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HEIDI SOININEN

EMPIRICAL STUDIES ON LABOR MARKET MATCHING

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Empirical Studies on Labor Market Matching

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Heidi Soininen
Swedish School of Economics and Business Administration
Department of Economics
P.O.Box 479
00101 Helsinki, Finland

Distributor:

Library
Swedish School of Economics and Business Administration
P.O.Box 479
00101 Helsinki, Finland

Telephone: +358-9-431 33 376, +358-9-431 33 265
Fax: +358-9-431 33 425
E-mail: publ@hanken.fi
http://www.hanken.fi

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Helsinki, 2.5.2006

Heidi Soininen

TABLE OF CONTENTS

Introductory Chapter

1 Introduction

Unemployment is one of the few truly persistent economic problems in both industrialized and developing countries today. The reasons for the emergence, existence and persistence of unemployment are important to determine, because unemployment creates a deadweight loss of welfare and is also a base for inequality, which is hard to eliminate.

There are many perspectives on unemployment. Its complexity creates a position where there never seems to be a single clear explanation for its existence, but instead many interacting factors. Recently labor market matching has evolved as one of the key perspectives on unemployment.

The reasons for initial rises in unemployment as well as persistence mechanisms of unemployment have received a large amount of attention. High unemployment usually emerges in some sort of recession or depression. However, in a well functioning economy unemployment disappears along with economic recovery. High unemployment should therefore be a transitory problem. This is, however, not the case in many economies today. Finland, the country studied in this thesis, underwent a serious economic crisis in the early 1990s, but its unemployment rate has still in 2005 not fully recovered. There must, in other words, be some mechanisms at work extending the periods of high unemployment beyond the duration of a downturn in the business cycle.

The initial rise in unemployment cannot always be avoided. Shocks, such as oil price shocks or structural changes, hit economies occasionally and no economy can completely protect itself from them. Naturally, there are also shocks that could be softened or completely avoided by proper policies. The time it takes for unemployment to return to the initial level once it has been created should be something that policy could affect extensively.

Initially when unemployment in Europe began to rise in the 1970s along with the first oil crash the interest of research was on the role of shocks causing the rise. Unemployment increased further in the 1980s and reached a plateau in the

1990s, which enhanced research focusing on the mechanisms generating persistence of unemployment and later on the role of institutions. Over the years many theories have been introduced and many have disappeared; There does not seem to exist one unified theory of unemployment, but instead there are many theories that all add to our understanding of unemployment. Nevertheless our understanding of the unemployment phenomenon still remains incomplete. A general conclusion is that there exists a great deal of heterogeneity of unemployment rates as well as potential explanations across countries (Blanchard, 2005). Layard et al. (2005) summarize the different potential determinants of equilibrium unemployment in their book on unemployment. These determinants can be categorized into two kinds of variables: 1) variables that influence the smoothness with which unemployed can match with vacant jobs and 2) variables that raise wages in a direct fashion despite excess supply in the labor market. The determinants are according to Layard et al. (2005): 1) the unemployment benefit system 2) active labor market policies, 3) the real interest rate, 4) employment protection laws, 5) barriers to labor mobility, 6) systems of wage determination, 7) product market competition, 8) labor taxes and 9) real wage resistance. All these variables have been shown to affect unemployment in some surroundings. The importance of one particular variable varies over time and over countries. Since discussing all the determinants mentioned above is outside the scope of this survey I will put a special emphasis on structural labor market imperfections as explanations of high unemployment in the remaining parts of this survey[1].

The research areas that have received most attention in the persistency debate on European unemployment are the theories on capital accumulation, collective bargaining, human capital and institutions. In the line of research focusing on capital accumulation Bruno and Sachs (1985) argued that if bargained wages did not respond fast enough to slowdowns in productivity growth or increases in the price of non-labor inputs, employment would drop. Drops in employment would lead to drops in profit rates and as long as the profit rate was below the user cost, capital would decrease over time leading to even further drops in employment (Blanchard, 2005).

