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Labour Policy Instruments and the Cyclical Behaviour of Vacancies and Unemployment

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The standard Mortensen–Pissarides (MP) model cannot match the observed elasticity of vacancies and unemployment in the data. This paper shows that by introducing labour policy instruments, the original MP model can replicate the observed fluctuations in unemployment and job vacancies in response to shocks. These instruments reduce the benefit of forming a match, thereby increasing the impact that shocks have on firms' incentives to post vacancies, and workers' to accept job offers. Additionally, the analysis shows that the design of labour policy instruments, e.g. whether taxation is progressive or regressive, has non-trivial consequences on the model's performance.

Introduction

The Mortensen–Pissarides (MP) search and matching model has been criticized recently for its inability to replicate the observed cyclical behaviour of vacancy and unemployment. In particular, Shimer (2005) and Hall (2005) point out that in the standard MP framework, vacancies and unemployment are almost insensitive to shocks, since wages move to offset the effects of any exogenous fluctuations. In response to this critique, a growing number of papers, as detailed below, have proposed changes to the original framework that could solve this problem. There are three main approaches. The first is to change the type of wage contract by introducing wage stickiness, which makes wages less responsive to shocks. The drawback of this resolution, as documented by Pissarides (2007), is that there is no clear empirical support for embedding a staggered wage setting in the model. A second approach is to calibrate the model such that fluctuations in vacancies and unemployment are more sensitive to shocks. However, Mortensen and Nagypal (2007) point out that this proposal leads the standard MP model to assume a low wage bargaining power for workers and a high value for leisure. A third approach is to enrich the structure of the model with a more detailed description of the labour market, including endogenous job destruction, on-the-job search and labour turnover costs.

This paper undertakes the last approach and considers to what extent labour policy instruments may increase the volatility of vacancies and unemployment in response to shocks. Labour policy instruments are embedded in the form of unemployment benefits, firing costs, payroll and labour income taxes, and income subsidies. The choice of these particular labour policy instruments is motivated by both empirical evidence and theoretical considerations. Empirically, Nickell (1997) and Blanchard and Wolfers (2000) conclude that such policy instruments in practice have a statistically significant influence on labour market performance. On theoretical grounds, Pissarides (2000, ch. 9) points out that these policy instruments are particularly relevant when explaining the functioning of the labour market. In fact, a worker and firm determine the profitability of forming a match by comparing the value of working against its outside option (i.e. being unemployed for the worker, and not engaging in production for the firm). Labour policy instruments, by affecting the surplus of forming an employment relationship, are key elements that the worker and the firm consider when undertaking labour market decisions such as deciding to work or posting a vacancy.

We find that the presence of taxes, levied on either firms or workers, makes vacancies and unemployment more responsive to shocks. Unemployment benefits and firing costs have a similar effect. These institutional arrangements decrease the joint surplus from forming a match, by reducing the benefit to either the worker or the firm from establishing an employment relationship, so that shocks exercise a higher influence on them. Intuitively, if the joint surplus from forming a match is low, shocks would affect more strongly the incentives that lead the firm to open a vacancy and the worker to fill it. This amplifies the cyclical fluctuations of vacancies and unemployment. Related studies, discussed below, have suggested the importance of reducing the firm's surplus (i.e. profits) in explaining this issue. Here we show that the total surplus, and therefore the share that goes to the worker, also plays a role in improving the model's performance. For instance, in the presence of labour income taxes, which do not affect the firm's profits but decrease the worker's surplus from working, the reaction of vacancies and unemployment to shocks increases. Moreover, we are able to generate higher response of vacancies and unemployment without imposing a high value for leisure or a low worker's share of the surplus from working.

Before proceeding, we discuss the context provided by related studies. As mentioned, one approach to solving the problem is to change the wage setting mechanism. Specifically, Hall (2005) proposes a wage norm in which the wage is constrained to lie in the bargaining set and, similarly, Hall and Milgrom (2008) make the wage dependent on the relative costs of acceptance delays. Both papers find that these changes yield larger fluctuations in vacancies and unemployment than in the MP model.

