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UNEMPLOYMENT AND VACANCIES

by

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Abstract: How can vacancy statistics be used to measure friction in job matching and the effects of friction on unemployment? First, measure deviations from instantaneous hirings by the average duration of recruitment as measured by the number of job vacancies divided by the number of hirings per month. Second, measure direct effects of recruitment times on employment by measuring unfilled jobs, defined as unoccupied job vacancies which are available immediately. Third, measure indirect effects of recruitment times on employment by estimating first the effect of recruitment times on product prices and then the effect of a price change on sales, production and employment. Fourth, measure 'search ineffectiveness' with potential effects on the NAIRU by the rate of unfilled jobs.

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1. Introduction

Information on job vacancies has been used increasingly in economics to explain unemployment; see in particular Pissarides (1986), Jackman, Layard, and Pissarides (1989), Pissarides (1990, 2000) and Layard, Nickell, and Jackman (1991). The key concept in this literature is the hiring function, which relates hirings to job vacancies and unemployment. And the hiring function is closely related to the 'flow approach' to unemployment.

Since the rate of unemployment as a proportion of employment is equal to the inflow rate divided by the outflow rate in a steady state, unemployment in a steady state can be explained, as a first step, by explaining the rates into and out of unemployment. And when persistent high unemployment is associated with a decline in the outflow rate, the next step is to explain a decline in hirings of unemployed by a shift of the hiring function.

The hiring function or, synonymously, the matching function, has been interpreted and estimated as a (Cobb-Douglas) production function, with stocks of vacancies and unemployment as inputs and the number of hirings per period as output, first by Pissarides (1986), Blanchard and Diamond (1989), and Layard et al. (1991), and then by many others, as the comprehensive survey by Petrongolo and Pissarides (2001) shows. Matching technologies of this form have been motivated by urn models in probability theory, where firms play the role of urns and workers the role of randomly chosen balls. But when summarizing the microfoundations behind the matching function, Petrongolo and Pissarides (2001 p. 6) conclude that: "although there are several microeconomic models that can be used to justify the existence of an aggregate matching function, none commands universal support".

In fact, as I will argue in this paper, the matching function is a misleading relation. The stock of job vacancies is not a determinant of hirings. Instead the flow of hirings is a determinant of job vacancies. A firm decides first on hirings and then on how these hirings are to be realized.

Hirings are determined by firms' decisions to expand or reduce employment and their need to replace workers who, for various reasons, are leaving the firm. Hirings are then realized instantaneously whenever possible, for instance by recall of former employees during an upswing, so many (perhaps most) hirings are *not* preceded by job vacancies as measured at employment services or in business surveys. This means that the relation between hirings, vacancies and unemployment should not be interpreted as a hiring function, with hirings as the dependent variable, but as a *vacancy function*, which explains job vacancies as a function

of its basic determinants, namely hirings, the proportion of these hirings which cannot be realized instantaneously, and the average duration of job vacancies.

Moreover, relating unemployment to its flow rates is certainly an illuminating *decomposition* of the stock of unemployment. It explains, in particular, the *distribution* of unemployment between flow and duration and hence also between short-term and long-term unemployment. But it does not explain the *size* of unemployment. The stock of unemployment is determined as a residual, more precisely as the difference between labour force and employment. Hence the stock of unemployment is not determined by, but is a *restriction on*, the flow rates.[1]

Thus, the point of departure in this paper is that friction in job matching does not raise unemployment by reducing hirings but by reducing employment. But exactly how can vacancy statistics be used to define and measure 'friction' and its impact on employment?

Note first that vacancies only relate to one aspect of friction, namely deviations from instantaneous hirings. There can be friction even when hirings are instantaneous, but this case is covered by the dynamic theory of labour demand, which shows how a firm's employment decisions depend not only on current prices and wages but also on its initial workforce and, in particular, adjustment costs and expectations of market conditions in the future.[2] If, for example, a firm expects an increase in the demand for its products to be only temporary, it will not necessarily increase its employment, due to costs of hiring and firing.

It follows that a theory of vacancies must show, first, how deviations from instantaneous hirings add to friction and, second, how these additions to friction affect employment.

If all hirings were instantaneous there would be no vacancies as measured in vacancy surveys. We can consequently interpret the number of vacancies as a summary measure of friction in terms of deviations from instantaneous hirings. In fact, the vacancy rate was suggested as a measure of friction already in the seminal paper by Dow and Dicks-Mireaux (1958 p. 3), where a declining vacancy rate was interpreted as a fall in labour maladjustment.

Of course, controlling for hirings is preferable whenever information on hirings is available, since a high job vacancy rate may also be due to a rise in job turnover or job reallocation, as emphasized by, for instance, Thomson (1966 p. 191), Abraham (1987), and Blanchard and Diamond (1989). In fact, dividing the number of job vacancies by the number

[1] The idea that unemployment in a stationary state is determined by its flow rates relies on the assumption that transitions between employed, unemployed, and others follow a Markov process with constant transition rates, an assumption which, however, "is rarely checked", as noted by Devine and Kiefer (1991 p. 308).
[2] See, in particular, Nickell (1986) and Hamermesh (1993 ch. 6).

of hirings per month we obtain a more precise measure of friction, namely the average duration of recruitment. But how will recruitment times affect employment?

First, the matching of workers and jobs takes time which adds directly to unemployment, as suggested by almost every introductory text in macroeconomics or labour economics. More precisely, the time it takes to recruit workers may add to unemployment by making the number of employees less than the number of jobs. And the difference is the number of *unfilled jobs*. But these direct effects of recruitment times on employment can only be identified by extending a traditional vacancy survey to include not only job vacancies but also unfilled jobs. Such a survey is also presented in this paper, suggesting that about 40 per cent of job vacancies are unfilled jobs, and that the rate of unfilled jobs varies around 0.6 per cent of employment, at least in Sweden since 2000.

Second, longer recruitment times may also reduce employment by raising recruitment costs. In this paper such indirect effects are analysed by extending previous models in Nickell (1986) and Pissarides (1990) to include price formation and the distinction between vacancy costs and hiring costs. I find that longer recruitment times reduce employment if they raise recruitment costs so much that sales, and hence also production and employment, are reduced by higher prices. I also find that the effect of recruitment times on employment does not depend on the size of all recruitment costs but only on vacancy costs as defined more precisely in Section 6. Note that we in this paper study the effect of recruitment costs on employment in a steady state, not the effect of recruitment costs as adjustment costs when firms contemplate changes in employment, as in the dynamic theory of labour demand.

Third, recruitment problems may reduce employment by increasing excess demand and hence also wage inflation and 'frictional' unemployment, as in classical literature, including Thirlwall (1969) and Hansen (1970), or by raising 'search ineffectiveness' and hence also wage pressure and the NAIRU, as in Layard et al. (1991). I find that the rate of unfilled jobs is a direct measure of 'search ineffectiveness' and consequently also important to measure during periods of high unemployment.

Thus, this paper offers a new approach to the use of vacancy statistics in measuring effects of friction in job matching on unemployment. And it is new in several respects. First, it argues that friction in job matching affects unemployment by affecting employment, not by affecting hirings and the duration of unemployment. Second, it argues that job vacancies depend on hirings, not hirings on job vacancies. Third, it updates traditional models of labour demand with price formation and argues that traditional models are incomplete without this update. Fourth, extending the updated model of labour demand with recruitment costs it shows how

recruitment costs affect labour demand as compared to all other determinants of employment in a firm. Fifth, it shows how recruitment times affect employment through vacancy costs, and it shows what constitutes vacancy costs as distinct from other recruitment costs. Sixth, it argues that the definition and measurement of vacancies is problematic because the term is ambiguous. In fact, firms create 'vacancies' in one sense (recruitment processes) in order to avoid 'vacancies' in another sense (unfilled jobs). And it is only the rate of unfilled jobs which is a measure of unsatisfied labour demand, corresponding to the traditional measure of unsatisfied labour supply (the unemployment rate). Seventh, it presents a new business survey which measures not only job vacancies but also unfilled jobs. Eighth, it argues that the rate of unfilled jobs shows how recruitment problems reduces employment directly by making the number of employed less than the number of jobs. Ninth, it argues that the rate of unfilled jobs is a relevant measure of 'search ineffectiveness', which may reduce employment indirectly by raising the NAIRU.

The paper is organized as follows. Job vacancies are defined and related to hirings in Section 2, observing that there are hirings without vacancies (probably many) as well as vacancies without hirings (probably few). Section 2 also introduces the vacancy function. In Section 3 measures of friction, including not only the rate of job vacancies but also the average duration of recruitment and the proportion of instantaneous hirings, are illustrated with data from a new vacancy survey in Sweden. The problem of defining and measuring unfilled jobs is tackled in Section 4 (and Appendix 1). To be able to see how much recruitment costs matter compared to all other determinants of employment in a firm, I extend traditional models of labour demand to include price formation in Section 5, before indirect effects of longer recruitment times on employment through vacancy costs are studied in Section 6. Indirect effects of longer recruitment times through higher wage pressure are then discussed in Section 7, and conclusions are listed in Section 8.