Wage rigidity in combination with aggregate demand and supply shocks were also advocated as reasons for high and persistent unemployment by among others Blanchard and Summers (1986) during the 1980s. Both unemployment benefits and structural changes can be seen as aggregate supply shocks in this

[1]Also credit market and product market imperfections are generally seen as important determinants of unemployment.

framework.

Labor market imperfections in the form of collective bargaining has been the second focal line of research. The starting point of this line of research is based on that wage bargaining takes place between a worker and an employer and that the unemployed are not represented in these discussions. Hence wage setting does not imply market clearing due to the fact that unions have market power which they exploit. This theory was extended to the so called insider-outsider theory by Lindbeck and Sower in a series of publications, among others Lindbeck and Snower (1986), and the key idea is that unions bargain for wages that are too high to be optimal for the unemployed, but which are optimal for the employed, because the wage is bargained so that the employment level remains the same in the long run. This line of research has been questioned, since in reality employed workers do take into account the situation of the unemployed because there is a positive probability that they will become unemployed themselves. Layard and Nickell (1987) presented an extension of this model which concentrated on the role of human capital on unemployment.

Unemployment in Europe did not drop even in the 1990s. Increased heterogeneity between countries, however, emerged and therefore the role of institutions was emphasized as a possible cause of differing unemployment levels. The question that arose was if the shocks of the 1970s and 1980s still could affect the systems and if differences in institutions could be the reason for the varying performances of different countries. Among others Ljungqvist and Sargent (2002) have claimed that a generous benefit system for the unemployed can partly be blamed for persistent unemployment.

At the same time an alternative explanation of unemployment arose. The fact that the labor market is characterized by large flows of workers and jobs and also by a large amount of simultaneous creation and destruction of jobs had caught the attention of some researchers as a possible cause of high unemployment. One of the pioneers in the field was Pissarides, who in many contributions (among others Pissarides (1985) and later Pissarides (2000)) developed a framework of creation and destruction of jobs, which was based on flows, matching and bargaining. Recently Davis et al. (1996) and Merz (1999) have argued that it is the inflows, rather than the outflows, that are the key driving force behind variations in the unemployment rate.

This line of research gave way to new perspectives on unemployment. The frictions on the labor market were suddenly center-staged in the unemployment debate and have been ever since. This richer framework of analyzing the labor market stimulated a great amount of research targeted at explaining unemploy-

ment as a matching problem. The matching function and the Beveridge curve partly emerged from this literature.

The failure in the matching of unemployed and other job seekers with available vacancies has since been extensively analyzed, one of the key contributions being Blanchard and Diamond (1990). These studies showed that high and perisistent unemployment could be caused by matching problems. The reason for this is that skills demanded and supplied in an economy do not always match and hence mismatch appears. There are vacant jobs but no one to fill them with, and at the same time there are unemployed but no jobs they can fill. Also the inefficiency of the matching process can create unemployment or prolong spells of unemployment.

A key observation is, however, that different explanations seem to fit different countries. In this thesis the Finnish unemployment problem is analyzed. The Finnish unemployment experience differs largely from the European unemployment experience; this is outlined in section 1.2. in which main events in the evolution of the Finnish unemployment are presented. The persistence of the Finnish unemployment development has partly been difficult to explain. For example Nickell et al. (2005) argue that institutions do not explain the Finnish experience. There are, however, many reasons, among others the high long-term unemployment and the uneven destruction and creation of jobs during the early 90s, to believe that matching issues form the core of the persistence problem. Hence, this thesis concentrates on empirically estimating different aspects of matching for the Finnish economy.

In the following section I briefly introduce the matching function and in section 1.2. I describe the Finnish economy during the past 30 years and in section 1.3. I present the key results of this thesis.

1.1 Matching as a way of estimating labor market imperfections

The Beveridge curve and the matching function are today very popular tools when analyzing the labor market. The aggregate matching function gives the number of matches formed at each moment in time given the number of unemployed, or job seekers, and the number of vacancies. The Beveridge curve again graphically describes the relation between vacancies and unemployed. If matching is efficient the number of matches is the minimum of either the number of unemployed or vacancies. Matching is, however, never fully efficient. The matching process is characterized by frictions. Frictions can be due to information imperfections, skill mismatch, location mismatch or just something as

simple as workers moving slowly. There is no central auctioneer matching both sides of the labor market in classical matching theory. Instead both sides of the market perform an individual search for an acceptable partner (Petrongolo and Pissarides, 2001).