A second approach, put forward by Hagedorn and Manovskii (2008), is to calibrate the standard MP model in an alternative way. They identify the cyclical response of wages and the average profit rate as the key features that the model needs to match. They show that if the value for the worker's outside option is high, then the model is able to produce realistic dynamic responses of vacancies and unemployment.[1]

The third approach enriches the original structure of the MP model with additional features that magnify the volatility of vacancies and unemployment. Pissarides (2007) shows that by embedding endogenous job destruction, the model's performance improves without modifying the wage bargaining structure. Similarly, Mortensen and Nagypal (2007) propose different amendments to the standard model that in principle can rehabilitate the MP model. They identify search job destruction shocks and, similarly to Krause and Lubik (2006, 2007) and Tasci (2007), on-the-job-search as the most valuable changes that would enable the model to match the volatility of vacancies and unemployment. Along these lines, Costain and Reiter (2008) find that match-specific productivity shocks increase the propagation mechanism in the model. Finally, Silva and Toledo (2009) and Thomas (2006) enrich the original model to account for post-match labour turnover costs and find that these would improve the model's performance. Similarly to these existing works, the present paper proposes a solution to the weak cyclicality of vacancies and unemployment in the standard MP model but, unlike any of them, it does so by means of labour policy instruments.

The remainder of the paper is structured as follows. Section I describes the model, Section II presents the results, and Section III concludes.

I. The Model

The model is based on Pissarides (2000, ch. 9) and Mortensen and Pissarides (2003), and resembles Shimer (2005). The original MP setup is enriched to account for labour policy instruments in the form of unemployment benefits, firing costs, payroll and labour income taxes, tax credit, and income subsidies. The model describes the behaviour of the representative worker and firm. They both discount the future at the rate r. During each period $t = 0,1,2,\ldots$, each representative firm posts vacancies to recruit a worker, and once the firm and worker agree on a specific wage contract, the firm produces a distinct, perishable good. Each firm has a single job that can be either filled or vacant and searching for a worker. The firm pays payroll taxes t_f. When the worker separates from the job, the firm incurs a firing cost F.[2] During each period $t = 0,1,2,\ldots$, the worker earns the agreed wage and receives a tax subsidy τ. Subsequently, this income is taxed at the marginal rate t_h, such that the worker's net earning is $(1 - t_h)(w + \tau)$. The tax subsidy τ can be either positive or negative. If $\tau > 0$, taxation is progressive, since the average tax rate increases with the wage; if $\tau < 0$, taxation is regressive; and if $\tau = 0$, taxation is proportional. An unemployed worker enjoys unemployment benefits b. As in Pissarides (2000, ch. 9), we assume that $b = \rho[(1 - t_h)(w + \tau)]$, where $0 < \rho < 1$ is the replacement ratio and the expression in square brackets, as already mentioned, is the average net income after tax. As long as the value of a vacancy is greater than zero, firms will open new vacancies. As the number of vacancies increases, the probability that any open vacancy finds a suitable match decreases, thereby reducing the profitability of recruiting workers and, consequently, reducing the value of an open vacancy. In equilibrium, free entry ensures that the present value of a vacancy equals zero.

The number of job matches depends on the matching technology $m(u, v)$, where v is the number of vacancies, and u is the number of unemployed workers searching for a job. Following Petrongolo and Pissarides (2001), the matching technology assumes the form $m(u, v) = \mu u^{\alpha} v^{1-\alpha}$, where $0 < \alpha < 1$, and μ is a scale parameter. It is convenient to introduce the variable $\theta = v/u$, labour market tightness, so that the probability that a searching firm finds a worker is denoted by $q(\theta) = m(u, v)/v = \mu\theta^{-\alpha}$, while the probability that an unemployed worker finds a job is denoted by $f(\theta) = m(u, v)/u = \mu\theta^{1-\alpha}$. During each period $t = 0,1,2,\ldots$, the flow into unemployment results from an exogenous shock with probability s. Consequently, the unemployment rate evolves according to

$$\dot{u} = s(1 - u) - m(u, v),$$

such that it is the difference between the number of jobs destroyed, $s(1 - u)$, and new matches, $m(u, v)$.

