

## Equilibrium in the Labor Market with Search Frictions<sup>†</sup>

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Research in the economics of the labor market when there are search frictions started in the 1960s, with influential contributions from George Stigler (1962), John McCall (1970), and the papers collected in Edmund Phelps et al. (1970). Of course, as is common in economics, this was not the first time that economists took seriously the role of search frictions in their research. Insightful discussions of the role of frictions in labor market equilibrium can be found much earlier, in books by John Hicks (1932) and William Hutt (1939). But it was not until the late 1960s that formal mathematical models of individual behavior and labor market equilibrium appeared.

The development of formal mathematical models with search frictions coincided with the time that I was looking for a topic for my PhD research.<sup>1</sup> Two things about search impressed me most. In the Phelps volume, search was claimed as a microfoundation for the natural rate of unemployment, introduced just a year or two before by Milton Friedman (1968) and Edmund Phelps (1967), and for the inflation-unemployment trade-off (the Phillips curve). It was also claimed, by Axel Leijonhufvud (1968) in particular, that it could provide a microfoundation for Keynes's concept of effective demand: the idea was that the job seeker could make her demand for goods effective only after she succeeded in locating a mutually acceptable job match.

The articles in the Phelps volume, however, especially those by Phelps (1970) and Dale Mortensen (1970) which had explicit models of the Phillips curve, required a wage distribution to obtain the microfoundations of the Phillips curve. As Peter Diamond (1971) and Michael Rothschild (1973) pointed out, this was not consistent with the other assumptions of the models.<sup>2</sup> Leijonhufvud's claims also required something more than search. They required either wage rigidity or absence of capital markets. Dealing with these two apparently unconnected issues appeared important items on the research agenda of the macroeconomics of the labor market. Both the Phillips curve and Keynesian demand management played a key role in both macroeconomic research and policy, yet they lacked good theoretical foundations.<sup>3</sup>

<sup>†</sup> This article is a revised version of the lecture Christopher A. Pissarides delivered in Stockholm, Sweden, on December 8, 2010, when he received the Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel. This article is copyright © The Nobel Foundation 2010 and is published here with the permission of the Nobel Foundation.

\* London School of Economics. I have benefited from discussions with my two co-winners, Peter Diamond and Dale Mortensen, and from comments from Gary Fethke, Yannis Ioannides, Rachel Ngai, and Robert Shimer.

<sup>1</sup> This timing coincided with my first meeting with Dale Mortensen, who was a visitor at the University of Essex when I was finishing my undergraduate and Master's studies there, but our collaboration had to wait for another 20 years to materialize.

<sup>2</sup> Another prominent critic of the papers in the Phelps volume, who influenced the literature that followed, was James Tobin (1972).

<sup>3</sup> The outcome of my early research in these issues was my first book, Pissarides (1976), based on my PhD thesis at the London School of Economics.

## I. Matching Frictions and Two-Sided Search

One of the appeals of early search theory was that it appeared realistic. The widely used ILO/OECD definition of unemployment is one of workers not in a job, looking for one, and available to take one. This was precisely the definition of unemployment used in search theory. In earlier theory, both neoclassical and Keynesian, the unemployed are not doing anything connected with their state. They might be enjoying temporary bouts of leisure or be idle waiting for a job to open up, but they are not looking for a job. In the Phelps volume, however, as in the important paper by McCall (1970), the worker is searching for a wage offer from a fixed distribution of wages, and if she is unemployed it is because she has failed to locate a high enough wage offer. This did not seem to be consistent with our intuition of what makes one unemployed for long periods of time, or with the view of unemployment taken by applied labor economists and official statistical agencies. It also appeared inconsistent with equilibrium in markets with search frictions, at least back then.

Although there were many attempts to derive an equilibrium wage distribution for markets with search frictions, I took a different approach to labor market equilibrium, that could be better described by the term “matching.” The idea is that the job search underlying unemployment in the official definitions is not about looking for a good wage, but about looking for a good job match. Moreover, it is not only the worker who is concerned to find a good match, with the firm passively prepared to hire anyone who accepts its wage offer, but the firm is also as concerned with locating a good match before hiring someone.

The foundation for this idea is that each worker has many distinct features, which make her suitable for different kinds of jobs. Job requirements vary across firms too, and employers are not indifferent about the type of worker that they hire, whatever the wage. The process of matching workers to jobs takes time, irrespective of the wage offered by each job. A process whereby both workers and firms search for each other and jointly either accept or reject the match seemed to be closer to reality.