2. Hirings and vacancies

Some hirings are made more or less directly, for example by recalling workers previously laid off or by offering jobs to spontaneous job applicants. In other cases there is no existing pool of job applicants which a firm can turn to. Instead the firm has to attract job applicants by advertising its demand for personnel in newspapers or other media, by placing job orders with a public or private employment agency, or by contacting potential candidates directly. And then vacancies understood as 'recruitment processes' arise, as discussed in, e.g., van Ours and Ridder (1992) and Burdett and Cunningham (1998).

More precisely, a *job vacancy* begins when a firm starts to recruit a worker and it ends when a worker offered the job accepts it (or when recruiting is discontinued for other reasons). This is also the usual definition in vacancy surveys, including all the surveys discussed in NBER (1966), Muysken (1994), and Verhage et al. (1997).

2.1 Hirings without vacancies

Can we assume that every hiring begins with a job vacancy? This assumption is implicitly made when attempts are made to estimate the total number of job vacancies (V) from the total number of hirings per period (H) and the average duration of job vacancies (T) for some part of the economy according to the formula

(1) $$V = HT,$$

as in, for instance, Abraham (1983) and Jackman et al. (1989). In this context the assumption is true by definition. But in general it may be difficult to define and measure job vacancies for some types of hirings.

Suppose, for example, that a firm is so big that it has to hire 10 workers per month to replace a constant flow of 10 separations per month, and that each month the firm hires those ten applicants who contact the firm first (assuming they are properly qualified). Then it may be difficult for the firm to say when it started to recruit a particular worker, since it always has some recruitment activities going on. In other words, the firm may find it difficult to specify the number of 'job vacancies' it has on a particular day, but easy to specify the number of hirings per month.

Moreover, some hirings may occur without any preceding recruitment activities at all, for example, when a job applicant contacts an employer who then decides to hire. In this case one might say that 'supply creates its own demand' when a properly qualified person turns up. And then there is no job vacancy (recruitment process) which precedes hiring.

Note also that even if a recruitment process precedes a hiring, it can sometimes be so short that the distinction between the recruitment process and the hiring is negligible. Examples include recalls by phone calls of former employees, or selection of casual labourers in a hiring hall at the beginning of a day. And in surveys on job vacancies firms may not consider recalls to be recruitment, even if the time between job offer and acceptance is long, unless instructed to do so.

Hirings with non-existent or negligible recruitment processes before hiring may be called *instantaneous hirings*, with recalls of former employees being perhaps the most important example. Information on such hirings is scarce. But what information there is does suggest

that not every hiring begins with a job vacancy. Consider, for instance, the Employment Opportunity Pilot Project (EOPP) surveys in the United States in 1980 and 1982.[3] In these surveys employers were asked questions about the hiring process for the most recent newly hired person. And in the first survey 28 percent responded that they did not recruit for the position.

In general we consequently have

$$V = bHT, \tag{2}$$

where b denotes the proportion of hirings preceded by job vacancies. And this formula can be used to estimate the proportion of instantaneous hirings $(1 - b)$ in a labour market, provided, of course, that we have information on not only H and T but also V (as in Section 3).

Note that, since flows are large compared to stocks for vacancies, equation (2) applies not only to a steady state but also to quarterly statistics. More precisely, the stock of vacancies is approximately determined by the inflow of vacancies during the past quarter and the average duration of vacancies during the past quarter according to the standard formula for flow equilibrium.

2.2 Vacancies without hirings

Equation (2) presupposes that all vacancies end in hiring, so that bH measures the inflow of job vacancies. But job vacancies can be cancelled by firms before hiring. This can happen simply because the situation has changed, so that the firms no longer want to recruit new personnel, or because firms having difficulties in forecasting their labour demand realize that they have exaggerated their needs.[4] Or some job vacancies may be cancelled because firms realize that no recruitment is possible at the moment and that they have to solve their staffing problems by other means, for instance reorganization and training followed by posting job vacancies which are easier to fill.

Information on cancelled job vacancies is scarce, particularly on firms' *reasons* for cancelling job vacancies. But some sample surveys by the Public Employment Service in Sweden in the beginning of the 1990's suggest that the proportion of job vacancies which end in hiring is very high, and *at least* equal to 90 percent.[5] Results by van Ours and Ridder (1992 p. 145) suggest the same thing.

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[3] Results from the first wave are reported in Barron, Bishop and Dunkelberg (1985) and results from the second wave in Barron and Bishop (1985).
[4] As emphasized by, for instance, Thomson (1966 p. 177).
[5] According to Falk (1996).

Thus, on one hand, it seems to be approximately true that all job vacancies (sooner or later) end in hiring. On the other hand, more information is needed, either to corroborate this assumption, which is in stark contrast to the fact that usually almost half of the unemployment spells end without hiring, or to throw light upon another important aspect of friction.

2.3 The vacancy function

Equation (1) was originally used to *estimate* the stock of job vacancies, using the flow of hirings as a measure of the inflow of job vacancies. However, I will use this equation, or more generally equation (2), to *explain* the stock of vacancies, starting from the flow of hirings as a measure of firms' *hiring decisions*. And I will refer to (2) as the *vacancy function*.

A firm decides to hire workers starting from its desired net change of employment and its need to replace workers who, for various reasons, are leaving the firm. Some of these decisions are followed (almost) instantaneously by hirings (like recalls of former employees), but other hirings are preceded by non-negligible recruitment processes, that is, by job vacancies as measured at employment agencies or in business surveys. The stock of job vacancies is consequently determined by the inflow of job vacancies and the average duration of these vacancies, while the inflow of job vacancies is determined by the inflow of hiring decisions and the proportion of these decisions which are followed by job vacancies. And the flow of hiring decisions is measured by the flow of hirings, since many (perhaps most) hirings are instantaneous and most job vacancies end in hiring.

On the other hand, equation (2) is a relation between hirings and job vacancies which also can be written as

(3) $$H = qV \text{ , where } q = 1/bT \text{ .}$$

Introducing in addition the assumption that q depends on the tightness of the labour market as measured by the ratio of vacancies to unemployment, $q = q(V/U)$, as well as a log-linear approximation, $q = c(U/V)^{\alpha}$, we obtain the relation

(4) $$H = h(V,U) = Vq(V/U) = cV^{1-\alpha}U^{\alpha} \text{ ,}$$

suggesting that a Cobb-Douglas specification with constant returns to scale should be successful when regressing hirings on vacancies and unemployment, as indeed it is.[6]

It is tempting to interpret (3) as a causal relationship between job vacancies and hirings, based on the assumption that the flow of a firm's hirings is proportional to its recruitment

[6] See, in particular, the survey by Petrongolo and Pissarides (2001).

efforts as measured by its stock of vacancies. And (4) has also been interpreted as a 'matching function' or 'hiring function', showing how vacancies and unemployment as 'inputs' give rise to 'output' in the form of hirings.[7] But such an interpretation is misleading.

First, many hirings are instantaneous, that is, not preceded by job vacancies, so many hirings do not involve job vacancies at all. Second, the stock of job vacancies is a poor measure of recruitment efforts. In fact, more intensive or costly efforts should reduce the duration of recruitment and thus reduce the stock of job vacancies. Third, increasing the number of job vacancies reported to an employment agency above the number of genuine vacancies may perhaps increase the number of job applicants but will not necessarily raise the number of a firm's hirings.[8]

More precisely, a firm decides first on hirings and then on how these hirings should be realized. A firm's hirings are determined not by (3) but by its change of employment (ΔN) and its replacement of separations (S) according to

$$H = \Delta N + S \,. \tag{5}$$

Separations may consist of redundancies, terminations of temporary jobs or quits (including retirements and job-to-job quits). Adjustment of employment (ΔN) is determined not only by the development of basic factors such as prices and wages, as well as product demand and labour productivity, but also by adjustment costs, which may, for instance, reduce ΔN when a firm expects an increase in product demand to be only temporary. And in the short run employment may fluctuate because of seasonal work or other temporary work, including hiring of substitutes for absent employees. Note also that most hirings are temporary, at least in Sweden, according to Table 1 in Appendix 2.

Hirings are realized instantaneously whenever possible, for instance recall of former employees during an upswing or hiring of spontaneous job applicants. Otherwise recruitment may be more or less time-consuming and costly, depending on type of work (blue-collar or white-collar, temporary or permanent) and method of recruitment (advertising or headhunting). But how can such recruitment problems be measured and exactly how can they affect employment?

[7] See, for example, Pissarides (2000) and Petrongolo and Pissarides (2001).
[8] Layard et al. (1991 p. 273) also argue that a firm's job vacancies "must be genuine", since otherwise "its future advertisements would carry little conviction".