During each period $t = 0,1,2,\ldots$, a shock hits the economy according to a Poisson process with an arrival rate λ, at which a new productivity level p' is drawn from a distribution that depends on the current productivity p. The shock generates a capital gain $EX' - X$, where EX' represents the expected value of the variable X following the next aggregate shock, conditional on the current state of p.

Let U and W denote the present value of the expected income of an unemployed worker and an employed worker, respectively. The unemployed worker enjoys current value from leisure z, earns unemployment benefits b, expects to move into employment with probability $f(\theta)$, and may enjoy a net capital gain triggered by a new shock with probability λ. Hence the present-discounted value of unemployment is

$$rU = z + b + f(\theta)(W - U) + \lambda(\mathbb{E}U' - U). \tag{1}$$

The employed worker earns after-tax income, may lose the job with probability s, therefore becoming unemployed, and may enjoy a net capital gain triggered by a new shock with probability λ. Hence the present-discounted value of a job to the worker is

$$rW = (1 - t_h)(w + \tau) - s(W - U) + \lambda(\mathbb{E}W' - W). \tag{2}$$

Let J denote the present value of a job to the employer. The firm earns income from production, and pays wages and payroll taxes. The job might terminate with probability s, leading the firm to incur firing costs, and the firm may enjoy a net capital gain triggered by a new shock with probability λ. Hence the present-discounted value of a job to the firm is

$$rJ = p - (1 + t_f)w - s(J + F) + \lambda(\mathbb{E}J' - J). \tag{3}$$

In equilibrium, the free entry condition guarantees that the cost of posting a vacancy, c, equals the firm's share of the total surplus, such that

$$c = q(\theta)(1 - \beta)V. \tag{4}$$

Using $V = J + W - U + F$ and substituting explicitly for the payoffs from equations (1)–(3) into equation (4) yields the job creation condition

$$\begin{aligned}&(r + s + \lambda)\frac{c}{q(\theta)} + \beta c\theta \\ &- (1 - \beta)[p - z - (1 + t_f)w + (1 - t_h)(1 - \rho)(w + \tau) + F] - \lambda\,\mathbb{E}\frac{c\theta'}{f(\theta')} = 0,\end{aligned} \tag{5}$$

which, as in Shimer (2005), implicitly defines the v/u ratio as a function of the current state p.

The structure of the model guarantees that a realized job match yields some pure economic surplus. The share of this surplus between the worker and the firm is determined by the wage level, in addition to compensating each side for its costs from forming the job. Given the structure of the economy, the value of the match for the firm is $J + F$, and the value of the match for the worker is $W - U$. Hence the total value of establishing an employment relationship is $V = J + W - U + F$. As in Pissarides (2000, ch. 9), the worker and the firm split the total value V according to Nash bargaining, such that the worker's surplus is $W - U = \beta V$, where β represents the worker's bargaining power. If we use this last expression, substituting for V and for the payoffs (1)–(3), we can derive the wage:

$$w = \frac{\beta(p + c\theta + rF) + (1 - \beta)[z - (1 - t_h)(1 - \rho)\tau]}{\beta(1 + t_f) + (1 - \beta)(1 - t_h)(1 - \rho)}. \tag{6}$$

Equation (6) states that the wage is made up of two parts. First, for a fraction β, from the revenue product generated p, the foregone cost of hiring a worker $c\theta$, and a charge for the future expected firing costs rF. Second, for a fraction $1 - \beta$, from the value from leisure z, adjusted for the after-tax net subsidy $(1 - t_h)(1 - \rho)\tau$.

Note that the model nests Shimer (2005), as a special case in which we rule out labour policy instruments, by imposing $\{t_h = 0, t_f = 0, \rho = 0, F = 0, \tau = 0\}_{t=0}^{\infty}$.[3]

II. Results

Before proceeding, we calibrate the model on a quarterly frequency for the US economy. To make the analysis as close as possible to Shimer (2005), we use his calibration where possible. Consequently, we set the discount rate to $r = 0.012$, the job separation rate to $s = 0.1$, and the bargaining power β and the elasticity of the matching function with respect to unemployment α both equal to 0.72, and, as in Shimer (2005), we normalize the labour productivity to $p = 1$.[4] We set the value for leisure to $z = 0.22$, such that it represents approximately 20% of the wage, which is in line with Hall and Milgrom (2008) once unemployment benefits are ruled out. We set the average job finding rate $f(\theta) = 1.35$, and choose the target mean θ to be 1, which requires setting $\mu = 1.35$.