This approach to search has the advantage that it makes unemployment neither “voluntary” nor “involuntary,” concepts that caused a lot of confusion and fruitless debate in the literature. Unemployment is instead the outcome of a decentralized equilibrium, which may or may not be optimal. It seemed to me that the two-sided matching view had a better chance of success, both in grounding itself in micro-economic theory and in interpreting the facts about unemployment. It allowed one to study equilibrium models that could incorporate real-world features like differences across workers and jobs, and differences in the institutional structure of labor markets.

The step from a theory of search based on the acceptance of a wage offer to one based on a good match is small but has far-reaching implications for the modeling of the labor market. The reason is that in the case of searching for a good match we can bring in the matching function as a description of the choices available to the worker. The matching function captures many features of frictions in labor markets that are not made explicit. It is a black box, as Barbara Petrongolo and I called it in our 2001 survey, in the same sense that the production function is a black box of technology. But it captures the key idea of a good match: it takes time to find a good match, the length of time it takes varies across workers in unpredictable ways, and if

there were more job vacancies available, on average workers would find a good job much faster. The same applies to firms looking for workers; the matching function treats workers and firms symmetrically.

Importantly, because the matching function was similar to other aggregate functions used in economic models, it became possible to write small equilibrium models of the labor market, with frictions captured by the matching function. It also became possible to estimate these models with real world data. I estimated the matching function with British data, and Olivier Blanchard and Peter Diamond estimated it with US data, with encouraging results (see Pissarides 1986; and Blanchard and Diamond 1989).

## II. Towards an Equilibrium Model

I first used the matching function explicitly in 1979 (Pissarides 1979), making it the main building block of an economywide model, at about the same time that Peter Diamond and Eric Maskin (1979) used the similar idea of the “search technology.” The model of my paper had no wage differentials, but it had different methods of search. My main interest was to show that with a matching function one could get an interesting, simple model of equilibrium vacancies and unemployment without a wage distribution.

But my 1979 paper still had no theory of wages. Soon after, however, it seems that all three of us independently realized that since frictions imply that the firm and the worker in a good match enjoy some monopoly power, wages need to share it between them. It helped that in the early 1980s, independent developments in bargaining theory were working out solutions for the splitting of a “cake.”<sup>4</sup> The rewards from a good match in the Diamond-Mortensen-Pissarides (DMP) model was the cake that workers and firms had to split.

I attempted the derivation of a wage equation in a search model using ideas in bargaining theory. The outcomes were some working papers that appeared around 1982, before the electronic era. I was unaware that both Peter Diamond (1982) and Dale Mortensen (1982) were working on similar issues and were one or two years ahead of me. The wage equation that I was deriving from the Nash solution to the wage bargain was virtually identical to the wage equation in Diamond’s (1982) paper. Seeing their papers on wages and efficiency made me switch to another issue that needed to be dealt with in an equilibrium model, that of job creation.

## III. Job Creation

In both the Diamond (1982) and Mortensen (1982) papers the problem investigated was that of a fixed number of workers interacting with a fixed number of jobs. Yet, when looking at the workings of real labor markets over time, the most striking feature that one sees is how employment and job vacancies fluctuate; in other words,

<sup>4</sup>Most influential among these was Ariel Rubinstein’s (1982) work. A bigger influence on my research were informal discussions with my colleagues at LSE, who also pioneered work in this area, in particular Kenneth Binmore, Avner Shaked and John Sutton. See Binmore, Rubinstein, and Asher Wolinski (1986) and Shaked and Sutton (1984).

how the total number of jobs varies over time, depending on economic conditions. In order to make the theory applicable to business cycles there was a need for a theory of job creation and job destruction. In my empirical research with British data (Pissarides 1976), I found that the entry into unemployment was a virtually constant fraction of employment.<sup>5</sup> Consequently, I focused on the derivation of a variable exit from unemployment, though a theory of job creation.