3. Three measures of deviations from instantaneous hirings

This section surveys three measures of friction, namely the rate of job vacancies, the average duration of recruitment and the proportion of non-instantaneous hirings, and illustrates these measures with data from a new business survey on job vacancies in Sweden. This survey started in July 2000 and covers not only the private but also the public sector since January 2001. It is mandatory since July 2003.

If all hirings were instantaneous there would be no vacancies as measured in vacancy surveys. We can consequently interpret the number of vacancies as a summary measure of friction in terms of deviations from instantaneous hirings. And the vacancy rate is closely related to the *UV* curve, which is the classical point of departure for analysis of friction in the labour market.

3.1 The vacancy rate and the UV curve

Movements of the *UV* point in a *UV* diagram are easy to explain starting from the vacancy equation (2), which says that the stock of vacancies is proportional to the flow of hirings.

As aggregate demand increases, hirings and vacancies will increase as employment (N) increases and unemployment falls, which implies a negative relationship between unemployment and vacancies. More precisely, substituting (5) into (2) we obtain

$$V = bT(S + \Delta N), \tag{6}$$

where ΔN is positive during an upswing, when unemployment decreases, and negative during a downswing. Thus, during a business cycle the *UV* point moves around an equilibrium locus, called the *UV* (or Beveridge) curve, here defined by the equation

$$V = bTS, \tag{7}$$

where, in general, not only T but also b and S depend on unemployment.

In the *UV* literature the traditional equation for the *UV* curve is

$$h(U,V) = I_u, \tag{8}$$

where $h(\cdot)$ is the hiring function and I_u the unemployment inflow. Its derivation presupposes not only the hiring function but also flow equilibrium for unemployment and equality between the flow of hirings and the unemployment outflow. None of these assumptions is necessary for the validity of the *UV* curve according to (7). Note also that $S \neq I_u$ for two reasons. First, S includes all separations, that is not only separations to unemployment but also, for instance, job-to-job quits. Second, in practice an important part of the unemployment inflow comes

from out of the labour force (namely many new entrants and re-entrants) and is thus not part of the flow of separations.

Large shifts of the *UV* curve have often been interpreted as a decline in search effectiveness of the unemployed with large effects on unemployment.[9] But note that an unchanged vacancy rate when unemployment increases does not necessarily suggest a decline in search effectiveness, since many hirings (for instance to white-collar jobs) may be preceded by recruitment processes with a predetermined length for advertising, interviewing and selection, independent of the state of the labour market. On the other hand, more vacancies at an unchanged unemployment rate do suggest a decline in search effectiveness – or a rise in job turnover or job reallocation.

3.2 The average duration of recruitment

Thus, controlling for hirings is preferable whenever information on hirings is available. In fact, dividing the number of job vacancies (V) by the number of hirings per period (H), we obtain a more precise measure of search effectiveness, namely the average duration of recruitment.

Table 1 in Appendix 2 reports hirings, job vacancies and average recruitment times in Sweden since 2000. It confirms what seems to be a stylized fact, namely that the average completed duration of a job vacancy is in most cases under a month.[10]

3.3 The proportion of non-instantaneous hirings

Note, however, that V/H is a measure of the average duration of all 'job vacancies', including 'vacancies with negligible duration', like recalls by phone calls of former employees. Since such vacancies are not usually measured in vacancy surveys, it is more accurate to say that V/H equals the average duration of job vacancies (T) multiplied by the proportion of non-instantaneous hirings (b), according to (2).

If, for instance, a separate sample survey on vacancy durations shows that the average spell of a (completed) job vacancy is 3 months, then the proportion of non-instantaneous hirings is 1/3 if V/H is equal to one month and 1/6 if V/H is equal to half a month. These examples suggest that instantaneous hirings may be quite common. And perhaps they are

[9] See, for instance, Layard et al. (1991 p. 220): "In a world where economists have little certain knowledge, the shift of the *U/V* curve provides us with vital clues to the sources of the rise in unemployment. Large shifts indicate that a major part of the rise is due to changed behaviour of workers and employers in the filling of vacancies."

[10] See, for instance, Petrongolo and Pissarides (2001 p. 421).

especially common among hirings to temporary employment, which, according to Table 1 in Appendix 2, dominate the flow of hirings.

It follows that instantaneous hirings may be so prevalent that information on them should be an important part of recruitment statistics. And a complementary sample survey on the duration of job vacancies would give not only valuable information on the duration of job vacancies – as distinct from the duration of recruitment – but also a possibility to estimate the proportion of instantaneous hirings from equation (2).

4. Direct effects of recruitment times on employment

Firms' recruitment problems may be expected to depend on labour supply, search intensity, and institutional designs. This dependence can be clarified, as a first step, by estimating the average duration of recruitment as a function of unemployment and other potentially important variables, including, for instance, long-term unemployment and unemployment benefits. But exactly how will deviations from instantaneous hirings affect employment?

As emphasized by Holt and David (1966 p. 82), firms create vacancies in anticipation of future needs. If, for instance, a separation can be anticipated and a replacement made before the separation, then replacement is instantaneous even if recruitment is not. But otherwise an *unfilled job* exists from the day the employer wants the worker to start to the day the worker starts. An unfilled job can consequently be interpreted as an *unplanned dip in employment*.

The number of unfilled jobs is a measure of the direct effect of recruitment problems on employment. More precisely, the time it takes to recruit workers may reduce employment by making the number of filled jobs (employees) less than the number of jobs. And the difference is the number of unfilled jobs.

It is sometimes assumed (for simplicity in theoretical models) that every separation gives rise to an unfilled job, or that firms have to create unfilled jobs in order to recruit workers.[11] But, as noted above, many separations are anticipated and replacements made before the corresponding jobs become unfilled. This applies particularly to large firms.[12]

In fact, according to the Swedish vacancy survey, which measures not only job vacancies but also unfilled jobs, only about 40 per cent of job vacancies are unfilled jobs, as shown by Table 2 in Appendix 2.

On the other hand, since 2000 the rate of unfilled jobs has averaged 0.6 per cent of employment in the private sector in Sweden. Thus, merely the time it takes to recruit workers

[11] See, for instance, Pissarides (2000 p. 5), where it is assumed that 'only vacant jobs can engage in trade'.
[12] As emphasized, for instance, by van Ours and Ridder (1992 p. 140).

reduces employment by creating a gap between jobs and employment of about 0.6 per cent of employment on the average.

4.1 Defining and measuring unfilled jobs

Unfilled jobs are defined more precisely as *unoccupied job vacancies which are available immediately* in the Swedish vacancy survey. This is a definition which excludes occupied job vacancies and job vacancies to be filled later, in the same way as the definition of unemployed workers in labour force surveys excludes job seekers with a job and job seekers without a job who cannot start work until later.

In the Swedish vacancy survey unmet demand (unfilled jobs) is measured indirectly, as unmet supply (unemployed workers) is measured in labour force surveys, by a succession of questions, as the questionnaire in Appendix 1 shows. More precisely, unfilled jobs are defined as a subset of job vacancies obtained by eliminating first 'occupied job vacancies' and then 'unoccupied job vacancies which are unoccupied because no work is wanted by the employer until later'.

'Occupied job vacancies' exist when, during recruitment of new workers, the corresponding jobs are occupied by retiring workers or substitutes until replacements or permanent personnel have been hired. Job vacancies which are occupied by retiring workers reflect employers' ability to anticipate their need for new hires and certainly not 'unsatisfied labour demand'. But job vacancies occupied by *substitutes* cannot represent completely satisfied labour demand, since the firms would not be recruiting new personnel if they did. On the other hand, workers with temporary employment who are looking for new jobs are not classified as unemployed, so a measure of unmet demand which corresponds to the usual measure of unmet supply should not include job vacancies occupied by substitutes.[13]

4.2 The rate of job vacancies as an indicator of the rate of unfilled jobs

The rate of job vacancies has traditionally been used not only as a leading indicator of changes in employment but also as an (ordinal) indicator of labour shortage (unmet demand). The basic idea seems to be that a higher job vacancy rate reflects longer recruitment times, and that longer recruitment times reflect more recruitment problems, including more severe labour shortage. But there are several objections to this argument.

[13] The problem of defining and measuring unfilled jobs is discussed in more detail in Appendix 1.

First, variations of the job vacancy rate over the business cycle are determined above all by variations in the inflow of job vacancies. Thus, as an indicator of recruitment times the job vacancy rate is not comparable across phases of the business cycle: a doubling of the job vacancy rate during a boom does not necessarily indicate a doubling of recruitment times.

Second, controlling for the phase of the business cycle is not enough. For example, an outward shift of the Beveridge curve, that is, more job vacancies at a given unemployment rate, is not necessarily due to longer recruitment times. For a high job vacancy rate may also be due to a rise in job turnover or job reallocation. Thus, as an indicator of recruitment times the job vacancy rate is not comparable across labour markets (including countries) with different turnover rates etc.