We now turn to the calibration of the labour policy instruments. The parameters are calibrated on US data. The marginal income tax rate t_h is set equal to 0.25 as in Mendoza *et al.* (1994), and the payroll tax rate t_f is set equal to 0.2 as in Nickell (1997). Firing costs F are set equal to 0.54, such that they represent 8 weeks of weekly wages, as in Silva and Toledo (2009). The replacement ratio ρ is set equal to 0.2, as in Millard and Mortensen (1997), such that approximately 40% of the unemployed workers receive 50% of the quarterly wage.[5] We assume that the worker's tax subsidies satisfy $\tau = 0$, such that the worker's taxation is proportional to the wage. As documented below, we consider alternative calibrations to this parameter in order to establish if the model's performance is at all sensitive to the design of the tax system. To close the model, as in Shimer (2005), equation (5) is used to calibrate $c = 0.173$,[6] and we assume that there are no aggregate shocks, such that $\lambda = 0$.

As stated at the outset, Shimer (2005) points out that the original MP model is unable to match the observed elasticity of labour market tightness with respect to labour productivity, which we indicate as $\xi_{\theta,p}$. In particular, he finds that the value of this elasticity in the standard MP model equals 0.481, which is rather low compared to the value of 5.9 in the US data. Hagedorn and Manovskii (2008) show that a model similar to Shimer (2005) is able to match this key elasticity by setting the value of leisure $z = 0.943$ and the worker's wage bargaining share $\beta = 0.061$. Here we show that when the model embeds labour policy instruments, it is able to match the data without resorting to this calibration. This allows us to overcome two important points that a number of authors, such as Mortensen and Nagypal (2007) and Costain and Reiter (2008), have put forward. First, a calibration of 0.061 for the worker's share of the total surplus from working is low compared to its empirical counterparts. This parameter is often interpreted as the worker's bargaining power in the wage setting, and therefore approximated by union density. Nickell (1997) estimates that the density of labour unions equals about 16% in the US. Second, the calibration of 0.943 for the value of leisure is probably too high. As Mortensen and Nagypal (2007) point out, this calibration implies that the percentage difference between the wage and the value of leisure, $(w - z)/z$, is 0.028, which is low compared to the value of 1.463 in Shimer (2005). Here, by enriching the model with labour policy instruments, the elasticity of labour market tightness with respect to labour productivity becomes

$$\xi_{\theta,p} = \frac{p[(r+s)+\beta f(\theta)]}{p-(1+t_f)w+(1-t_h)(1-\rho)(w+\tau)-z+rF} \times \frac{1+(\partial w/\partial p)\kappa}{(r+s)(1-\eta)+\beta f(\theta)-(f(\theta)/c)(1-\beta)(\partial w/\partial\theta)\kappa}, \tag{7}$$

where η is the elasticity of $f(\theta)$ with respect to θ, and

$$\kappa = (1 - t_h)(1 - \rho) - (1 + t_f),$$

$$\frac{\partial w}{\partial p} = \frac{\beta}{[\beta(1 + t_f) + (1 - \beta)(1 - t_h)(1 - \rho)]},$$

$$\frac{\partial w}{\partial \theta} = \frac{c\beta}{[\beta(1 + t_f) + (1 - \beta)(1 - t_h)(1 - \rho)]}.$$

