Demand uncertainty mismatch and (un)employment

Jellal, Mohamed and Thisse, Jacques-François and Zenou, Yves

Al Makrîzî Institut d'Economie

2005

Demand uncertainty, mismatch, and (un)employment*

Mohamed Jellal[†], Jacques-François Thisse[‡] and Yves Zenou[§]

September 23, 2002

Abstract

A finite number of heterogeneous firms facing demand-induced price fluctuations imperfectly compete for heterogeneous workers. Because firms must commit to wages and employment before the realization of product price, they exhibit a risk-averse behavior. It is then shown that unemployment may arise in equilibrium because of the combination of uncertainty on product price and mismatch between workers' skills and firms' job requirements.

Keywords: skill mismatch, price uncertainty, unemployment equilibrium.
JEL Classification: I28, J41, L13.

*The authors thank two anonymous referees and the editor Klaus Zimmermann as well as Daniel Cohen, Pierre-Philippe Combes and Henri Sneessens for very helpful comments. They also thank the participants of the 1999 CEPR European Summer Symposium in Labour Economics, especially Juan Dolado and Etienne Wasmer, for helpful discussions. This research has been partially conducted within the convention 00/05-262 with the Ministère de l'éducation, de la recherche et de la formation (Communauté française de Belgique).

[†]GREI , Université Mohammed V and Toulouse Business School

[‡]CORE, Université Catholique de Louvain, CERAS and CEPR.

[§]Corresponding author. University of Southampton, GAINS, CEPR and IZA. Address of correspondence: Department of Economics, University of Southampton, Southampton SO17 1BJ, UK. Tel: (44) 23 80 59 32 64, Fax: (44) 23 80 59 38 58, E-mail: yz@soton.ac.uk

1 Introduction

There seems to be a large agreement in the economics profession to consider that unemployment in European countries is due to the combination of distinct factors, such as labor market rigidities and economic turbulence (Ljungqvist and Sargent, 1998; Mortensen and Pissarides, 1999; Blanchard and Wolfers, 2000; Marimon and Zilibotti, 1999). It is, indeed, widely accepted that one of the main explanations for European unemployment is the presence of mismatch between firms and workers (Drèze and Bean, 1990; Layard et al., 1991; Pissarides, 2000). Another reason for unemployment that has also been put forward is the growing uncertainty prevailing on product demand due to increases in consumers' idiosyncracies and the inability of firms to adjust their labor policy to such demand fluctuations. This idea has been developed within the framework of implicit contract theory with the aim of explaining wage rigidity and, in turn, unemployment for some realizations of demand (Rosen, 1985; Stiglitz, 1986; Haley, 1990). In this paper, we attempt to bring together some of the main ingredients that can be found in these two strands of labor economics within a partial equilibrium microeconomic framework.

It is our contention that workers have heterogeneous skills while firms have differentiated job requirements. Indeed, as argued by Stevens (1994), firms have an incentive to differentiate their skill requirements in order to obtain monopsony power in the labor market. Once it is recognized that firms and workers are heterogeneous, it is reasonable to assume that the process of job matching drives the formation of wage in the labor market (Hamilton et al., 2000). As a result, firms have oligopsonistic power in the labor market, which allows them to charge wages lower than the competitive level. Furthermore, when labor market rigidities prevent the possibility of state-contingent wage contracts and foster permanent job tenures, firms must commit to wages and employment before the realization of product demand. In such a context, they may be viewed as agents who make investments in risky assets, as in Markowitz (1959). This implies that firms are risk-averse, but here, diversification being impossible, firms protect themselves by imposing wage cuts.

To be more precise, we show that, *when training costs are large and the volatility of price fluctuations is high, the labor market equilibrium involves unemployment in the absence of wage-contingent contracts.* Indeed, firms are able to set wages below marginal productivity because (i) they can use their monopsony power on workers who have a good match in the labor market and (ii) they insure workers against the risk inherent to the product market by paying them a wage independent of demand shocks. In this way, we uncover some of the microeconomic underpinnings of unemployment. We also show that *both mismatch and random shocks combine to increase unemployment.* The relative importance of both explanations is an empirical issue. For example, the work of Lillien and Hall (1986) and of Manacorda and Petrogonlo (1999) shows that both explanations are relevant, depending on the particular country under consideration. In our model, *wages and employment are determined before the realization of product prices* and are, therefore, not state-contingent. This assumption is made to capture the idea of rigidity in the labor market in that firms are not able to adjust wages and employment according to fluctuations in product demand. This implies that *employed workers are completely insured against price volatility at the expense of a possible higher unemployment level.*