The key feature of the matching model that I made use of was that employment was derived as the sum of distinct units called jobs, and not as an aggregate that could be chosen as a single unit. A job is an asset owned by the firm: if it is vacant it has some value because it can expect to recruit a worker and yield some profit in the future; if it is filled it is producing for profit. Vacant jobs are like nascent investment projects that have not started yielding a return yet. If their net value is positive, the firm can create them for profit; if it is negative, it is losing money from them, so it makes sense to close them down. It follows that an equilibrium number of jobs could be derived from the condition that the value of a new job vacancy must be zero.<sup>6</sup>

When the zero-profit condition for new vacancies is combined with the Nash wage equation it gives an equilibrium wage rate and job creation rate that depend on the frictions as summarized in the matching function, and on all the other variables that influence labor market outcomes in standard models, such as productivity and taxes. From this condition I can get the equilibrium ratio of vacancies to unemployment, called tightness and usually denoted by the Greek letter  $\theta$ . See Figure 1: the zero-profit condition slopes down because at a lower wage rate jobs are more profitable, and more vacancies are created; the wage equation slopes up because at higher tightness workers are more likely to locate an alternative job offer, and firms are less likely to locate an alternative worker if the wage bargain fails, so the worker's hand in the wage bargain strengthens.

#### IV. Beveridge Curve Equilibrium

The transition from a model that yields an equilibrium ratio of vacancies to unemployment to one that yields an equilibrium unemployment is made through the Beveridge curve. The Beveridge curve shows combinations of vacancies and unemployment that are consistent with equality between the entry into unemployment and the exit from it. This implies that once on the Beveridge curve, unemployment is not changing, unless one of the flows (in or out) changes because of an exogenous shock. When the entry into unemployment is a constant fraction of employment, as we are still assuming, the shape and properties of the Beveridge curve are essentially given by the aggregate matching function. At a higher vacancy rate there are more matches between a given number of unemployed workers and job vacancies. Unemployment falls because of the increased exit from it, and as employment rises, the entry into unemployment also rises. A new point is reached with lower unemployment rate, more job matches taking place, and more workers entering unemployment.

<sup>5</sup>This feature of the data changed dramatically in the years that followed. See Petrongolo and Pissarides (2008).

<sup>6</sup>See Pissarides (1984, 1985) for the first applications of the "zero-profit condition" to close the model.

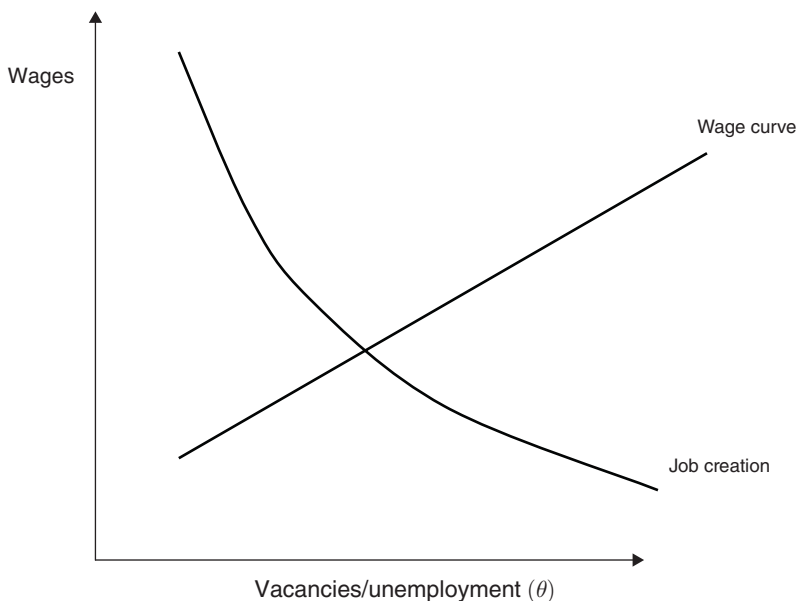


FIGURE 1. EQUILIBRIUM WAGES AND MARKET TIGHTNESS

The Beveridge curve is shown in Figure 2. The convex shape is due to the constant returns satisfied by the aggregate matching function. To find equilibrium unemployment I need to know at what point on the curve the economy will settle. But since I already have an equilibrium value for the ratio of vacancies to unemployment from the job creation condition, I can find that point immediately. I draw a line through the origin with slope the equilibrium  $\theta$ , and the intersection of the Beveridge curve with this line is the overall equilibrium of this economy.

At the core of this economy are the frictions that characterize the labor market. These frictions are the forces that keep the Beveridge curve away from the origin. The frictions could be due to a number of factors, such as mismatch between the skill requirements of jobs and the skill mix of the unemployed, differences in location, the institutional structure of an economy with regard to the transmission of information about jobs, and others. An economy characterized by more frictions has a Beveridge curve further away from the origin than an economy with fewer frictions.