Third, the relation between recruitment times and labour shortages is not necessarily close. Of course, longer recruitment times may, *if they are unanticipated*, increase the risk of not succeeding in hiring new workers in time to replace separations or expand employment according to plan. But when a firm can anticipate its need for new hires, it can also reduce the risk for unmet demand by starting to recruit earlier. In other words, labour shortages can often be reduced by more active recruiting, that is, by more job vacancies. And then the job vacancy rate should be interpreted as an indicator of search intensity, not as a measure of labour shortage. For instance, more active search for job applicants, as reflected by a rise in the rate of job vacancies due to longer recruitment times caused by starting recruitment earlier, may lead to less severe labour shortages, as measured by a fall in the rate of unfilled jobs.

4.3 Interpretation of vacancies in vacancy surveys

The definition and measurement of vacancies is problematic not least because the term is ambiguous, both in the economics literature and in everyday language. In fact, firms create ‘vacancies’ in one sense (recruitment processes) in order to avoid ‘vacancies’ in another sense (unfilled jobs). And this ambiguity has important consequences.

First, one should always check carefully exactly what is measured in a particular vacancy survey. Is a vacancy defined as a job vacancy (recruitment process) or an unfilled job (unmet demand) or something in between? And if vacancies are defined as unfilled jobs, how are they measured in the questionnaire: by a single question accompanied by a definition (which may be more or less complex) or a succession of questions? For example, is it really unmet labour

demand which is measured in the US by JOLTS, as stated by BLS?[14] If it is, there is an important difference between the rate of unmet labour demand in the US (about 2.5 %) and Sweden (about 0.6 %). Second, the best way to make it quite clear what is measured in a vacancy survey is probably to measure both job vacancies and unfilled jobs.

5. Labour demand without friction

We have seen that longer recruitment times may reduce employment directly by increasing the extent of *unplanned* reductions in employment (unfilled jobs). But longer recruitment times may also reduce a firm's employment indirectly through higher recruitment costs followed by *planned* reductions in employment.

But exactly how much will recruitment costs matter for employment compared to other determinants of employment in a firm? To answer this question I shall begin by clarifying the determinants of a firm's labour demand when there is no friction.

Now, the most well-known and widely used proposition in this field is that a competitive firm in the short run, when the capital stock is given, chooses its level of employment by setting the value of the marginal product equal to the wage,

$$pF'(N) = w \text{ if } F'' < 0, \tag{9}$$

where N denotes employment (in hours), w the nominal wage, p the product price, and F the production function. And the corresponding result for a non-competitive firm is

$$(1 - 1/\eta)pF'(N) = w \text{ if } F'' < 0, \tag{10}$$

where η denotes the price elasticity of the firm´s product demand.[15]

The outcome of this traditional approach to labour demand is microeconomic labour-demand relations where labour demand is represented as a function of the real wage. Such relations can be influenced by the level of product demand only if the level of product demand affects the marginal product of labour or, with imperfect competition, the mark-up on marginal cost. It consequently appears as if labour demand only indirectly depends on the level of product demand, which makes it difficult to explain the transmission of product-demand shocks to the labour market, as emphasized, for instance, by Lindbeck (1998).

However, as emphasized by Layard et al. (1991 p. 341), equation (10) is an equilibrium relationship: "It is not a labour demand function because prices are chosen jointly with

[14] See, for example, Clark and Hyson (2001 p. 32). However, news releases from JOLTS no longer state that "job openings are a measure of unmet labor demand and can be compared with unemployment" as, for instance, the news release for July 2002 did.

[15] See, for instance, Hamermesh (1993 p. 22) or Cahuc and Zylberberg (2004 p. 175).

employment". In this section I first explore the consequences of this fact, emphasizing that employment does depend directly on product demand. And then I show that employment depends directly on product demand even for a competitive firm.

Throughout this section I study labour demand as usually defined when there is no friction, that is, the relation between employment and wages on the assumption that firms can hire all the labour they want at a given wage rate, and that they can do so instantaneously and without hiring costs. I also assume that firms are free to adjust prices and employment to wages once wages have been set, with or without bargaining.

5.1 The labour-demand function of a non-competitive firm

We begin by rewriting (10) as

$$p = \mu w / F'(N), \tag{11}$$

where $\mu = 1/(1-1/\eta)$. This equation is valid even when the marginal product of labour is constant, $F'(N) = a$, in which case it is particularly clear that (10) should be interpreted not as a labour-demand function but as a *price equation*. Employment, on the other hand, is determined by

$$N = (1/a)\,D(\mu w/a) \text{ if } F'(N) = a, \tag{12}$$

and in general by the equation

$$F(N) = D\left(\mu w / F'(N)\right), \tag{13}$$

where $D(\cdot)$ is the firm's product-demand function.

Let us consider the firm's choice of price and employment somewhat more in detail. Suppose, for simplicity, that the marginal productivity is constant, $F'(N) = a$, up to a certain employment level equal to *K*, where it begins to fall. If in addition the fall in marginal productivity is very strong, output and employment cannot be much higher than *aK* and *K*, which consequently characterize the firm's *capacity* and *full-employment level*. This example is not only useful as a bench-mark but probably also rather realistic.[16]

To initiate sales the firm has to announce a price (in a market where buyers take prices as given). If the firm anticipates that product demand will be low in relation to its capacity, it will announce $p = \mu w/a$. This formula shows how the firm adjusts its price to changes in wages and productivity for a given mark-up, while the mark-up is adjusted by the firm

[16] See, for example, Layard et al. (1991 p. 340).

according to its perceptions of the price elasticity of product demand. And the firm adjusts its employment according to (12) as long as $D(\mu w/a) \leq aK$. Thus,

(14) $$p = \mu w/a \text{ and } N = (1/a)D(\mu w/a) \text{ if } D(\mu w/a) \leq aK .$$

If instead $D(\mu w/a) > aK$, price and employment are adjusted until the equations

(15) $$p = \mu w/F'(N),$$

(16) $$F(N) = D(p),$$

are satisfied. When the fall in marginal productivity is very strong for employment above *K*, employment is (approximately) equal to *K*, while the price is raised until (quantity) rationing has been eliminated, that is, until the price is (approximately) equal to the capacity-clearing price $D^{-1}(aK)$. In this case the firm's labour demand is (almost) completely inelastic so that, as a first approximation,

(17) $$p = D^{-1}(aK) \text{ and } N = K \text{ if } D(\mu w/a) > aK .$$

According to (17), variation in product demand will only affect prices but not employment in a boom, when capacity constraints are binding. This is, in general, only a first approximation. But it does represent the reasonable notion that a firm's employment can only increase marginally when its capacity has been reached. Formally, this marginal adjustment involves (10), but (10) only applies to a very small interval of employment, assuming that $F'(N)$ declines rapidly above the full-employment level *K*. And during this adjustment of employment the market price will also rise, according to (15) and (16).

We conclude that, as a first approximation, employment is *never* determined by (10), at least not directly. Employment is determined *indirectly* by (10) in a recession, since then (10) determines the product price, while employment is determined by the demand for the firm's product at this price and the firm's labour productivity, according to (14). And in a boom (10) has no effect at all on employment, since production and employment are restricted by the firm's capacity, according to (17).

Characterizing a firm's production function by two parameters, its labour productivity (*a*) and its full-employment level (*K*), greatly facilitates both the analysis and the intuition. As noted above this is probably also a very reasonable approximation, implying only that a firm's production and employment are restricted by its capacity in a boom and its sales at the chosen product price in a recession. Note, however, that this approximation captures all the basic determinants of employment *even if* $F''(N) < 0$ for every *N*. The fundamental problem with

(15) is not that it is wrong but that it only indirectly affects employment, through its effect on the product price, while the direct determinants of employment are incorporated in (16).

5.2 The labour-demand function of a competitive firm

These results for a non-competitive firm generalize easily to a competitive firm. Not only (10) but also (9) is an equilibrium relationship. In fact, price and employment of a firm in a competitive industry with *n* identical firms and a wage level equal to *w* are determined by the equations

(18) $$pF'(N) = w,$$

(19) $$nF(N) = D(p),$$

where $D(\cdot)$ is the industry's product-demand function and $F'' \leq 0$.

If the marginal productivity is constant, $F'(N) = a$, equation (18) leaves *N* indeterminate for every *p*, while it completely determines *p* as equal to marginal cost (w/a). And this happens if product demand is low, so that

(20) $$p = w/a \text{ and } N = (1/na)D(w/a) \text{ if } D(w/a) \leq naK.$$

In a recession production and employment will consequently be restricted by sales even in a competitive industry. This implies that an individual firm will also be restricted by sales, or more precisely by its market share, which in our simple example with identical firms is $1/n$. Note that this possibility is excluded *by assumption* in the traditional model of employment in a competitive firm in the short run.[17]

Moreover, capacity constraints ($F'' < 0$) will *raise* product prices (since $p = w/F'(N) > w/a$) but *reduce* the effect of wage changes on employment. In fact, as a first approximation,

(21) $$p = D^{-1}(naK) \text{ and } N = K \text{ if } D(w/a) > naK.$$

In a boom production and employment will consequently be restricted by capacity, and the market price will be the capacity-clearing price as soon as this is higher than marginal cost. And employment will be constant or only marginally effected by (18).