In this paper, we adopt a research strategy that is becoming increasingly popular in labor economics. Following Salop (1979), this emerging body of literature models heterogeneity by means of a circle along which both workers' skills and firms' needs are distributed (Kim, 1989; Bhaskar and To, 1999; Marimon and Zilibotti, 1999; Fiorillo et al., 2000; Hamilton et al., 2000; Thisse and Zenou, 2000). What distinguish the present paper from existing ones (including ours) are the following two basic features. First, we provide a complete description of the market outcome, involving either full employment or unemployment. Second, we highlight the role of (European) institutions that prevent firms to adjust wages and employment to random fluctuations in product demand. This in turn allows us to focus on the combination between mismatch and demand uncertainty as potential explanations for unemployment.

The remainder of the paper is organized as follows. The model is introduced in the next section. In section 3, we determine the full-employment market equilibrium whereas section 4 develops the equilibrium with unemployment. Section 5 concludes with some policy implications.

2 The model

Consider an industry with n firms producing a homogeneous good sold on a competitive market and facing *demand-induced price fluctuations*. To express the resulting uncertainty, we suppose that the market price $\widetilde{p}$ is a random variable whose mean is chosen to be 1 (without loss of generality) and variance is $\sigma^2 > 0$. As in Sandmo (1971), greater price uncertainty is measured by a mean-preserving spread in prices, that is, an increase in σ^2.

A firm is fully described by the type of job it offers. This means that a job is a collection of tasks determined only by the technology used by the firm. Firm i's $(= 1, ...n)$ skill requirement is denoted by x_i. Labor is the only input and production involves constant returns to scale. There is a continuum of workers with the same level of general human capital but with heterogeneous skills. There is no a priori superiority or inferiority among workers who are just different in the type of work they are best suited for. The characteristics of a worker are summarized by her skill and are denoted by x. When unemployed, workers obtain the same level of unemployment benefit $b \geq 0$. Each worker supplies one unit of labor provided that her wage net of training costs (her earnings) is greater than or equal to b.

We consider a labor market in which the information structure is assumed to be as follows. First, firms are not able to identify the skill type of workers prior to hiring but they know the distribution of worker skills; this typically happens in a thick labor market. Second, workers know their own types and observe the firms' skill needs. Hence, workers are able to evaluate their training costs but firms are not.

Each firm has a specific technology such that workers can produce output only when they perfectly match the firm's skill needs. Since workers are heterogeneous, they have different matchings with the firm's job offer. Thus, if firm i hires a worker whose skill differs from x_i, the worker must get trained and her cost of training to meet the firm's skill requirement is a function of the difference between the worker's skill x and the skill needs x_i. Workers pay for all the costs of training. The reason for this is to be found in the information available to firms and workers. First, firms derive their market power from the fact that workers have to pay at least some part of their training costs (just as firms selling a differentiated product have market power on the neighboring customers). Indeed, would firms pay for the whole training cost, workers would no longer be induced to take jobs in the most suitable firms. Since firms do not observe workers' types, they would run the risk of implementing unprofitable hiring policies. Further, since the supply of a worker is perfectly inelastic, firms are not able to offer a wage menu. This in turn implies that workers must pay for their whole training costs.[1]

As mentioned in the introduction, the skill space is described by the circumference C of a circle which has length L. Individuals' skills are continuously and uniformly distributed along this circumference; the density is constant and denoted by Δ. The density Δ expresses the thickness of the market, whereas L is a measure of the heterogeneity of workers. This implies that the size of the labor market is measured through two parameters, L and Δ, the impact of which on the market outcome is not necessarily the same. Firms' job requirements x_i are equally spaced along the circumference C so that L/n is the distance between two adjacent firms in the skill space.

When the matching is perfect, the worker produces q units of the output. The more distant the skill of a worker from the firm's skill requirement, the larger the training cost. More precisely, the training cost is given by a linear function $s\,|x - x_i|$ of the difference between the worker's skill x and the firm's skill requirement x_i, where $s > 0$ is a parameter inversely related to the efficiency of the training process. After training, all workers are identical from the firm's viewpoint since their ex post productivity is observable and equal to q by convention with $q > b$ for the model to make sense. Consequently, each firm i offers a wage to all workers, conditional on the worker having been trained to the skill x_i. Each worker then compares the wage offers of firms and the required training costs; she simply chooses to work for the firm offering the highest wage net of training costs.