Because of frictions, jobs that compete for the same workers could have different productivities and yet survive in equilibrium. In frictionless markets only the most productive of these jobs survive, as competition drives the wages in all jobs to the wage offered by the most productive. Workers search for the best job that they can find. In models that allow for different productivities, the position of the Beveridge curve is also affected by the incentives that workers have to search for and accept jobs. The matching rate in these models depends on two factors, making a contact with a firm looking for workers and finding the firm's offer acceptable.

In an economy where workers do not have strong incentives to accept an offer quickly, for example because they are generously compensated without preconditions by the unemployment insurance system, the Beveridge curve lies further away from the origin. An income support policy that does not impose preconditions is called a passive policy. But policies that support the unemployed during search and

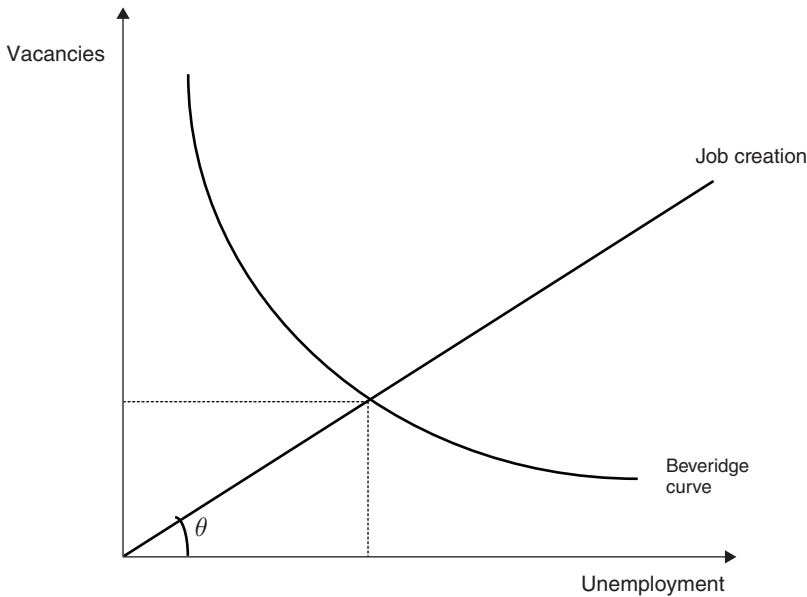


FIGURE 2. THE BEVERIDGE CURVE AND EQUILIBRIUM VACANCIES AND UNEMPLOYMENT

provide incentives for more intensive job search can shift the Beveridge towards the origin and improve the performance of the labor market in matching workers to jobs. In this case policies are called “active.”

A leader in the implementation of active labor market policies is Sweden, which spends far more than other advanced countries on bringing unemployed workers to jobs. In contrast, up to the 1980s most countries supported the unemployed through passive policies, with poor outcomes in the recession of the 1980s. Most countries have switched from passive to active policies in the course of the 1990s, following the poor performance of their labor markets in the 1980s.

### V. Comparing Economies over Space and Time

We can use the model to compare two economies, one with more frictions and passive policies with one with fewer frictions and active policies. The first economy has a Beveridge curve further away from the origin. It also has fewer job vacancies for each unemployed worker, because firms expect to take longer to fill a vacancy. Figure 3 compares these two economies. The economy with more frictions is shown with the broken lines. An important conclusion is that the economy with more frictions has more unemployment than the economy with fewer frictions, but the two economies may have a similar level of vacancies.

This conclusion can be contrasted with the comparison of two economies at different levels of aggregate economic activity, demand or supply. A lower level of aggregate activity implies lower profitability from new jobs. Job creation falls, and this rotates the job creation line clockwise, but the Beveridge curve does not move. Equilibrium unemployment increases and vacancies fall in response to this shock.

The different response of vacancies to more frictions and lower level of aggregate activity was used by a number of authors to identify the reasons for the rise