Since (18) is so firmly established in the literature, it is perhaps hard to accept that it determines employment in a competitive firm only partly and indirectly, through its

[17] Of course, since profits are negative for firms with fixed costs, some firms will exit the industry if the recession is sufficiently long, until 'normal' or at least some profits are restored by a capacity-clearing price above marginal cost.

determination of the market price in a recession. The marginal-productivity function is of course a basic determinant of employment in a firm. But it determines employment essentially through two parameters, namely its labour productivity (*a*) and its full-employment level (*K*). At least this is true as a first approximation. I have also argued that this first approximation is probably rather good, and it is certainly helpful for the intuition. But note that it is not crucial for my argument. Equation (18) is an incomplete model of employment in a competitive firm even if $F''(N) < 0$ for every *N*.

Note finally that we can include other variable costs than wages in the model by assuming that they are proportional to employment and equal to cN. By substituting $w+c$ for *w* in the formulas above we can then see how employment depends on not only wages but also other variable costs of production.

Note also that, apart from the mark-up, my results are the same for a competitive and a non-competitive firm. This is because I have relaxed an implicit assumption of the traditional model of a competitive market, namely that a price-taking firm can never be restricted by what it can sell. The necessity to relax this assumption is most obvious with constant returns, when production must be restricted by sales in the firm's industry and hence also in the industry's firms.

Thus, employment is indeed affected by (18) over a certain range of employment, but when (18) applies it is probably also so that the main effect of higher wages is higher prices. My analysis also predicts that a firm's decisions on production and employment in practice are based on its market share in a recession and its capacity in a boom and not on a slowly decreasing marginal productivity function.

6. Indirect effects of recruitment times on employment through recruitment costs

Now, introducing recruitment the flow of profits for a competitive firm in a steady state is

$$\pi = pF(N) - wN - cN - \alpha H - \gamma V , \tag{22}$$

where p denotes the product price, *F* the firm's production function, *N* its employment, *H* its number of hirings per period, and *V* its number of job vacancies. The wage level is denoted by *w*, other variable production costs are summarized by *c*, and recruitment costs are captured by the parameters α, as in Nickell (1986), and γ, as in Pissarides (1990).

Recruitment costs are in general composed of both *hiring costs* (α per hiring) and *vacancy costs* (γ per vacancy and period). We incorporate both hiring costs and vacancy

costs in the model because, as we shall see below, not only the size but also the structure of recruitment costs matter.

6.1 Employment

In a steady state we have $H = sN$, where *s* denotes the separation rate, and substituting this expression and $V = bHT = bTsN$ into (22) we obtain

(23) $$\pi = pF(N) - wN - cN - (\alpha + \gamma bT)sN \ .$$

Next we use the simple economic principles in Nickell (1986 p. 481) and argue as follows. According to (23) a unit increase in employment generates additional costs of $w + c + (\alpha + \gamma bT)s$ per period in equilibrium. But in order to obtain a new employee the firm also has to generate a vacancy for *bT* weeks (on the average). A unit increase in employment consequently also involves a once for all cost of $\alpha + \gamma bT$, or, equivalently, a flow cost of $r(\alpha + \gamma bT)$ per period, where *r* is the interest rate. It follows that

(24) $$pF'(N) = w + c + (r + s)(\alpha + \gamma bT)$$

in equilibrium for a profit-maximizing firm in a competitive market. Note that eq. (24) with $c = 0$, $\alpha = 0$, $b = 1$ and $T = 1/q$ reduces to the 'job condition' in Pissarides (1990 p. 23).

Pissarides (1990) assumes that the marginal product of labour is constant, and then it is particularly clear that equation (24) should be interpreted as a *price equation*. As emphasized by Pissarides elsewhere (in Pissarides 1984 p. 133), an equation like (24) with $F'(N) = a$ is basically a modification of the classical condition on wages under constant returns to scale. The marginal product of labour (*a*) exceeds the real wage (w/p) because firms need to cover their recruitment costs. And in equilibrium in a competitive market prices adjust to marginal costs, including recruitment costs.

If the marginal productivity is constant, $F'(N) = a$, equation (24) leaves *N* indeterminate for every *p*, while it completely determines *p*. In this case employment is completely determined by product demand according to

(25) $$F(N) = D(p)/n,$$

where $D(\cdot)$ is the product-demand function of the firm's industry and *n* is the number of firms, assuming (for simplicity) that all firms have the same market share. In general, however, employment and product price are determined simultaneously by (24) and (25).

Next we assume (also for simplicity) that the marginal productivity is constant, $F'(N) = a$, up to a certain employment level equal to *K*, where it begins to fall. It follows that if product demand is low, so that $D(p^c) \leq naK$, where

$$p^c = \left(w + c + (r+s)(\alpha + \gamma bT)\right)/a, \tag{26}$$

then employment is determined by

$$N = (1/n)D(p^c)/a, \tag{27}$$

while, if product demand is high, so that $D(p^c) > naK$, capacity constraints ($F'' < 0$) will raise product prices above costs and reduce the sensitivity of employment to cost changes. Thus, higher recruitment costs reduce employment by reducing sales through higher prices, but only when capacity constraints are not binding. Note, in particular, that the magnitude of the effect of recruitment costs on employment depends on how important recruitment costs are for price setting and on the price elasticity of the industry's product-demand curve.

When calculating prices for a firm producing below capacity, it follows from (26) that recruitment costs as a proportion of (variable) production costs are given by

$$m = \frac{(r+s)(\alpha + \gamma bT)}{w + c}. \tag{28}$$

If, for example, $w = 1$ per month, $c = 0.5$ per month, $r = 0.25$ per cent per month, $s = 3$ per cent per month, $\alpha = 3$ per hire (including the cost of introduction and training of a new employee), $\gamma = 0.5$ per month, and $bT = 1$ month, then

$$m = \frac{(0.0025 + 0.03)(3 + 0.5)}{1 + 0.5} = 0.082. \tag{29}$$

When calculating the cost of a product, the firm will consequently apply a mark-up equal to 8.2 per cent to its costs of production in order to cover recruitment costs as well. And the contribution of the vacancy cost γ to this mark-up is 1.1 per cent.

Equation (28) shows what information is needed from firms in order to evaluate the effect of recruitment costs on output prices, and equation (27) shows how a price change will affect employment. Information on separations is available in official statistics, so we know that in the example above a separation rate of 36 per cent per year is a realistic average. Much less is known about the size and structure of recruitment costs,[18] and the values chosen above for hiring costs α and vacancy costs γ are merely theoretical examples. However, before asking

[18] For surveys of what *is* known se Nickell (1986) and Hamermesh (1993).

firms about these costs it is important to note that the effect of *recruitment times* on output prices does not depend on the size of all recruitment costs but only on vacancy costs. It consequently remains to see how vacancy costs differ from hiring costs.

6.2 The structure of recruitment costs

The structure of recruitment costs depends on the search strategy used by firms. This question has been addressed by, for instance, van Ours and Ridder (1992). Using vacancy data from the Netherlands they conclude that employer search is mostly non-sequential. Almost all applicants arrive during the first two weeks after the announcement of a vacancy, which suggests that resources spent on job advertising in most cases are concentrated to the beginning of the recruitment process. Hence these costs do not depend on the duration of the vacancy and are consequently *fixed* vacancy costs. The same is true if the firm is using a private employment agency and is paying the agency for its services per job match and not per week. Fixed vacancy costs only depend on hirings and can consequently be incorporated in hiring costs.

During recruitment of replacements firms sometimes experience unfilled jobs. Does this also mean that the (opportunity) cost per week of unfilled jobs should be included as vacancy costs which affect the price in (26)? The answer is 'no', for the following reasons.

Recruitment activities comprise efforts to attract job applicants followed by selection. Equation (22) does not model the choice between different methods of recruitment, only the effect on employment of choosing costly recruitment. But an implicit assumption of this model is, of course, that firms only use methods of recruitment which are consistent with profit-maximizing behaviour. And such methods cannot include unfilled jobs, since having unfilled jobs ('idle machines') does not in itself attract job applicants.

In fact, equation (22) already excludes unfilled jobs, because employment is assumed to be constant over time in (22). In other words, this section deals with the effect on employment of costly search on the simplifying assumption that firms completely control employment.

This may be a reasonable approach if unfilled jobs are rare and hard to predict, so that firms simply ignore them when prices are adjusted to recruitment costs. The approach may also be reasonable for employers who anticipate problems to keep employment constant, provided it also incorporates plans to use substitutes (including personnel from temporary work agencies) whenever substitutes are necessary during recruitment of replacements in order to avoid unfilled jobs. Of course, this also means that anticipated costs of the necessary substitutes must be added to vacancy costs. But note that only vacancy costs *above* the wage

level *w* can be included, since the term *wN* in (22) already includes the basic costs of having posts occupied.