As mentioned in the introduction, we assume that state-contingent wage contracts are not allowed by labor market institutions or that such states are not verifiable (to our knowledge, state-contingent wage contracts are not implemented in Europe). In other words, firms commit to wages and employment before price realizations, thus implying that *wages and employment are not*

[1] For firms to cover a fraction of the training costs, they must be able to observe workers' types. If this is so, one should expect some bargaining to arise between firms and workers on both training costs and wages, as in Hamilton et al. (2000).

random variables. In such a context, firms bear the whole risk associated with random price fluctuations so that it is reasonable to assume that they display a risk-averse behavior. In addition, as firms make wage and employment decisions before producing, liquidity constraints may even lead a risk-neutral firm to behave as if it were risk averse (Drèze, 1987, ch. 15). This argument is supported by empirical studies showing that many firms have an imperfect access to the capital markets, especially when they are not large, and must therefore bear part of the risk associated with their production activity (Fazzari et al., 1988; Evans and Jovanovic, 1989).

In order to derive closed-form solutions, we use the mean-variance utility model (Markowitz, 1959; Hirshleifer and Riley, 1992). This is admittedly a restrictive approach, although this model has been shown to have a fairly good descriptive power in several economic fields, and to be a special case of the expected utility model in which the utility is the negative exponential function - thus having a constant absolute degree of risk aversion equal to $a \geq 0$ - and the random variable is normally distributed (Eeckhoudt and Gollier, 1995). In addition, it allows us to provide a full and detailed characterization of the market equilibrium.

3 Full employment equilibrium

Firms choose simultaneously their wage level, $(w_1, .., w_i, .., w_n)$. The net wage is therefore equal to $w_i - s\,|x - x_i|$. Firms understand that workers choose to be hired by the firms which give them the highest net wage. As a result, they hire all the workers who want to work at the prevailing wages, since they know that these workers are willing to adjust to their skill requirement. Furthermore, w_i cannot exceed the productivity q for otherwise firm i would make a negative profit.

Let i be the representative firm. Given the wages w_{i-1} and w_{i+1} set by the two adjacent firms, firm i's labor pool is composed of two sub-segments whose outside boundaries are given by marginal workers $\overline{x}$ and $\overline{y}$ for whom the net wage is identical between firms $i-1$ and i, on the one hand, and firms i and $i+1$, on the other. In other words, $\overline{x}$ is the solution of the equation:

$$w_i - s(x_i - \overline{x}) = w_{i-1} - s(\overline{x} - x_{i-1})$$

so that

$$\overline{x} = \frac{w_{i-1} - w_i + s(x_i + x_{i-1})}{2s} \tag{1}$$

In this case, firm i attracts workers whose skills belong to the interval $[\overline{x}, x_i]$ because the net wage they obtain from firm i is higher than the one they would obtain from firm $i-1$. Clearly, workers belonging to the interval $[x_{i-1}, \overline{x}]$ are hired by firm $i-1$. In a similar way, we show that:

$$\overline{y} = \frac{w_i - w_{i+1} + s(x_i + x_{i+1})}{2s} \tag{2}$$

Firm i's labor pool thus consists of all workers with skill types in the interval $[\overline{x}, \overline{y}]$. Hence, its profits are defined by:

$$\widetilde{\Pi}_i = \int_{\overline{x}}^{\overline{y}} \Delta(\widetilde{p}q - w_i)dx = \Delta(\widetilde{p}q - w_i)(\overline{y} - \overline{x}) \tag{3}$$

As said in the foregoing, we consider a mean-variance utility function so that firm i's payoff is as follows:

$$V_i = E(\widetilde{\Pi}_i) - \frac{a}{2} Var(\widetilde{\Pi}_i) \tag{4}$$

where $a \geq 0$ expresses the absolute degree of the firm's risk aversion and where $\widetilde{\Pi}_i$ is defined by (3). Because the terms a and σ^2 will always appear together throughout this paper, we find it convenient to set $\upsilon \equiv a\sigma^2$, which may be viewed as a measure of the impact of uncertainty on firms' behavior. Of course, $\upsilon > 0$ if and only if firms are risk averse; otherwise $\upsilon = 0$.