The standard matching function in the literature describes how the stock of vacancies match with the stock of unemployed. This process is often described by a Cobb-Douglas matching function. Critique has been presented against the Cobb-Douglas specification by among others Yashiv (2000) and Warren (1996). The emprical literature, however, gives overwhelming support for the Cobb-Douglas specification. It is more on the theoretical side the problems lie, since there has been no theoretical explanation for such a specific functional form. Stevens (2002), however, shows using a "telephone line" Poisson queuing process, that when marginal search costs are approximately constant matching in the form of the Cobb-Douglas matching function also gets theoretical support.

When using the matching function the main things to estimate are the importance and influence of the number of unemployed and the number of vacancies on matching. The factor which is more important for matching also reveals something about the problems in the market. Additionally a lot of emphasis has been put on returns to scale. Are there decreasing, constant or increasing returns to scale in the matching function? No consensus has been reached on this issue, but aggregate studies quite often show evidence of constant returns to scale.

There are many ways of using the matching function as a tool when analyzing the labor market. The aggregate matching function is the most popular tool, mainly due to data availability. Micro foundations, disaggregation and misspecification are, however, issues that have been extensively debated lately. Micro foundations have been debated because there is no widely accepted theory for the micro foundations of an aggregate matching function. The aggregate matching function is usually described as a black box (Petrongolo and Pissarides, 2001). Only lately has stock-flow matching emerged as a potential micro foundation for the aggregate matching function. The idea behind stock-flow matching is that when an unemployed enters the market he scans all available vacancies, applies to the prospective ones and then waits and sees if he gets employed. If he is accepted by one of the employers he applied to he moves out of the market during the same period. If he does not find employment he stays on the market until the next period. But since he has already scanned the available vacancies he will not scan them again. Instead he will wait for new vacancies to enter the market, hence in period 1 the unemployed

is inflow and the vacancies he scans are stock and in period 2 the situation is reversed. Lagos (2000) provides a convincing theoretical framework building on stock-flow matching at the disaggregate level and traditional aggregate matching. Lagos (2000) then sees stock-flow matching as a micro foundation of the aggregate matching function. Coles and Smith (1998) and Coles (1999) also advocate stock-flow matching but more as a way of explaining misspecification of the aggregate matching function.

Disaggregation has also been popular since it is widely acknowledged that the aggregate matching function is only a rule of thumb suffering from aggregation issues. Disaggregation for different regions and industries has been extensively studied.

1.2 The Finnish labor market

Finland has during the past twenty years experienced extreme changes in its economy. In the 1970s and early 1980s Finland experienced a steady growth rate coupled with low unemployment. Figure 1 shows the unemployment rate for Finland for the period 1982-2004. Up until the 1970s the unemployment rate in Finland lay around 2%. While most other European economies suffered from high unemployment during the 1980s, the closed Finnish economy managed a relatively low unemployment rate around 5%. During this period Finland can be considered to have been even more closed and protected than other Western European countries due to bilateral trade agreements with the Soviet Union. One result of the bilateral trade agreements was that the oil shocks did not hit the Finnish economy as hard as they hit many other economies, because an increase in the prices of Soviet goods led to a corresponding increase in demand for Finnish goods (Koskela and Uusitalo, 2005).