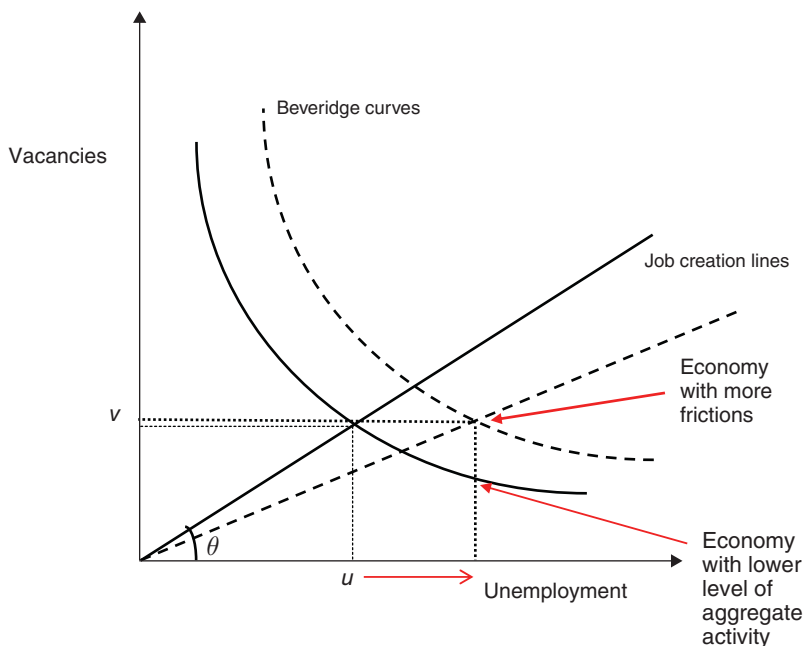


FIGURE 3. COMPARING ECONOMIES

in unemployment in different countries. Richard Jackman, Richard Layard, and Pissarides (1989) first used it to argue that the rise in unemployment in Britain in the 1980s, after the initial big surge associated with Prime Minister Thatcher's restrictive monetary and fiscal policies, took place at more or less constant vacancies. This is shown in Figure 4. The underlying reasons must have been related to increased frictions in the labor market. These could be associated with increased mismatch, as the transformation of the economy from an industrial to a service one intensified, and to more generous income support for the unemployed.

It was also very likely due to the build-up of long term unemployment, which disillusiones the unemployed and damages the incentives they have to look for work. Long-term unemployment, meaning unemployment that lasts for a year or more, is a serious consequence of recession that disenfranchises workers from the labor force and prolongs the impact that recession has on the quality of the work force. It can explain why the unemployment rate in Britain was not falling in the 1980s when the rest of the economy was booming. Governments realized the negative impact of long-term unemployment since then, and they have tried to contain it with active labor market policies.<sup>7</sup> For this reason, more recent recessions do not exhibit the big shifts in the Beveridge curve and the long persistence of the negative shocks on the labor market.

We can see this contrast for Britain when we compare the economy's responses to the recession of 2008, in Figure 5. Although other reforms took place in Britain following the recession of the early 1980s, active policy also played an important role

<sup>7</sup>Several countries adopted such policies, led by the Nordic countries. See OECD (2007) for an update.