Expression (4) may be written as follows:

$$V_i = \Delta(q - w_i)(\overline{y} - \overline{x}) - \frac{\upsilon}{2}\Delta^2(\overline{y} - \overline{x})^2 q^2 \tag{5}$$

Since all workers take a job, the outer boundaries of firm's labor pool are given by (1) and (2). Hence, (5) is continuous in (w_{i-1}, w_i, w_{i+1}) and concave in w_i. Therefore, there exists a Nash equilibrium in wages. Applying the first-order conditions yield:

$$\frac{\partial V_i}{\partial w_i} = \Delta \left[-(\overline{y} - \overline{x}) + (q - w_i)\left(\frac{\partial \overline{y}}{\partial w_i} - \frac{\partial \overline{x}}{\partial w_i} \right) \right] \tag{6}$$

$$-\upsilon \Delta^2 q^2 (\overline{y} - \overline{x}) \left(\frac{\partial \overline{y}}{\partial w_i} - \frac{\partial \overline{x}}{\partial w_i} \right) = 0$$

Combining (1), (2) and (6), we obtain:

$$w^F = q - \upsilon q^2 \frac{\Delta L}{n} - s\frac{L}{n} \tag{7}$$

It is worth writing (7) as follows:

$$q = w^F + s\frac{L}{n} + \upsilon q^2 \frac{\Delta L}{n} \tag{8}$$

In this expression, the LHS stands for the value productivity of a worker while the RHS is composed by three elements. The first one (w^F) is the marginal cost, the second one (sL/n) measures the oligopsonistic exploitation of labor, whereas the last one may be viewed as the risk premium that firms levy on workers because of their commitment to wage and employment before the realization of uncertainty. This premium increases with the worker productivity q as well as the density Δ (see below for an explanation), whereas it decreases with n because the risk is spread over a larger number of firms.

The following comments are in order. First, when firms are risk neutral ($\upsilon = 0$), price fluctuations do not affect firms' utility and the wage is given by $q - sL/n$. Observe that in this case (risk neutrality), the worker density Δ has no impact on the equilibrium wage while the equilibrium wage falls with the size of the skill space. By contrast, when firms are risk averse ($\upsilon > 0$), increasing Δ has a negative impact on wage. Stated differently, *when state-contingent contracts are not allowed, a larger labor market* (both in terms of workers' density and skill space) *leads to a lower wage.* This seemingly surprising result can be explained by the fact that, at the full employment equilibrium, each firm is committed to hiring the fraction $1/n$ of the labor force, regardless of its size ΔL, while facing the same uncertainty on the product market. It must then be that the premium rises with ΔL (the same holds for an increase in q) and decreases with n, as shown by our results.

Second, when firms are risk averse, the equilibrium wage decreases with the degree of risk aversion and the variance of the output price. In other words, industries with greater price uncertainty are likely to charge lower wages. This is because, at the full employment equilibrium, risk-averse firms share with workers the risk generated by price volatility and because the sharing varies with the attitude of firms toward risk.

Third, changing n and s have more direct and intuitive implications. Indeed, w^F decreases with s because firms have more market power on the workers whose skills are close to their skill requirement,[2] whereas it increases with n because the average matching is better when the number of firms is larger. In fact, when n becomes arbitrarily large, the wage tends to q. The competitive model of the labor market is thus the asymptotic version of the spatial model of job assignment. Last, since there is no profitable deviation by any single firm at a Nash equilibrium, competition among firms precludes the emergence of poaching effects. Likewise, no worker can be better off by changing jobs since she would have to incur new training costs while receiving the same gross wage.

We must now determine under which conditions there is full employment at the equilibrium wage candidate (7). To do that, we set

$$\Phi(q) \equiv q(1 - \upsilon q \Delta L/n)$$

which is a quadratic function of q with $\Phi''(.) < 0$ as long as $\upsilon > 0$. Clearly, we have

$$\begin{aligned} \widehat{q} \equiv \arg\max_q \Phi(q) &= \frac{n}{2\upsilon\Delta L} \\ \Phi(\widehat{q}) = &\max_q \Phi(q) = \frac{n}{4\upsilon\Delta L} \end{aligned} \tag{9}$$

Proposition 1 *Assume that firms have a mean-variance utility. Then, there is full employment at the equilibrium wage*

$$w^F = q - \upsilon\Delta q^2 \frac{L}{n} - s\frac{L}{n}$$

if and only if

$$0 < \upsilon < \frac{n^2}{2\Delta L(2nb + 3sL)} \tag{10}$$

Furthermore, the equilibrium value of each firm's payoff is given by

$$V^F = \Delta \frac{L^2}{n^2}\left(\frac{\upsilon\Delta q^2}{2} + s\right)$$

which is always positive.