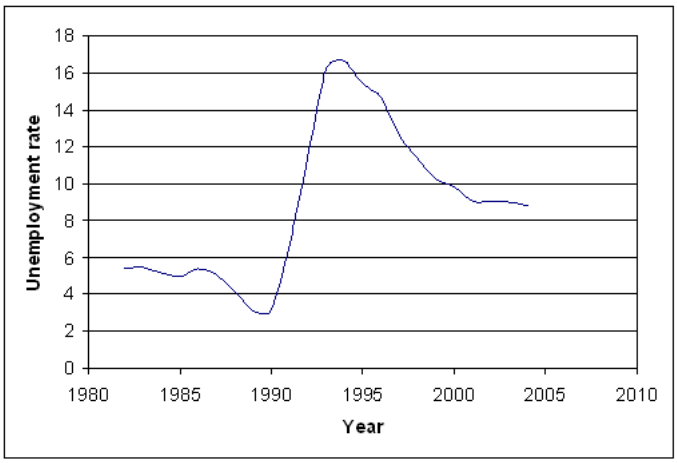

Figure 1: Unemployment rate in Finland for the period 1982-2004. Source ETLA

During the 1980s the economy opened up. Financial deregulation and increased foreign trade and borrowing paved the way for the booming economy. However, a poorly designed financial market deregulation along with a sharp increase in terms of trade, as a result of the fall in energy prices and the rise in world market prices for forest products, and a slack fiscal policy led to a period of overheating starting in 1986-87. This period of overheating was followed by a banking crisis along with a huge economic crisis.

The reasons for the crisis were many and they can be categorized into shocks and economic policy effects as follows; 1) Finnish exports declined due to slow international growth, loss in price competitiveness of the Finnish industry and and the fall in terms of trade. Also, the fall of the Soviet Union led to a 70 percent drop in exports to Russia. 2) Interest rates rose after the German unification in Europe and in Finland as well due to free capital mobility. Also expansive fiscal policy and tight German monetary policy added to this effect. 3) Monetary conditions became very restrictive in 1989/90 due to increases in real interest rates and appreciation of the Markka. (Honkapohja et al., 2005)

To emphasize the magnitude of the crisis it can be worth mentioning that the crisis was the deepest economic crisis a western economy has experienced after the second world war. Between 1991 and 1993 GDP fell by 13% and the employment level fell by 18%. Finland devalued twice during the early 1990s and after that the Finnish markka floated freely (Honkapohja and Koskela, 1999).

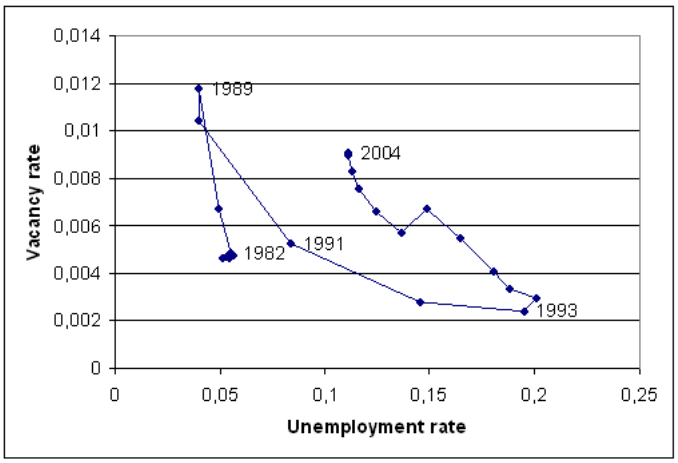

Figure 2: The Finnish Beveridge curve, 1982-2004, annual data. Source ETLA.

In 1993 the economy turned around and most economic indicators recouped fast. Since then, economic growth has been high, while unemployment has not recovered in the desired way. The persistence of the unemployment rate cannot be said to have been surprising as most European countries had experienced high and persistent unemployment already from the 70s onwards. The high degree of long-term unemployment also correlated to general European figures. The unemployment rate was almost 20% in 1993 and has since fallen much but still remains high. Today the unemployment rate is around 8% and it is predicted to fall further during the coming years.

A structural break has been suggested to have played a significant role for the Finnish unemployment developments during the post-crisis period. Koskela and Uusitalo (2005) show that the jobs destroyed during the crisis and the jobs created after the crisis were in very different disciplines supporting the view of structural break.