Thus, since most recruitment costs appear to be fixed (independent of the length of a vacancy), recruitment times probably have a negligible impact on a firm's costs and hence also on prices, sales, production and employment, at least compared to all other determinants of a firm's employment, including hiring costs (which may be far from negligible, particularly in firms with a high turnover). A simple way of verifying – or refuting – this conjecture would be to ask employers how variation in recruitment times affects output prices.

7. Indirect effects of recruitment times on employment through wages

In classical literature on vacancies the key concept was the *UV* curve, which was introduced by Dow and Dicks-Mireaux (1958 p. 4-5) to construct an index of excess demand in the labour market.[19] Using this curve Thirlwall (1969) defined demand-deficient unemployment as that amount of unemployment which can be eliminated by increasing demand up to the point where the unemployment rate is equal to the vacancy rate. And since then remaining unemployment has often been called frictional or structural unemployment, depending on the explanation for having both unsatisfied labour demand (as measured by vacancies) and unsatisfied labour supply (as measured by unemployment) at the same time.

Of course equality between supply and demand in the labour market is a classical point of departure in economics, closely associated with the notion that wages are increasing with excess demand, decreasing with excess supply, and stable when demand equals supply. But Thirlwall (1969 p. 20) also argues that "if the demand for labour was strong enough almost all unemployment could probably be eliminated (as in war time) but only at the cost of substantial upward pressure on wages and prices", suggesting that the concept of frictional unemployment also relies on a definition of 'tolerable' inflation. And Hansen (1970 p. 23) argues that for wages to rise at the rate needed to keep inflation stable, the rate of vacancies may in practice have to be higher or lower than the rate of unemployment. (This might happen, for instance, if only an *ordinal* measure of unmet demand is available, like the rate of job vacancies instead of the rate of unfilled jobs.)

[19] The index is defined more precisely as the vacancy rate minus that unemployment rate on the associated *UV* curve for which the vacancy rate is equal to the unemployment rate (and not simply as the vacancy rate minus the unemployment rate).

In general the concept of 'frictional' unemployment consequently depends on 1) a target for wage inflation, 2) a stable relation between wage inflation and excess demand as measured by the difference between the vacancy rate and the unemployment rate (a wage equation), and 3) a stable relation between vacancies and unemployment (the equation of the *UV* curve). And this is essentially the same concept as 'equilibrium' unemployment in modern attempts to explain the persistence of high unemployment.

But wage inflation cannot be explained by excess demand when unemployment is high. Instead the basic idea in Layard et al. (1991) is that wage pressure builds up unless there is a sufficient excess supply of labour, and the basic variable determining wage inflation is consequently excess supply, or more precisely 'effective' excess supply, measured by cu, where c measures the 'search effectiveness' of the unemployed and u is the unemployment rate. (And since the vacancy rate v is small and relatively constant when unemployment is high, it can be omitted from the exact measure of 'effective' excess supply, which is $cu - v$.)

Thus, instead of excess demand it is the 'search effectiveness' of the unemployed which together with unemployment determines 'wage pressure' in Layard et al. (1991). Search effectiveness depends on time spent on search, number of job applications, willingness to change occupation or region, willingness to commute, and willingness to take a low-quality job, etc. And 'wage pressure' means firms bidding up wages against each other or workers pressing their wage claims, which depend on firms' chances of filling their vacancies or workers' chances of finding jobs.

Now, firms may be tempted to bid up wages against each other if hirings are non-instantaneous and job vacancies are difficult to fill. A measure of 'search ineffectiveness' which is relevant for wage pressure from firms is consequently a measure of deviations from instantaneous hirings, and in particular the rate of unfilled jobs. But even the rate of vacancies as usually measured in vacancy surveys (as recruitment processes) is a relevant measure of 'search ineffectiveness' as interpreted as recruitment problems which may trigger wage competition. Hence it is difficult to interpret an unchanged vacancy rate when unemployment rises as an indication of a decline in search effectiveness which increases wage pressure.

What about wage pressure from workers when unemployment is high? Can wage claims from workers increase as long-term unemployment grows and the search effectiveness of the long-term unemployed declines? Yes, but only if it leads to fewer qualified job applicants competing for work. Now, fewer job applicants also mean larger recruitment problems, so the rate of unfilled jobs is also a relevant measure of the wage pressure from workers. Workers or

unions will be hesitant to raise their wage claims as long as hirings are instantaneous or vacancies easy to fill.

I conclude, first, that vacancy statistics can provide direct measures of 'search ineffectiveness'. *Indirect* measures, like indices based on estimates of shifts of the *UV* curve or the hiring function, as in Layard at al. (1991), are not necessary. Second, vacancy statistics is important even during periods of high unemployment. If, for instance, the rate of unfilled jobs starts to rise when unemployment is high, it may be an indication of rising wage pressure (due to a decline in search effectiveness caused by long-term unemployment) which will make it difficult to raise demand and reduce unemployment without increasing inflation.

8. Conclusions

In spite of recent developments in vacancy statistics,[20] some basic facts on friction in job matching are still unknown, in particular the proportion of instantaneous hirings.

A summary measure of deviations from instantaneous hirings is the average recruitment time as measured by V/H , where *V* denotes the stock of job vacancies (defined as ongoing recruitment processes) and *H* is the flow of hirings. But this is an average which includes instantaneous hirings. Information on the proportion of instantaneous hirings presupposes measurement of not only job vacancies and hirings but also the average spell of a vacancy (*T*).

Suppose, for example, that *T* is equal to 3 months. Then the proportion of instantaneous hirings is about 80 per cent, according to equation (2), if the average recruitment time as measured by V/H is equal to 0.5 months, as it has been in Sweden in recent years. This suggests that the proportion of instantaneous hirings is relatively large or, alternatively, that positive recruitment times are relatively short.

Deviations from instantaneous hirings may increase the risk of *unfilled jobs*, which will reduce a firm's employment directly by creating a gap between the number of jobs and the number of employed. Results from a new vacancy survey, which measures not only job vacancies but also unfilled jobs, show that the rate of unfilled jobs has varied between 1.1 and 0.3 per cent of employment in the private sector in Sweden between 2000 and 2009.

Longer recruitment times may also reduce employment *indirectly*, either through higher wage pressure or through higher recruitment costs. Measurement of the first effect

[20] Today there are quarterly (or monthly) business surveys of vacancies not only in Australia (since 1983) and the Netherlands (since 1988), but also in, for example, Sweden (since July 2000), the US (since December 2000), and the UK (since September 2002). A process of developing business surveys on vacancies in all EU-countries was initiated by Eurostat in 2003 and reinforced by a regulation (453/2008) in 2008.

presupposes information on unfilled jobs, which reflect ‘search ineffectiveness’ with consequences for wage pressure. And measurement of the second effect presupposes information from firms on how longer recruitment times raise recruitment costs and thus also product prices, with negative effects on sales, production and employment.

The bottom line of this paper is that studies of how deviations from instantaneous hirings affect employment – and hence also unemployment – should be based on unfilled jobs, defined as unoccupied job vacancies which are available immediately. This is a definition which excludes occupied job vacancies and job vacancies to be filled later, in the same way as the definition of unemployed workers in labour force surveys excludes job seekers with a job and job seekers without a job who cannot start work until later.

Appendix 1. Defining and measuring unfilled jobs[21]

Firms create 'vacancies' in one sense (recruitment processes) in order to avoid 'vacancies' in another sense (unmet labour demand). To emphasize this distinction, vacancies as recruitment processes will be called *job openings* in this appendix, while vacancies as unmet labour demand will be called *unfilled jobs*.

But how should 'unfilled jobs' be defined more precisely to give an adequate measure of unmet labour demand? Four different definitions of unfilled jobs are discussed below, namely a *traditional definition* ('unoccupied job openings which are available immediately'); a definition which corresponds to the *ILO-definition* of unemployment; the *classical definition* ('unsatisfied labour demand'); and a definition suggested by *Eurostat* ('job openings which are available immediately'). We find that the first three of these definitions are almost equivalent. This equivalence is useful. For, as we shall see below, while in a given context one of these definitions may be easier to interpret, another may be easier to measure.

The problem of measuring unfilled jobs is addressed in Section 5, introducing a questionnaire designed to measure not only job openings but also unfilled jobs, while the problem of measuring characteristics of unfilled jobs is discussed in Section 6.

1. The traditional definition

As noted by Burdett and Cunningham (1998 p. 447) the definition of a vacancy commonly used in economics implies that 'a firm has a vacancy if it is looking for a worker to fill an existing opening' and this excludes 'firms looking to fill future openings'. A more elaborate formulation of this 'traditional' definition is used by Layard, Nickel, and Jackman (1991 p. 272), namely: 'a job that is currently vacant, available immediately and for which the firm has taken some specific recruiting action during the past four weeks.'