Proof. The domain of parameters for which there is full employment at the equilibrium candidate (7) is such that:

$$w^F - \frac{sL}{2n} \geq b \quad \Leftrightarrow \quad \Phi(q) \geq b + \frac{3sL}{2n} \tag{11}$$

[2] When $s = 0$, workers are not differentiated and there is no strategic competition betwen firms. As a result, workers are paid at their marginal productivity minus the risk premium.

A necessary and sufficient condition on the parameters for (11) to hold is :

$$\max_q \Phi(q) = \Phi(\widehat{q}) > b + \frac{3sL}{2n}$$

where $\Phi(\widehat{q})$ is defined by (9). After some manipulations, this inequality is equivalent to (10). ■

Condition (10) insures that under the equilibrium wage (7), there is always full employment. In other words, if the variance of $\widetilde{p}$ is not too large, everybody will accept to work at the equilibrium wage. The condition (10) is intuitive since each firm must set a sufficiently high wage to attract all workers in its labor pool. This is so when the demand is not too volatile. On the other hand, *the existence of big random shocks in market demand leads to a labor market equilibrium with unemployment.* Observe also that, ceteris paribus, condition (10) is more likely to be satisfied if the number of firms n is large and if υ, Δ, L, s and b are not too large. Stated differently, when firms are very risk averse, or there are many workers in the labor market, or the unit cost of mismatch is large, or the unemployment benefit is high, it is likely that there is no equilibrium with full employment (see section 4).

It is worth pointing out an interesting difference between the cases of risk neutrality ($\upsilon = 0$) and risk aversion ($\upsilon > 0$). When $\upsilon = 0$, the condition reduces to $q \geq b + 3sL/2n$, i.e., the productivity of workers must be large enough for the full employment configuration to arise. On the contrary, when $\upsilon > 0$, there is full employment for all the values of q such that $\Phi(q) \geq b + 3sL/2n$, that is, q must belong to the interval $[q_0, q_1]$ described in Figure 1 (the size of this interval depends on the value of the exogenous parameters υ, n, Δ, L, s and b). This means that full employment occurs when the productivity of a worker takes intermediate values. Indeed, when q is very large, the premium becomes too high for the firms to be able to set wages that sustain full employment. This is a rather surprising result because one would expect that a rise in workers' productivity is favorable to full employment when the output market is competitive. However, this intuition disregards the impact that price uncertainty has on the wage-setting process. Because they show risk-aversion, *firms become reluctant to hiring more productive workers because they must pay them a higher wage, regardless of the realized price for their output.*[3] By contrast, risk-neutral firms behave as if the product price

[3]Though our model does not deal with differences in qualification across workers, this

were fixed and equal to its mean.

4 Unemployment equilibrium

We now consider an economic environment in which not all workers take a job, while the remainder of the setting is similar to the one described in the foregoing section. Consequently, each firm acts as a monopsony in the labor market. The corresponding outer boundaries of its labor pool $\widehat{x}$ and $\widehat{y}$ are such that $\widehat{y} - \widehat{x} = 2(w_i - b)/s$.[4] The profit function of a monopsony firm i is given by:

$$\widetilde{\Pi}_i = 2\Delta(\widetilde{p}q - w_i)\frac{w_i - b}{s}$$

and its payoff is as follows:

$$V^U = 2\Delta(q - w_i)\frac{w_i - b}{s} - \frac{v}{2}\Delta^2 q^2 \left[\frac{2(w_i - b)}{s}\right]^2 \tag{12}$$

which is concave in w_i. By taking the first-order condition of (12) and combining the equations in a similar way as in the full-employment case, we easily obtain:

$$w^U = \frac{qs + b(s + 2v\Delta q^2)}{2s + 2v\Delta q^2} \tag{13}$$

Observe first that the impact of v on the monopsony wage (13) is the same as for the Nash equilibrium wage (7) and for the same reason. However, s now has a positive impact on w^U whereas it had a negative one on the full employment equilibrium wage (7). This is because firms no longer compete in the labor market. The training costs being borne by the workers, firms must compensate them when s increases in order to attract enough workers (the labor pool shrinks as s rises). On the contrary, as shown by (1) and (2), the size of the labor pool is independent of s at the full employment wage equilibrium. Thus, *under uncertain product demand, when the unit cost of mismatch becomes larger, monopsonistic firms are induced to rise their wages whereas oligopsonistic firms are induced to reduce their wages.* Moreover, the

result seems to be in accordance with recent empirical analyses suggesting that employment of the most skilled workers is fairly sensitive to random shocks.