The Finnish labor market has for a long time been highly centralized, as in most Nordic countries. The union density has increased quite steadily since the 1960s as opposed to most countries where density is declining (Blanchflower, 2006). According to Pehkonen and Tanninen (1997) union density in 1960 was 22% while it in 1992 was 82%. Koskela and Uusitalo (2005) report that union density peaked in 1995 at 86% and then dropped to 83% in 2001. The wage bargains are negotiated at a centralized level between worker and employee organizations and the collective agreements also cover non union members in

sectors where at least half of the employers belong to an employer organization. In reality this means that 95% of Finnish workers are covered by the collective agreements (Koskela and Uusitalo, 2005). During the period 1969-2002 there have been only 7 rounds when no central agreement was reached. Hence, wage bargaining has been very centralized in Finland during the past decades. In a recent study Uusitalo (2005) shows, using Finnish data, that both bargained and actual nominal wage increases are lower when the bargaining takes place at the national level.

Unemployment benefits are generous in Finland. Unemployment benefits consist of two parts; Unemployment allowance and labor market subsidies. A person must have worked for 43 weeks during the past 2 years in order to be eligible to unemployment allowance. Additionally, earnings related allowances also require that the worker has been a member of an unemployment insurance fund 10 months prior to unemployment. Unemployment allowance can be received for 500 days, with some exceptions. Employed who do not meet the requirements for unemployment allowance can receive a labor market subsidy, which is paid during an unlimited period. Both unemployment allowance and labor market subsidies are 23,24 euro per day (2005).

Hence, Finland exhibits most of the reasons which are typically cited for high and persistent unemployment: A serious structural break in the beginning of the 1990s followed by high unemployment, a high degree of union power and centralized wage bargaining leading to relatively inflexible wages, and extensive unemployment benefits thereby reducing the incentives for finding employment. But, during the period 1980-2005 institutions have not changed much; Neither has wage bargaining nor union density. Hence it seems strange if the traditional explanations for unemployment alone could account for the high unemployment. It has however been argued that the same institutions have very different effects in a well functioning economy and in an economy with structural problems and therefore the effect of rigid institutions and rigid wages should not be underestimated. The interaction of shocks and institutions is of great importance in this framework according to Blanchard and Wolfers (2000), since neither explanation can alone explain the European unemployment experiences. Saint-Paul (2004) again emphasize lack of reform as a potential explanation while Nickell et al. (2005) argue that institutions cannot explain the Finnish unemployment experience.

This thesis concentrates on the matching aspect of the labor market in analyzing the persistent Finnish unemployment. Mismatch is a quite natural consequence of severe structural change, and given the radical changes Finland underwent

in the early 1990s such a scenario seems plausible. When a lot of jobs disappear and new jobs are created it is logical if some mismatch appears. Koskela and Uusitalo (2005) visually show that the jobs destroyed during the crisis and the jobs created after the crisis were in very different disciplines giving indirect support for a link between industrial restructuring and mismatch. Essay 3 of this thesis studies the mismatch framework through occupational differences. Mismatch can naturally be extended by rigid institutions which do not create incentives for reeducation. Either way the matching scenario seems to be very important for a thorough labor market analysis in order to widen the understanding of the problems of the labor market.

1.3 Purpose and central results of study

The purpose of this thesis is to study the matching process on the Finnish labor market, both at an aggregate and a disaggregate level and to study the micro foundation of the aggregate matching function. There are three key results in the essays.

- In *essay 1* I show that the aggregate matching process has changed severely between the 80s and the mid-90s. The process by which unemployed and vacancies find each other has changed.
- In *essay 2* I show that stock-flow matching can be seen as a micro foundation for the aggregate matching function.
- In *essay 3* I show that matching varies greatly between occupational groups and that empirically consistent variables are very important for matching results.

The remaining part of this introductory chapter is organized in the following way; Chapter 2 discusses the matching literature and earlier empirical contributions. Chapter 3 presents the main results of the three essays.

2 The matching function in the literature

The matching function is a popular tool for modeling frictions in the labor market and it has been extensively studied both theoretically and empirically. The matching function gives the number of matches formed at each moment in time given the number of vacancies and job seekers. In this section the evolution of the matching function is described. This is followed by a description of the

baseline matching model and a survey of the most important contributions in the field.

