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Demand uncertainty, mismatch and (un)employment

Mohamed Jellal[a], Jacques-François Thisse[b], Yves Zenou[c,*]

[a]Université Mohamed V, Rabat, ESC Toulouse and Conseils-Eco, Sweden
[b]CORE, Université Catholique de Louvain and CERAS, Belgium
[c]IUI and GAINS, Université du Maine, Sweden

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Abstract

Heterogeneous firms facing demand-induced price fluctuations imperfectly compete for heterogeneous workers. It is 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: J41; L13

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; Blanchard and Wolfers, 2000). 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). Another reason for unemployment that has also

* Corresponding author. IUI, The Research Institute of Industrial Economics, Box 5501, 114 85 Stockholm, Sweden. Tel.: +46 8 665 45 35; fax: +46 8 665 45 99.
E-mail address: yvesz@iui.se (Y. Zenou).

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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). 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.

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 $\tilde{p}$ 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 ($=1,\ldots n$) 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].

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

[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).

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 to 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.

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 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).

3. Full employment equilibrium

Firms simultaneously choose 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 $\bar{x}$ and $\bar{y}$ 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, $\bar{x}$ is given by:

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

In this case, firm i attracts workers whose skills belong to the interval $[\bar{x},x_i]$ 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 $[x_{i-1},\bar{x}]$ are hired by firm $i-1$. In a similar way, we have:

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

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

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

For analytical simplicity, we consider a mean-variance utility function so that firm i's payoff is as follows:

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

where $a \geq 0$ expresses the absolute degree of the firm's risk aversion and where $\widetilde{\Pi}_i$ is defined by Eq. (3). Because the terms a and σ^2 will always appear together throughout this paper, we find it convenient to set $v \equiv a\sigma^2$, which may be viewed as a measure of the impact of uncertainty on firms' behavior. Of course, $v>0$ if and only if firms are risk averse; otherwise $v=0$. Expression (4) may be written as follows:

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

Since all workers take a job, the outer boundaries of firm's labor pool are given by Eqs. (1) and (2). Hence, Eq. (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, which is given by:

$$w^F = q - vq^2\frac{\Delta L}{n} - s\frac{L}{n} \tag{6}$$

The wage w^F increases with workers' productivity q and decreases with the risk premium that firms levy on workers $(vq^2\Delta L/n)$ and with sL/n, which measures the oligopsonistic exploitation of labor. We must now determine under which conditions there is full employment at the equilibrium wage candidate (6).

Proposition 1. *There is full employment at the equilibrium wage w^F if and only if*

$$0 < v < \frac{n^2}{2\Delta L(2nb + 3sL)} \tag{7}$$

By guaranteeing that the individual with the worse match (i.e. $w^F - sL/2n > b$) accepts to work, condition (7) insures that, at the equilibrium wage (Eq. (6)), there is always full employment. In other words, if the variance of $\tilde{p}$ is not too large, everybody will accept to work at the equilibrium wage. The condition (Eq. (7)) 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.

It is worth pointing out an interesting difference between the cases of risk neutrality ($v=0$) and risk aversion ($v>0$). When $v=0$, 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 $v>0$, there is full employment for all the values of q such that $q\ (1 - vq\Delta L/n) \geq b+3sL/2n$, that is, q must belong to the interval $[q_0, q_1]$ (the size of this interval depends on the value of the exogenous parameters v, 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. By contrast, risk-neutral firms behave as if the product price 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 $\hat{x}$ and $\hat{y}$ are such that $\hat{y}-\hat{x}=2(w_i-b)/s$. The profit function of a monopsony firm i is given by:

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

and its payoff is as follows:

$$V^U = 2\Delta(q - w_i)\frac{w_i - b}{s} - v\frac{}{2}\Delta^2 q^2\left[\frac{2(w_i - b)}{s}\right]^2 \tag{8}$$

which is concave in w_i. By taking the first-order condition of Eq. (8) and combining the equations in a similar way as in the full-employment case, we easily obtain:

$$\mathrm{w}^U = \frac{qs + b(s + 2v\Delta q^2)}{2s + 2v\Delta q^2} \tag{9}$$

Observe first that the impact of v on the monopsony wage (Eq. (9)) is the same as for the Nash equilibrium wage (6) 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 (6). 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 Eqs. (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. It remains to check that there is unemployment at the equilibrium wage (Eq. (9)).

Proposition 2. *There is unemployment at the equilibrium wage w^U with an unemployment level given by*

$$u = \Delta\left(L - n\frac{q - b}{s + v\Delta q^2}\right) \tag{10}$$

if and only if

$$\nu > \frac{n^2}{4\Delta L(nb + sL)} \tag{11}$$

By stating that workers with the worst matches do not accept to work (i.e. $w^U - sL/2n < b$), this proposition shows that the variance of $\tilde{p}$ 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).

In our setting, unemployment has two different sources that combine to generate its level, as shown by Eq. (10). The former is due to the mismatch of firms and workers, whereas the latter is due to the uncertainty affecting the 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 does 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 ($\nu = 0$). Then Eq. (10) becomes $u = \Delta\left(L - n\frac{q-b}{s}\right)$. 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.

References

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

Drèze, J., 1987. Essays on Economic Decisions Under Uncertainty. Cambridge University Press, Cambridge.

Drèze, J., Bean, C.R., 1990. Europe's Unemployment Problem. MIT Press, Cambridge.

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

Ljungqvist, L., Sargent, T.J., 1998. The European unemployment dilemma. Journal of Political Economy 106, 514–550.

Rosen, S., 1985. Implicit contracts: a survey. Journal of Economic Literature 23, 1144–1175.

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

Stiglitz, J., 1986. Theories of wage rigidities. In: Butkiewicz, J.L., et al., (Eds.), Keynes' Economic Legacy: Contemporary Economic Theories. Praeger Publishers, New York, pp. 153–206.