[4] When $s = 0$, we have seen that the model with full employment remains meaningful. However, this is no longer true for the unemployment case because, workers being undifferentiated, the concept of isolated monopsonies makes no sense anymore.

monopsony wage (13) falls with Δ. Indeed, since each firm finds more suitable workers in its vicinity, it can afford to pay a lower wage because workers need a lower compensation for their training cost. Finally, the unemployment benefit positively affects the monopsony wage since workers are more reluctant to take a job and thus firms' monopsony power decreases when b rises.

It remains to check when there is unemployment for the equilibrium candidate (13).

Proposition 2 *Assume that firms have a mean-variance utility. Then, there is unemployment at the equilibrium wage*

$$w^U = \frac{qs + b(s + 2\upsilon\Delta q^2)}{2s + 2\upsilon\Delta q^2}$$

with an unemployment level given by

$$u = \Delta\left(L - n\frac{q-b}{s+\upsilon\Delta q^2}\right) \tag{14}$$

if and only if

$$\upsilon > \frac{n^2}{4\Delta L(nb + sL)} \tag{15}$$

Furthermore, the equilibrium value of each firm's payoff is given by

$$V^U = \frac{\Delta(q-b)^2}{2(s+\upsilon\Delta q^2)}$$

which is always positive.

Proof. The domain of parameters for which there is unemployment at the equilibrium candidate (13) is such that:

$$w^U - \frac{sL}{2n} < b \tag{16}$$

It readily verified that (16) is equivalent to:

$$\Phi(q) < b + \frac{sL}{n}$$

In this context, a necessary and sufficient condition for (16) to hold is thus given by:

$$\Phi(\widehat{q}) < b + \frac{sL}{n}$$

where $\Phi(\widehat{q})$ is defined by (9). It is readily verified that the condition above is equivalent to (15). ■

This proposition shows that the variance of $\widetilde{p}$ must be large enough to guarantee that there is unemployment in equilibrium. Indeed, if the demand is not volatile, monopsonistic firms will set sufficiently high wages for all workers to be willing to work. This captures the idea that both demand shocks and labor market institutions precluding state-contingent wage contracts may be responsible for equilibrium unemployment. In this sense, our results are in accordance with the recent literature that put forward economic turbulence and labor market rigidities as the main causes for the European unemployment (Ljungqvist and Sargent, 1998; Blanchard and Wolfers, 2000).

It is useful to write w^U as follows:

$$w^U = \frac{q+b}{2} - \frac{q-b}{2}\frac{\upsilon\Delta q^2}{s+\upsilon\Delta q^2}$$

because $(q+b)/2$ is the monopsony wage in the case of risk-neutral firms so that the second term stands for the wage cut that risk-averse firms levy upon workers. It may be interpreted as the risk premium that firms charge to workers for the risk borne because of their commitment to wage and employment before the realization of uncertainty. This premium increases with the worker productivity q as well as the density Δ (as in the full-employment case), whereas it decreases with the unemployment benefit b as well as with s because, in either case, it is more difficult for firms to attract workers.

As expected, the level of unemployment rises with the unemployment benefit. However, even in the absence of such a benefit ($b = 0$), there is still unemployment as long as

$$L > n\frac{q}{s+\upsilon\Delta q^2}$$

and the risk premium remains positive.

In our setting, unemployment has two different sources that combine to generate its level, as shown by (14). The former is due to the mismatch of firms and workers,[5] whereas the latter is due to the uncertainty affecting the

[5]Strictly speaking, this is not a mismatch unemployment in the sense of the search-matching literature (Pissarides, 2000) since, in equilibrium, all vacancies are filled. There is, in our model, an asymmetry between firms and workers because, from the firms' point of view, the matching is efficient whereas it is not for the workers. However, equilibrium unemployment can be viewed as caused by mismatch between workers and firms. Indeed, because of initial skill mismatch, in equilibrium, utilities differ across workers and is a major cause for unemployment. More precisely, because workers are not initially perfectly

price level. The first source of unemployment is due to firms' market power in the labor market. This statement must be qualified, however. In a perfectly competitive market, more workers would be employed because they would benefit from a higher net wage. Indeed, imagine that at each location x_i there is not one but two firms. This would obviously lead to Bertrand competition so that wages would equal marginal productivity ($w_i = q$). In this case, unemployment is reduced but not vanish as long as $q < b + sL/2n$. This discussion has two major implications. First, our model illustrates in a very simple way how *market power on the labor market may generate unemployment*. Second, *some workers may never be employable* because, even at the competitive wage, they are just too far away from firms' job requirements. In other words, the first source of unemployment arises both because workers' skills are too far from firms' needs and because firms exploit their market power in the labor market.