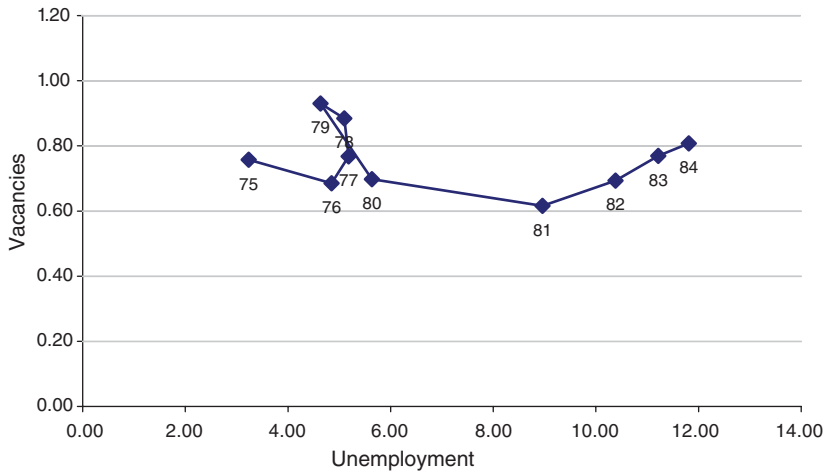


FIGURE 4. THE BRITISH BEVERIDGE CURVE, 1975-1984

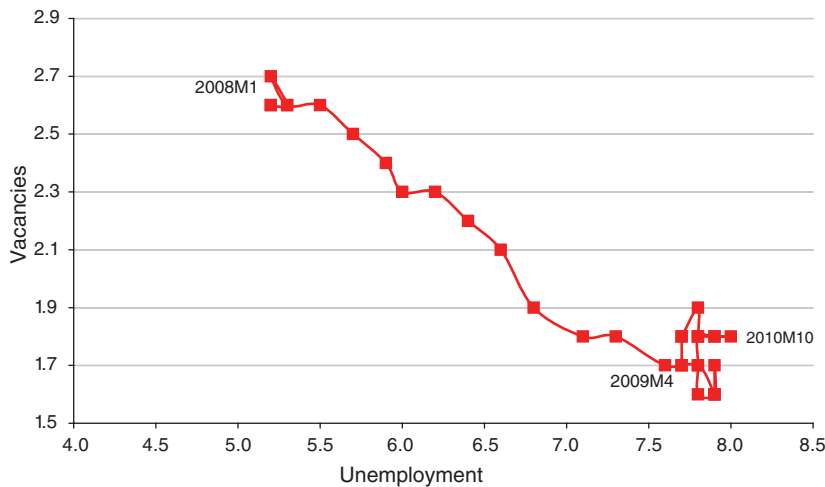


FIGURE 5. THE BRITISH BEVERIDGE CURVE, 2008-2010

in containing long-term unemployment. The path of the economy in the Beveridge diagram in the recent recession is a typical example of the response of an economy to a negative aggregate shock.

The British experience contrasts sharply with the experience of the United States. Katharine Abraham and Lawrence Katz (1986) used unemployment and vacancy data for the United States<sup>8</sup> to argue that the business cycles of the 1970s and 1980s were due to aggregate shocks and not sectoral shocks, as argued by David Lillien (1982) and others. Sectoral shocks would have similar implications to mismatch shocks. But the economy in the late 1970s and early 1980s was tracing a Beveridge curve in the south-eastern direction, as implied by an aggregate shock (see Figure 6).

<sup>8</sup>The vacancy data were derived from the Conference Board Help-Wanted Index. See their article for more details.



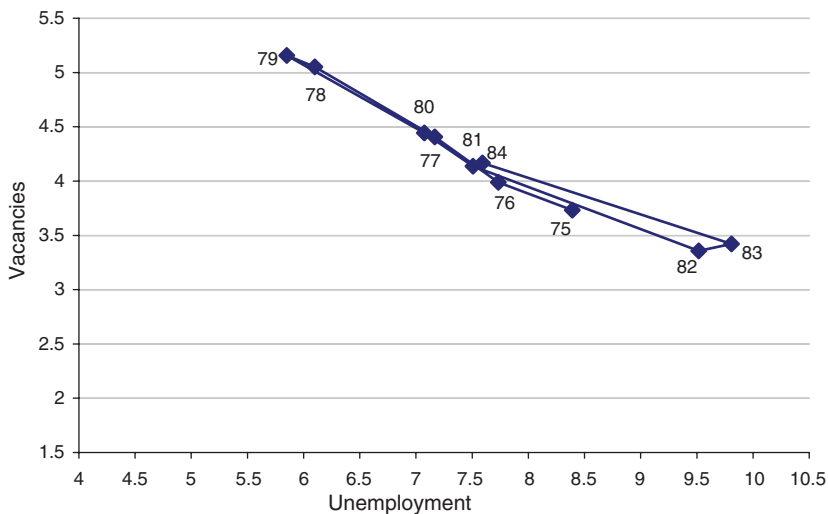


FIGURE 6. THE US BEVERIDGE CURVE, 1975–1984

In the 2008 recession, the US economy started off on a downward south-eastern direction, but after the initial shock it traced an increase in unemployment at more or less constant vacancies. It is still too soon to conclude that this is a shift of the Beveridge curve to the right, but if it was it would be a feature of intensifying frictions in the United States labor market, which have not yet been identified (Figure 7). The rise in vacancies and recovery in output at virtually constant unemployment rate explain why the fragile recovery has been described as “jobless.”

## VI. Wage Stickiness

The response of unemployment to shocks is bigger when wages are sticky. Do markets with frictions have anything new to say about wage stickiness? I am talking here about real wage stickiness, although similar arguments should apply to nominal wage stickiness.

In frictionless markets there are no compelling reasons for wage stickiness. In contrast, in markets with frictions and Nash wage bargains there is a built-in reason for some wage stickiness. It is that the wage rate depends on the worker’s non-market returns, which include unemployment insurance income, the value of home activities like home decoration or child care, and the value of extra leisure, like more sleep. The payoffs from these activities are not cyclical. When the market payoffs go down because of recession, the home payoffs remain high, and this stops the Nash wage rate short of falling by as much as the market payoffs.