Note that if we rule out labour policy instruments, by imposing $\{t_h = 0, t_f = 0, \rho = 0, F = 0, \tau = 0\}_{t=0}^{\infty}$, equation (7) simplifies to the equivalent in Shimer (2005).[7] Using the benchmark calibration, the elasticity $\xi_{\theta,p}$ is equal to 5.99, which is significantly higher than the value of 1.03 in Shimer (2005) and close to the value of 5.9 in the data. Hence the presence of labour policy instruments makes this key elasticity approximately 6 times higher than in the standard MP model, and in line with the data, without resorting to alternative parameters' calibration. The mechanism that generates such an increase is straightforward. In the presence of labour market instruments in the form of income and payroll taxes, firing costs and unemployment benefits, the total surplus of forming a match decreases. Consequently, shocks have a greater effect on the firm's incentive to post a vacancy and the worker's incentive to accept a job offer, thereby amplifying the aggregate fluctuations of unemployment and vacancies to shocks. Analytically, the total surplus of the match is represented by the denominator of the first term in equation (7), and therefore it is negatively related to $\xi_{\theta,p}$. Related studies, such as Hagedorn and Manovskii (2008), Mortensen and Nagypal (2007), Silva and Toledo (2009) and Thomas (2006), stress the importance of the size of the percentage change of profits—i.e. the firm's surplus—to changes in productivity to increase $\xi_{\theta,p}$ in the model. The presence of labour policy instruments makes clear that the worker's surplus is important too. For instance, from equation (7), an increase of labour income tax t_h that affects only the worker's surplus, alone magnifies the reaction of labour market tightness to shocks. Figure 1 shows how the elasticity of labour market tightness with respect to productivity, $\xi_{\theta,p}$, changes for calibrations of labour income tax t_h in the range $(0.2, 0.3)$. When income tax increases, the worker's outside option (i.e. being unemployed) becomes more valuable, thereby reducing the worker's surplus from working and, consequently, reducing the total surplus from establishing an employment relationship. If $t_h = 0.3$, shocks exercise a high influence on the firm's and worker's incentives to post vacancies and accept job offers, thereby almost doubling $\xi_{\theta,p}$ to about 11. On the other hand, if $t_h = 0.24$, the elasticity $\xi_{\theta,p}$ closely matches the data.

In the benchmark calibration we assume proportional taxation, thus setting the worker's tax subsidy at $\tau = 0$. If we assume that worker's tax subsidies are different from zero, the model's amplification mechanism becomes sensitive to the design of labour policy instruments. Having a progressive or regressive taxation system, when $\tau > 0$ or $\tau < 0$, respectively, has a non-trivial effect on the cyclicality of vacancies and unemployment. Figure 2 shows numerical values of $\xi_{\theta,p}$ for τ in the range $(-0.05, 0.1)$, which implies pre-tax worker's subsidies between -4% and 9% of the quarterly wage. A progressive (regressive) taxation decreases (increases) the reaction of vacancies and unemployment to shocks. Also, in this instance, the mechanism that generates the results confirms that the effect of taxation on the total surplus is important: if taxation is progressive (regressive), the total surplus increases (decreases),

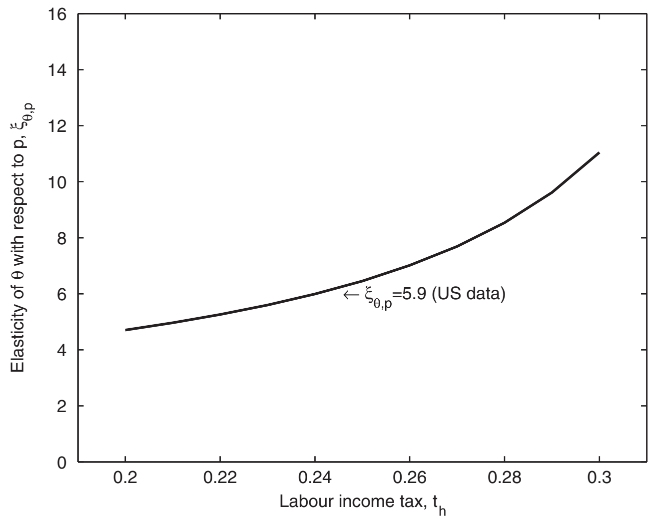

FIGURE 1. Labour income tax t_h and the elasticity of labour market tightness θ with respect to labour productivity p. (The figure shows changes in the elasticity of labour market tightness with respect to productivity $\xi_{\theta,p}$ for different values of labour income tax t_h.)