Let us now come to the second source. We have just seen that demand uncertainty leads firms to lower their wages by charging a positive risk premium. Stated differently, firms use their market power to transfer the risk of price volatility on workers, thus worsening unemployment. In order to highlight the role of the second source of unemployment, consider the case of risk-neutral firms ($\upsilon = 0$). Then (14) becomes

$$\Delta\left(L - n\frac{q-b}{s}\right)$$

It is readily verified that the unemployment level observed with risk-neutral firms is lower than the one caused when both mismatch and price fluctuation are combined, even though wages are higher. This suggests that, in a context in which firms must commit to wage and employment before observing the realization of the product market uncertainty, *unemployment is amplified when firms are risk-averse*. This is so because firms pass the risk onto workers by reducing wages. Hence, in our model, it appears that workers heterogeneity and rigidities in the labor market gives rise to two forces which combine to raise unemployment.

matched to firms, they must bear the training costs corresponding to their initial mismatch, thus implying that "mismatch" unemployment arises when these costs are too high for some workers.

It remains to consider the domain $b + sL/n \leq \Phi(q) \leq b + 3sL/2n$ in which Propositions 1 and 2 are no longer valid. Ever since Salop (1979) and others, it is well known that the transition from one setting to the other goes through some intermediate domain in which *labor pools just touch in equilibrium.* Hence, all workers are hired but the market context is different from the full-employment case discussed in section 3. In particular, the equilibrium wage is no longer given by (7). To illustrate, we assume that firms are risk-neutral and show that all workers are hired at a wage equal to $b+sL/2n$. When $q = b + 3sL/2n$, the equilibrium wage (7) is equal to $b + sL/2n$. Similarly, when $q = b + sL/n$, the equilibrium wage (13) is equal to $b + sL/2n$. Hence, the equilibrium wage is a continuous function of the structural parameters of the economy. Thus, starting from a sufficiently large value of s such that there is unemployment ($q \leq b + sL/n$), a gradual decrease in s leads to a reduction in unemployment, which vanishes when s satisfies $q = b + sL/n$. Further decreases in s affects only wages which, first, decreases ($b + sL/2n$) and, then, increases ($q - sL/n$) up to the point where the level of marginal productivity is reached ($s = 0$). The former effect finds its origin in the fact that the equilibrium arises at a *kink* in the labor supply function, whereas the latter is due to the decrease in firms' market power. Similar results may be obtained in the case of risk-averse firms, but the analysis is much more cumbersome.

5 Concluding remarks

In this paper, we have provided a unifying framework whose equilibrium displays full employment or unemployment according to the values of the structural parameters of the economy. As seen above, unemployment can be attributed to imbalance in demand and supply of skills as well as to random shocks in product demand that risk-adverse firms must face. To reach this conclusion, we have assumed that the labor market is imperfectly competitive because both firms and workers are heterogeneous. Demand uncertainty and mismatch reinforce each other in generating unemployment. Our analysis has also identified the impact of a few observable and structural parameters on the labor market outcome. These predictions can lead to empirical tests. We acknowledge the fact that we have used a partial equilibrium model but we see no reasons for the general tendencies uncovered here to become invalid in a general equilibrium setting, although the details will be different. Furthermore, when there is free entry with fixed entry costs so that the number of firms becomes endogenous, the number of active firms will remain finite and, for sufficiently large fixed costs, unemployment will prevail in the conditions described in Proposition 2.[6]

Our model provides a natural framework to evaluate the impact of various policy instruments. First, the implications of a minimum wage legislation are easy to trace. The government should institute a minimum wage above the monopsony one. Such a minimum wage would reduce firms' monopsony power and induce more workers to accept 'decently paid' jobs. This sheds some additional lights on the recent debate revolving around the positive effects of the minimum wage in the US (Card and Krueger, 1995) as well as in Europe (Dolado et al., 1996). Second, the literature does not give a clear answer to whether the government should cut unemployment benefits (Atkinson and Micklewright, 1991). Assume that the unemployment benefit is financed by a lump-sum tax paid by firms. In such a context, it is readily verified that the level of unemployment is as given in section 4. Therefore, more workers are willing to take a job rather than to stay unemployed when the unemployment benefit is reduced. This is because a reduction in unemployment benefit strengthens firms' monopsony power.

References

[1] Atkinson, A. and J. Micklewright, 1991. Unemployment compensation and labor market transitions: A critical review, Journal of Economic Literature 29, 1679-1728.