I explored this wage stickiness in my 1985 paper to derive cyclical fluctuations in unemployment in the model with frictions. But as Robert Shimer (2005) has shown, it is not enough to explain all the amplification of the shocks required to match the data. Subsequent work has shown that it can be enough, but only if the firm’s profit share from the match is very small, either because workers take most of the surplus or because firms have large labor hiring costs (Marcus Hagedorn and Iourii Manovskii 2008; Pissarides 2009).

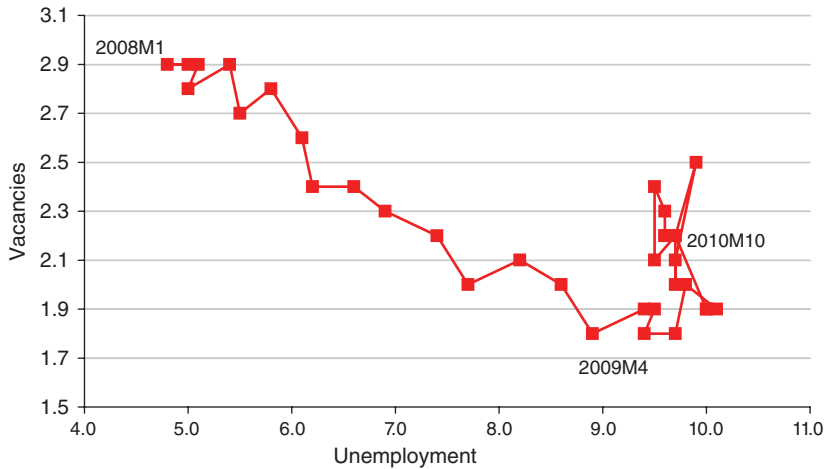


FIGURE 7. THE US BEVERIDGE CURVE, 2008–2010

But markets with frictions can justify another form of wage stickiness, much more substantial than the one implied by the Nash wage equation. This was first explored by Robert Hall (2005), who argued that since the monopoly power implied by frictions implies that there are no conventional supply and demand functions to tie down the wage rate, the Nash wage is only one possible outcome consistent with equilibrium. Another is the wage that depends on the historical median hiring wage, and shocks to demand do not necessarily change it by much. Hall showed that the wage stickiness consistent with this argument is enough to give an equilibrium that delivers all the amplification of shocks on job creation that we see in the data.

This analysis reopens the issue of wage determination and puts it into center stage as a topic for future research. Given the many possibilities allowed by the bilateral monopoly nature of a good match, research needs to be driven by empirical studies of wage determination for new hires at different phases of the cycle (see Christian Haefke, Marcus Sonntag, and Thijs van Rens 2007; and Pissarides 2007).

## VII. Job Destruction

New establishment data by Steven Davis and John Haltiwanger (1990) and others working in Industrial Organization, published in the late 1980s and early 1990s, showed that job destruction rates varied a lot across business cycles. The main cause of job destruction and the biggest number were connected with idiosyncratic establishment-specific shocks, but there was enough variation over the business cycle to render untenable the assumption that the rate at which workers flow into unemployment is constant. Although the rate of job destruction determined the job flow, and not the worker flow into unemployment, the two are closely connected. Anyway, subsequent work showed that flows into unemployment were cyclical too, although not as cyclical as the flow out of unemployment (see Shigeru Fujita and Garey Ramey 2009).

Following a criticism by Mortensen (1992) of the assumption of a constant flow rate of workers into unemployment in the first edition of my book (Pissarides 1990),

we came together to work on extending the model to a variable job destruction rate. The outcome was our 1994 paper (Mortensen and Pissarides 1994) and a series of papers that applied the model to several issues (Mortensen and Pissarides 1999).

In our analysis of job destruction we assumed that once jobs are created, they cannot easily adapt to new technologies. In the simplest version of the model they do not adapt at all, so the firm keeps the job going for as long as it is still profitable. When shocks hit that make a job unprofitable, it is destroyed, the worker is made unemployed, and some new job is established elsewhere to take its place.

We have shown that like the job acceptance decision in the first generation of search models, the job destruction decision was governed by a reservation productivity. The firm and the worker agreed which jobs to destroy on the basis of their joint real return. Under our rules, most job destruction in the steady state is due to unidentified idiosyncratic shocks, as in the data. But over the cycle, job destruction goes up in recession, usually with a sudden upsurge of terminations when the news first breaks out, and goes down in the recovery phase. This introduces cyclicity in both the job creation and job destruction rate, predicting well the time series data for the United States.