To clarify this definition even further we begin by noting that 'a job … for which the firm has taken some specific recruiting action during the past four weeks' is essentially the same as

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[21] The first version of this appendix was written as part of a project to develop a Swedish vacancy survey which began in 1999 and involved the Swedish National Labour Market Board (AMS), the Office of Labour Market Policy Evaluation (IFAU), the National Institute of Economic Research (KI), the Swedish Institute for Social Research (SOFI), and Statistics Sweden (SCB). The exposition draws on work done in a working party consisting of representatives of these institutes, including myself. I have also benefited from discussions (via e-mail) with Eivind Hoffmann and his detailed comments to earlier drafts; comments on earlier versions from Eskil Wadensjö (SOFI) and Alois Van Bastelaer (Eurostat); and comments from participants in a meeting at SCB in September 1999 and participants of seminars at SOFI in October 1999 and September 2000. A meeting in April 2000 with André Mares at CBS on the Dutch vacancy survey and a meeting in October 2002 with Kelly Clark at BLS on JOLTS were very informative. Discussions on job vacancy statistics at Eurostat meetings in May 2000, September 2001, November 2001, and January 2002 have also influenced the exposition.

a ‘job opening’ as defined above, that is, a job for which the employer is recruiting a new worker.

Next we observe that a job for which the employer is recruiting a new worker may still be occupied by a retiring worker who has not yet left the firm, or it may be temporarily occupied during the recruitment period by a substitute. In these cases an opening cannot be a vacancy according to the definition above, since it is not ‘currently vacant’. And by excluding these cases we define the remaining job openings as ‘currently vacant’ or ‘unoccupied’.

We finally note that for an ‘unoccupied job opening’ to be an ‘unfilled job’ it must also be ‘available immediately’. In other words, the unoccupied job opening must be a ‘current’ as opposed to a ‘future’ opening. For example, when a firm is recruiting people to a project in the future, the corresponding job openings change from future job openings to current job openings when the project begins.

To sum up this specification of the traditional definition in economics, vacancies as a measure of unmet demand are *unoccupied job openings which are available immediately*. This definition excludes occupied job openings and job openings to be filled later, in the same way as unmet supply (unemployment) excludes job seekers with a job (on-the-job search) and job seekers without a job who cannot start work until later.

2. The ILO-definition

Eivind Hoffmann has in Hoffmann (1999) proposed a definition of vacancies as unmet demand which corresponds to the well-known ILO-definition of unemployment. This definition, which for simplicity may be called the ILO-definition of vacancies, can be summarized as follows:

An employer has a vacancy if the employer:

1) would have hired a person to carry out some work if a suitable candidate had been available; and
2) would not have dismissed anyone as a consequence; and
3) a) has made efforts in the recent past to obtain job applicants, or
   b) is in the process of screening job applicants, or
   c) is waiting for a job applicant to accept a job offer, or
   d) is waiting for a job applicant who has accepted a job offer to start working.

The first condition in this definition can be interpreted as an alternative formulation of ‘available immediately’ in the traditional definition of vacancies as unmet demand, and corresponds to ‘available for work’ in the ILO-definition of unemployment.

The second condition corresponds to 'without a job' in the ILO-definition of unemployment. It can also be interpreted as an alternative formulation of 'currently vacant' in the traditional definition of vacancies. More precisely, instead of asking if an employer has 'a job which is available immediately and currently vacant', Hoffmann is asking if an employer 'would have hired someone if a suitable candidate had been available, and would not have dismissed anyone as a consequence'. In this way Hoffmann avoids referring to 'unfilled jobs'. He wants to do this because the concept of a 'currently vacant' or 'unfilled' job presupposes that there is a 'job' or 'post' which exists even when no person has been hired. This Hoffmann thinks 'is likely to be limited to large and/or bureaucratic organisations'.

Note that the second condition means that even the ILO-definition excludes job openings which are occupied during recruitment, assuming that retiring workers leave the firm soon after hiring of the workers who replace them, and that substitutes are dismissed soon after hiring of permanent personnel. In general, however, the ILO-definition does include some occupied job openings, namely job openings occupied by *internal* substitutes, since such substitutes would not leave the firm but return to their original jobs if the openings were filled.

Also note that condition 3.d is an extension of the traditional definition of unfilled jobs, since according to the traditional definition an unfilled job has to be a job opening, and a job opening is terminated when a job offer is accepted. Condition 3.d corresponds to the extended search condition in the ILO-definition of unemployment, which includes not only job seekers (corresponding to 3.a-c) but also persons who are waiting to start a new job (corresponding to 3.d).

We conclude that the difference between the ILO-definition and the traditional definition of unmet demand in general includes 'job openings occupied by internal substitutes' and the equivalent of 'persons who are waiting to start a new job' in the ILO-definition of unemployment, a component which may be called 'jobs which are waiting for a new employee to start'.[22]

3. The classical definition

In the classical literature on vacancies, including Dow and Dicks-Mireaux (1958) and Hansen (1970), vacancies were defined as 'unsatisfied labour demand'. Identifying 'satisfied labour demand' with employment, this approach suggests that vacancies can be defined *indirectly* as

[22] Note that the measurement of this component requires questions about not only 1) workers who have been hired but not yet started to work but also 2) cases where it is the employer and not the employee who is waiting, and 3) jobs which are not filled during the waiting time by substitutes.

that part of labour demand which is not employment, or as jobs which are not filled, provided, of course, that we don't define jobs as the sum of employment and vacancies.

The concept of a 'vacant job' can be associated with an 'idle machine', as suggested, for instance, by Pissarides (1985 p. 679). Thus, starting from a firm's number of 'idle machines', we can think of the firm's number of jobs as the number of 'idle machines' which the firm wants to be operated.

In general we can define the number of jobs in a firm on a certain day as the number of workers which the firm would have had employed on that day if there had been no recruitment problems, that is, if the firm had been able to recruit personnel (with proper qualifications at current wages) without waiting times. An unfilled job can then be interpreted as *an unplanned dip in employment* (if related to a separation) *or an unplanned delay in employment* (if related to an expansion), or *an employment level below plan* (if related to a more permanent labour shortage).

An equivalent definition is that the number of jobs in a firm with N workers is equal to D if the firm is ready to employ $D - N$ properly qualified persons if they turn up (without firing anyone as a consequence). This is essentially the same as the definition of 'established posts' in Layard et al. (1991 p. 273), where the number of 'established posts' in a firm is equal to M if the firm will 'advertise' $M - N$ jobs when it has N workers. And the definitions are exactly the same if we assume, as Layard et al. (1991 p. 273) do, that '(i)f a firm advertises y vacancies, it must be ready to employ y (properly qualified) people if they turn up'.

Since $D = N + V$ this definition implies that *a firm has V unfilled jobs if the number of employees would have been raised by V if there had been no recruitment problems*. And this is the same as saying: 1) that a firm is ready to employ V properly qualified persons if they turn up, and 2) that this would also raise employment by V persons. Note that these conditions are equivalent to conditions 1 and 2 of the ILO-definition. It follows that the ILO-definition and the classical definition are completely equivalent if we can assume that all unfilled jobs are associated with at least some recruitment efforts, so that condition 3 of the ILO-definition is satisfied.[23] Note, in particular, that both of these definitions include 'job openings occupied by internal substitutes' and 'jobs which are waiting for a new employee to start'.

[23] If this assumption is not true, then the classical definition also includes unfilled jobs for which no recruiting efforts have been made in the recent past, that is, 'hidden vacancies', corresponding to hidden unemployment in labour force surveys.

4. The Eurostat-definition

We have seen that in general both the ILO-definition and the classical definition include some occupied job openings, namely job openings occupied by internal substitutes. There is another definition of unmet labour demand, suggested by, for instance, Eurostat,[24] which may include even more occupied job openings, namely 'job openings which are immediately available'. In fact, perhaps *all* openings occupied by retiring workers or substitutes are 'immediately available' to replacements or permanent personnel.

In practice job openings which are 'immediately available' can be defined more precisely as job openings such that new employees could start work immediately or within a specified time period. For instance, the Job Openings and Labor Turnover Survey (JOLTS) in the US measures 'job openings' for which 'work could start within 30 days'.[25] Such job openings may include most of the occupied job openings. This may imply that JOLTS measures something which is close to job openings (recruitment processes), but the difference between job openings and unfilled jobs in the US is not known, since JOLTS does not measure both job openings and unfilled jobs.

5. Measuring unfilled jobs

Measurement of unfilled jobs in business surveys presupposes an operational definition in terms of specific questions to firms (or establishments). An example of a questionnaire designed to measure not only the number of job openings but also the number of unfilled jobs is presented below. The example is taken from the Swedish vacancy survey, which started in July 2000, and which is statutory since July 2003.

The questionnaire in Figure 1 measures unfilled jobs according to the traditional definition as specified above, that is, unoccupied job openings which are available immediately. It combines two basic principles. First, a direct question about the number of job openings is asked, as in the Dutch vacancy survey.[26] This approach rests on the fundamental assumption that employers interpret 'job openings' as recruitment processes, particularly if a brief definition is given, as in Figure 1. Second, unmet demand is measured indirectly, as unemployment is measured in labour force surveys, by a succession of questions.