[2] Bhaskar, V. and T. To, 1999. Minimum wage laws for Ronald McDonald monopsonies: A theory of monopsonistic competition, Economic Journal 109, 190-203.

[3] Blanchard, O., 1999. European unemployment: The role of shocks and institutions, Baffi Lecture, Rome.

[6]This can be shown by re-labelling the analysis of Steinmetz and Zenou (2001) who proved this result for the product market.

[4] Blanchard, O. and J. Wolfers, 2000. The role of shocks and institutions in the rise of European unemployment: The aggregate evidence, Economic Journal 110, 1-33.

[5] Card, D. and A.B. Krueger, 1995. Myth and measurement. The economics of the minimum wage (Princeton University Press, Princeton).

[6] Dolado, J., Kramarz, F., Machin, S., Manning, A., Margolis, D. and C. Teulings, 1996. The economic impact of minimum wages in Europe, Economic Policy 23, 317-372.

[7] Drèze, J., 1987. Essays on economic decisions under uncertainty (Cambridge University Press, Cambridge).

[8] Drèze J. and C.R. Bean. 1990. Europe's unemployment problem (MIT Press, Cambridge).

[9] Eeckhoudt, L. and C. Gollier. 1995. Risk: evaluation, management and sharing (Harvester Wheatsheaf, New York).

[10] Evans, D. and B. Jovanovic, 1989. An estimated model of entrepreneurial choice under liquidity constraints, Journal of Political Economy 97, 808-827.

[11] Fazzari, S., Hubbard, R. and B. Petersen, 1988. Financing constraints and corporate investment, Brookings Papers on Economic Activity 1, 141-209.

[12] Fiorillo, F., Santacroce, S. and S. Staffolani, 2000. Monopsonistic competition for the "best" workers, Labour Economics 7, 313-334.

[13] Haley, J., 1990. Theoretical foundations for sticky wages, Journal of Economic Surveys 4, 115-155.

[14] Hamilton, J., Thisse, J.-F. and Y. Zenou, 2000. Wage competition with heterogeneous workers and firms, Journal of Labor Economics 18, 453-472.

[15] Hirshleifer, J. and J.G. Riley, 1992. The analytics of uncertainty and information (Cambridge University Press, Cambridge).

[16] Kim. S, 1989. Labor specialization and the extent of the market, Journal of Political Economy 97, 692-705.

[17] Layard, R., S. Nickell and R. Jackman, 1991. Unemployment. Macroeconomic performance and the labour market (Oxford University Press, Oxford).

[18] Lillien, D.M. and R.E. Hall, 1986. Cyclical fluctuations in the labor market, in: O. Ashenfelter and R. Layard, eds., Handbook of Labor Economics, Vol. 2 (North Holland, Amsterdam) 1001-1035.

[19] Ljungqvist L. and T. J. Sargent, 1998. The European unemployment dilemma, Journal of Political Economy 106, 514-550.

[20] Manacorda, M. and B. Petrongolo, 1999. Skill mismatch and unemployment in OECD countries, Economica 66, 181-207.

[21] Marimon R. and F. Zilibotti, 1999. Unemployment versus mismatch of talents: Reconsidering unemployment benefits, Economic Journal 109, 266-291.

[22] Markowitz, H.M., 1959. Portofolio selection. Efficient diversification of investments (Yale University Press, New Haven).

[23] Mortensen, D.T. and C. Pissarides, 1999. Unemployment responses to skill-biased technology shocks: the role of labour market policy, Economic Journal 109, 242-265.

[24] Pissarides, C., 2000. Equilibrium unemployment theory (MIT Press, Cambridge).

[25] Rosen, S., 1985. Implicit contracts: A survey, Journal of Economic Literature 23, 1144-1175.

[26] Sandmo, A., 1971. On the theory of the competitive firm under price uncertainty, American Economic Review 61, 65-73.

[27] Salop, S., 1979. Monopolistic competition with outside goods, Bell Journal of Economics 10, 141-156.

[28] Steinmetz, S. and Y. Zenou, 2001. On the existence of spatial monopolies under free entry, Economics Bulletin 4, 1-10.

[29] Stevens, M., 1994. A theoretical model of on-the-job training with imperfect competition, Oxford Economic Papers 46, 537-562.

[30] Stiglitz, J., 1986. Theories of wage rigidities, in: J.Butkiewicz et al., eds., Keynes' Economic Legacy (Praeger Publishers, New York) 153-206.

[31] Thisse, J-F. and Y. Zenou, 2000. Skill mismatch and unemployment, Economics Letters 69, 415-420.