as before with this endogenous reference point. Table 2 gives the results for different values of  $\beta$ . One can observe

$\beta$	$\phi_W = W^{MP} - U^{MP}$	$\epsilon_\omega$	$\epsilon_\theta$	$\epsilon_\theta^{MP}$
0.1	0.1377	0.95	5.26	3.81
0.2	0.2121	0.97	5.29	3.72
0.3	0.2805	0.97	5.34	3.68
0.4	0.3513	0.97	5.39	3.67
0.5	0.4309	0.98	5.46	3.66
0.6	0.5270	0.98	5.55	3.67
0.7	0.6544	0.98	5.68	3.68
0.8	0.8482	0.99	5.89	3.72
0.9	1.2394	0.99	6.37	3.81

**Table 2:** Simulations results with endogenous reference point

that even if the volatility is not always matched, the introduction of reference point in a standard MP model increase considerably the volatility generated by the model. Nevertheless, in this case, when the bargaining power of the worker increases, the volatility increases as well. This is due to the fact that the endogenous reference point and bargaining power are now positively correlated.

### 3 Conclusion

In this note, I integrate the notion of reference points in the wage bargaining of the benchmark MP model and I show that the obtained model is similar to the one of Pissarides (2009) with matching costs. I also find that these reference points can generate unemployment volatility via a mechanism à la Hagedorn and Manovskii (2008).

<sup>6</sup>Observe that, in a dynamical model, the natural candidate would be the past wage.

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