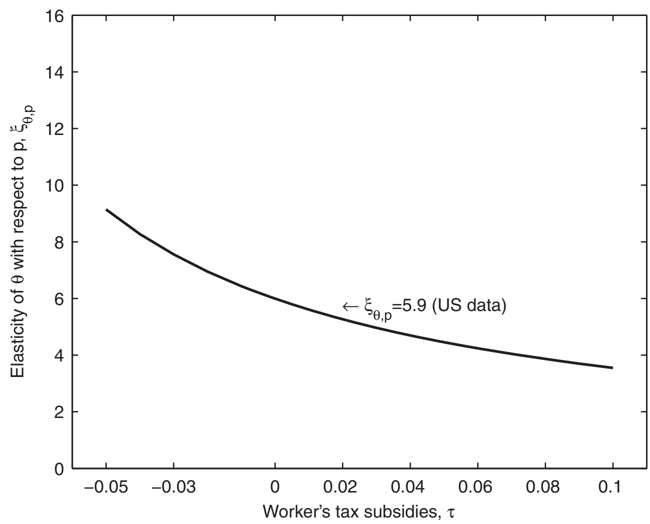

FIGURE 2. Worker's tax subsidies τ and the elasticity of labour market tightness θ with respect to labour productivity p. (The figure shows changes in the elasticity of labour market tightness with respect to productivity $\xi_{\theta,p}$ for different values of worker's tax subsidies τ.)

thereby reducing (amplifying) the reaction of vacancies and unemployment to shocks. In particular, when the worker's tax subsidies are set approximately equal to 0.01, such that they are approximately 1% of the quarterly wage, the model closely matches the elasticity of vacancies and unemployment in the data. This suggests that a detailed description of the tax system is important for the cyclical behaviour of vacancies and unemployment in a standard MP model to be in line with the data.

III. CONCLUSION

Shimer's (2005) and Hall's (2005) papers raised an important point: the original MP model is unable to match the observed elasticity of vacancies and unemployment in the data. A growing number of works have proposed solutions, by embedding staggered wages, or recalibrating the model's parameters, or amending the structure of the original model. Here we proposed an alternative approach. We added labour policy instruments and showed that their presence enables the standard MP model to match the elasticity of vacancies and unemployment in the data. Since labour policy instruments decrease the total surplus of the match, the firm's and worker's incentives to post vacancies and accept job offers are more sensitive to shocks, and therefore the latter have a greater effect on fluctuations in unemployment and vacancies. The analysis pointed out that the worker's surplus is relevant to the model's amplification mechanism. Moreover, the design of labour policy instruments, such as whether taxation is progressive or regressive, is important.

But while the model finds that including labour policy instruments can match the elasticity of vacancies and unemployment in the US data, the results suggest that further empirical investigation should explore the cross-country implication of the results. We leave this task as a topic for future research.

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NOTES

1. In particular, Hagedorn and Manovskii (2008) show that a high value for leisure and a low worker's share of the surplus from working enable the best empirical performance of the model. This paper shows that when the model embeds labour policy instruments, it is able to match the data without resorting to this specific calibration. This, as detailed below, allows us to overcome important shortcomings that Mortensen and Nagypal (2007) and Costain and Reiter (2008) have put forward.
2. Firing costs are assumed to be a sunk cost. This assumption is important because, as pointed out by Lazear (1990), Mortensen and Pissarides (1999) and Ljungqvist (2002), any mandated severance transfer can be offset by an efficient labour contract, hence there would be no real effects.
3. In Shimer (2005) the corresponding equation reads $w = \beta(p + c\theta) + (1 - \beta)z$.
4. As mentioned in Shimer (2005), the value $\alpha = 0.72$ lies towards the upper end of the range of estimates in Petrongolo and Pissarides (2001).
5. Nickell (1997) estimates that the replacement ratio is 50% of earnings for 6 months in the US. However, Blank and Card (1991, Table I) estimate that only approximately 40% of laid-off workers receive unemployment benefits, because either they do not qualify, on the basis of insufficient prior employment, or they do not claim them. Hence the replacement ratio for unemployed workers is $\rho = 0.5 \times 0.4 = 0.2$.
6. In Shimer (2005) the calibration is $c = 0.213$.
7. The elasticity $\xi_{\theta,p}$ is derived using the implicit function theorem on the job creation condition (5).

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