The variable job destruction rate has implications for the dynamics of unemployment and the Beveridge curve, but it does not affect the dynamics of the job creation rate that I discussed earlier in this lecture. It also implies that there is now an incentive to search on the job and move from one job to another without experiencing unemployment. The reason is that workers have an incentive to leave the jobs that are becoming obsolete or have low profitability for other reasons. The full model is set out in the second edition of my book (Pissarides 2000). Rather than discuss the full model here, I will discuss the implications of employment protection legislation for unemployment and job flows. This is one policy whose study needs the extended model with variable job destruction rates, since its objective is to make job destruction more difficult for the firm, with the objective of securing a longer-lasting employment spell for the worker.

### VIII. Employment Protection Legislation

Although all advanced countries exercise some kind of employment protection, there are large variations in the type of restrictions implemented, and there are also big differences in their severity across countries (see Per Skedinger 2010 for a full analysis). At the risk of oversimplifying, we know from the OECD that the southern European countries have much stricter employment protection legislation than the northern countries, and especially than the United States and United Kingdom (OECD 1999). I will discuss here the restrictions on dismissals that take the form of administrative procedures that cost the firm time and money. These can be represented in our models as a pure tax paid by the firm at the time of dismissal.<sup>9</sup>

<sup>9</sup>In the simple model there is no obvious benefit to the worker from these administrative restrictions on dismissal, other than saving some jobs from destruction. But in more general models with risk aversion these restrictions also can act as insurance against sudden income fluctuations, and these can be beneficial to the worker. The welfare implications of employment protection legislation would then be different in these models. See Pissarides (2010) for one such model.

A tax on dismissals reduces job separations. Some low-productivity jobs that would have been destroyed before the imposition of the tax will now not be destroyed, as the firm reduces its reservation productivity to reduce the chances that it might have to pay the tax. So one implication of employment protection legislation is that the size of the flow into unemployment is lower than otherwise; but average labor productivity is also lower and wages should also be lower to compensate the firm for the tax and the lower productivity.

Another important impact of employment protection legislation is on job creation. When the firm is creating a job it expects to have to pay the tax at some future date if it has to dismiss the worker. Job creation falls as a result, so just like the flow into unemployment, the flow out of unemployment at given unemployment also falls.

The net impact on unemployment depends on which flow falls more. If the flow into unemployment falls more than the flow out of unemployment, unemployment falls to compensate, and vice versa. Empirical work shows that the impact of employment protection legislation on unemployment is small and can go either way; but the size of the flows falls, there is less labor and job turnover, lower average labor productivity, and longer durations of both unemployment and employment (OECD 1999).

In extended versions of our models, with training, the longer durations of employment might encourage more training, as workers are more secure in their jobs and are more willing to undertake training that is specific to the needs of their firm. And in yet other extended versions with different kinds of workers, employment protection legislation tends to benefit primary workers, usually male workers over 25 years old, but hurts other workers, like women and youths, who go in and out of the labor force at more frequent intervals than prime-age males.

### **IX. Concluding Remarks: Where Do We Go Next?**

Search and matching theory has come a long way since the early 1980s, when the first equilibrium matching models appeared in the literature. A recent book by Brian and John McCall that surveys the economics of search is 550 pages long, and there was a second volume planned for the things left out (McCall and McCall 2008).

But there is still a lot to do. We have discovered, just as Sir John Hicks did in 1932, that the theory of wages is key to understanding the functioning of labor markets. Sir John described in detail how frictions in labor markets, mobility costs, and trade unions and other institutions influence wages, and how wages influence employment, very much along the lines that modern theory describes. But modern theory has still to explore more fully the role of institutions in its formal models, and this is an area of research that should attract a lot of attention in the future.

I have also argued that wage stickiness is as important an issue as it has ever been in macroeconomics. Markets with frictions open up many more possibilities for wage stickiness, and future research needs to explore these.

The financial crisis of 2008 has thrown open the question of the interaction between capital and labor markets. Equilibrium matching models are built on the assumption of perfect capital markets. The implied arbitrage equations under perfect foresight and unlimited borrowing and lending are used to calculate a value for jobs and workers. These are good starting assumptions, and they have yielded

important results. But future work needs to explore other assumptions about capital markets and integrate the financial sector with the labor market. This might suggest another amplification mechanism for shocks, independent from wage stickiness or fixed costs.

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