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[24] The definition is included in Eurostat (2002) but not in the final (informal) agreement in 2002 to develop quarterly business surveys on vacancies in all EU-countries, since this agreement was restricted to the measurement of job openings.

[25] See http://stats.bls.gov/jlt for a detailed description of the JOLTS program, including the questionnaire and monthly data since December 2000.

[26] See Van Bastelaer and Laan (1994) for a detailed presentation of the Dutch vacancy survey, including its questionnaires.

Thus, after the first question on the total number of job openings, questions are asked about how many of these job openings which are occupied on the reference day by retiring workers or substitutes, and then those job openings which are *not* occupied are divided between 'future' and 'current' unoccupied job openings. Unfilled jobs are defined operationally as a subset of job openings obtained by eliminating first 'occupied job openings' and then 'future unoccupied job openings'.

A complete measurement of unfilled jobs according to the ILO-definition and the classical definition requires the measurement of two additional components, namely 'job openings occupied by internal substitutes' and 'jobs which are waiting for a new worker to start'. Both of these components may be negligible, but this is, of course, ultimately an empirical question.

Figure 1 The questionnaire in the Swedish vacancy survey

1 JOB OPENINGS

Total number of job openings on the reference day: ……

A job is open if the employer has started to recruit a new worker from outside the firm on or before the reference day but has not yet hired one. During recruitment of new workers the corresponding jobs may be occupied or unoccupied according to the following questions.

2 JOB OPENINGS WHICH ARE OCCUPIED

a) Number of job openings which on the reference day are occupied by retiring workers who have not yet left the employer: ……

b) Number of job openings which on the reference day are occupied by substitutes or other temporary workers: ……

c) Number of job openings which on the reference day are occupied by consultants or personnel from a temporary employment agency: ……

3 JOB OPENINGS WHICH ARE UNOCCUPIED

a) Total number of unoccupied job openings: ……

b) Number of these unoccupied job openings which on the reference day are unoccupied because no work is wanted or planned until after the reference day: ……

6. Measuring characteristics of unfilled jobs

Interpreting unfilled jobs (unmet demand) as deviations from a planned or desired employment path, as we did when discussing the classical definition above, suggests measuring unfilled jobs by measuring these deviations. More precisely, deviations from a desired employment path can be measured using information on starting dates and desired starting dates. The basic idea is that if the starting date of a new worker comes after the starting date desired by the employer, then the period delimited by these dates is a vacancy spell (spell of unmet demand), as suggested, for instance, by Wadensjö (1978).

This approach to measuring unfilled jobs is based upon the (reasonable) assumption that an employer during recruitment of a new worker can answer a question about when she wants a new worker to start working. Note that vacancies defined in this way do include 'jobs which are waiting for a new worker to start', as the ILO-definition does, since the vacancy spell is based on the starting date and not the hiring date. But if a job is occupied some time between the desired starting date and the starting date (by a retiring worker or a substitute), then it may be necessary to eliminate at least part of this time by asking the appropriate questions, if unmet demand is to be measured exactly according to the ILO-definition.

Information on *desired* starting dates may be relatively easy to collect from employers when they report job orders to a Public Employment Service (PES). Information on *actual* starting dates may be more difficult to obtain, since a job order may be cancelled by the PES long before work starts. In any case, if the PES is to produce statistics not only on job openings but also on unfilled jobs, then the only way to do so is by adding information on starting dates and desired starting dates to job orders. And then all the characteristics on individual job orders that are available to the PES can also be used in producing breakdowns of unfilled jobs.

If it is possible in business surveys to obtain information on individual recruitments, including recruitment spells, then it should also be possible to obtain information on spells and characteristics of individual unfilled jobs by asking for desired starting dates and actual starting dates. This approach may be useful in (yearly) surveys designed to give structural information on unfilled jobs, while an approach based on a questionnaire like the example given in Figure 1 may be useful in (monthly or quarterly) surveys designed to give summary information on the number of unfilled jobs in individual firms or establishments.

Appendix 2. Tables

Table 1 Hirings, job vacancies, and average recruitment times in Sweden. Quarterly averages of monthly figures in the private sector.

Period	Hirings to permanent employ-ment (thousands per month)	Hirings to temporary employ-ment (thousands per month)	Hirings (thousands per month)	Job vacancies (thousands)	Average recruitment times (months)
(1)	(2)	(3)	(4)	(5)	(6)
2000 Q3	31.9	56.5	88.4	69.2	0.8
Q4	28.9	43.3	72.2	63.1	1.1
2001 Q1	35.4	34.9	70.3	57.9	0.9
Q2	28.2	63.6	91.8	49.4	0.6
Q3	28.7	54.4	83.2	44.7	0.6
Q4	25.4	39.8	65.1	38.8	0.7
2002 Q1	25.4	36.1	61.4	38.4	0.6
Q2	27.1	70.6	97.7	39.1	0.4
Q3	27.2	56.9	84.1	35.2	0.4
Q4	25.9	46.3	72.2	31.9	0.5
2003 Q1	24.6	39.0	63.6	36.0	0.6
Q2	23.7	74.0	97.7	30.6	0.3
Q3	22.7	52.3	75.0	26.4	0.4
Q4	20.7	39.6	60.3	23.7	0.4
2004 Q1	20.7	37.2	57.9	25.7	0.4
Q2	23.8	72.4	96.2	27.8	0.3
Q3	20.7	53.1	73.8	26.8	0.4
Q4	21.7	45.8	67.5	26.2	0.4
2005 Q1	22.9	39.2	62.1	28.5	0.5
Q2	22.7	71.1	93.8	30.3	0.3
Q3	24.4	56.8	81.2	27.2	0.3
Q4	22.6	46.8	69.4	31.0	0.5
2006 Q1	19.4	35.1	54.5	35.7	0.7
Q2	20.5	72.8	93.3	39.1	0.4
Q3	19.5	54.5	74.0	38.1	0.5
Q4	18.2	44.4	62.6	38.7	0.6
2007 Q1	23.5	39.2	62.7	43.8	0.7
Q2	25.5	69.1	94.6	51.0	0.5
Q3	23.3	47.5	70.8	44.9	0.6
Q4	21.4	38.2	59.6	44.4	0.7
2008 Q1	23.8	36.6	60.4	47.5	0.8
Q2	26.9	72.6	99.5	45.8	0.5
Q3	23.2	41.3	64.5	40.8	0.6
Q4	20.4	32.4	52.8	28.8	0.6
2009 Q1	19.6	29.4	49.0	27.6	0.6
Q2	20.0	55.7	75.7	28.0	0.4
Q3	17.3	39.2	56.5	22.7	0.4

Notes: Column 6 reports ratio estimates of *V/H* (not estimates in column 5 divided by estimates in column 4). Standard errors are at most 0.05 in column 6. Temporary employment is defined as employment of limited duration, that is, a job with a predetermined end, and permanent employment is defined as employment which is *not* temporary.

Source: Business surveys on employment and vacancies, Statistics Sweden (www.scb.se).

Table 2 Employment, job vacancies, and unfilled jobs in Sweden. Quarterly averages of monthly figures in the private sector.

Period	Employ-ment (thousands)	Job vacancies (per cent)	Unfilled jobs (per cent)
(1)	(2)	(3)	(4)
2000 Q3	2550	2.7	1.1
Q4	2493	2.6	1.1
2001 Q1	2504	2.3	1.0
Q2	2538	2.0	0.8
Q3	2647	1.7	0.7
Q4	2574	1.5	0.6
2002 Q1	2522	1.6	0.6
Q2	2573	1.6	0.6
Q3	2575	1.4	0.6
Q4	2556	1.3	0.5
2003 Q1	2498	1.5	0.7
Q2	2562	1.2	0.4
Q3	2563	1.0	0.4
Q4	2518	0.9	0.4
2004 Q1	2458	1.0	0.4
Q2	2547	1.1	0.4
Q3	2563	1.1	0.4
Q4	2526	1.0	0.4
2005 Q1	2466	1.2	0.5
Q2	2560	1.2	0.5
Q3	2574	1.1	0.5
Q4	2558	1.2	0.5
2006 Q1	2522	1.4	0.4
Q2	2630	1.5	0.5
Q3	2650	1.4	0.5
Q4	2647	1.4	0.5
2007 Q1	2621	1.7	0.7
Q2	2724	1.9	0.7
Q3	2760	1.6	0.6
Q4	2771	1.6	0.7
2008 Q1	2721	1.8	0.8
Q2	2830	1.6	0.7
Q3	2841	1.4	0.6
Q4	2810	1.0	0.4
2009 Q1	2712	1.0	0.3
Q2	2780	1.0	0.3
Q3	2760	0.8	0.3

Notes: Columns 3 and 4 report job vacancies and unfilled jobs as per cent of employment. Standard errors are approximately 0.05.

Source: Business surveys on employment and vacancies, Statistics Sweden (www.scb.se).

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