The matching function and the Beveridge curve are two extensively utilized relationships in labor economics. The Beveridge curve describes the negative, convex to origo relationship between vacancies and unemployed, which is the outcome of the matching function. The name derives from William Beveridge, an English social politician, who discovered the relationship in the 1930s. This relationship has shifted out over time in most western economies, indicating increased difficulties to match available vacancies with available unemployed. Being far down on the Beveridge curve indicates that a low number of vacancies corresponds to high unemployment and being far up on the curve indicates that a high number of vacancies corresponds to low unemployment.

The matching function appeared much later than the Beveridge Curve in the literature. The matching function was first mentioned at the end of the 1970s. After this both the matching function and the Beveridge curve have been used as major tools for the analysis of the labor market (Blanchard and Diamond, 1989). A vast amount of theoretical and empirical studies has been produced and the general consensus is that the matching function contains important information on how matches are formed (Pissarides, 2000).

The key idea of the matching function is that it is a well-behaved function describing how jobs are being formed at each moment in time as a function of the number of workers looking for jobs and the number of firms looking for workers (Petrongolo and Pissarides, 2001). The matching function captures the efficiency of this process as well as the importance of the two inputs for matching.

2.1 From frictions to matching

The matching function builds on the presence of frictions. Frictions can, as earlier mentioned, be due to information imperfections, skill mismatch, location mismatch or something as simple as workers moving slowly.

Frictions were, however, difficult to formally model for a long time. Hicks (1963) acknowledged that frictions are important when determining equilibrium wages. He claimed that short-run disequilibria in the labor market will arise when wages respond slowly to shocks due to frictions. Frictions do slow down the response of wages to shocks and are hence major causes of disequilibria in the labor market (Petrongolo and Pissarides, 2001). Also in the 1930s Hutt (1939) underlined the importance of frictions in the labor market. He discussed the implications of

workers who are actively searching for jobs and if these should be considered to be unemployed. Keynes (1936) was probably the first to use the term *frictional* unemployment, by which he meant unemployment that is compatible with "full employment". This kind of unemployment he found uninteresting. Keynes thought that Pigou (1933) had presented the classical view of unemployment in the best way but he did not agree with both Hicks' and Pigou's view that frictions constitute a major cause of slow real wage adjustments (Petrongolo and Pissarides, 2001).

Frictions experienced a boom in the literature again in the late 1960s and early 1970s. At this time Phelps (1968) and Mortensen (1970) modeled frictions in a flow-of-labor function which depended on the firms' relative wage offers. This approach was questioned by among others Diamond (1971) and Rothschild (1973). The main contribution of these new works, however, came from the realization that there are large flows of workers and jobs in modern labor markets and that search models do increase our understanding of these mechanisms (Petrongolo and Pissarides, 2001).

The matching function, which in an easy way summarizes the way frictions slow down the mobility of workers, became the key concept in the new generation of models appearing in the 1970s (Petrongolo and Pissarides, 2001). Now equilibrium models avoiding wage distributions and explicitly modeled search decisions appeared. In 1977 Butters (1977) characterized the process in which sellers let buyers know their prices by randomly putting ads in their mailboxes. Hall (1979) built on the same idea and derived a job-finding rate describing how recruiting firms select workers out of a homogenous unemployment pool, and Pissarides (1979) combined the same model with the constant returns to scale job matching function, in which employment agencies also match workers to jobs. Bowden (1980) introduced the Cobb-Douglas functional form in this setting as an example when examining vacancy-unemployment dynamics in search markets by using a linearly homogenous engagement function.

These early models and their success led to models considering many other aspects of labor market equilibrium and the success of the matching function to date can probably be attributed to the fact that the matching function enables modeling of frictions in otherwise conventional models with very little added complexity (Petrongolo and Pissarides, 2001).

2.2 The baseline matching model

The matching function describes how workers looking for jobs and jobs looking for workers match in the labor market. The matching function is a well behaved function that gives the number of formed jobs as a function of the number of vacancies and the number of unemployed. In its simplest form the matching function can be written as

$$M = m(V, U), \tag{1}$$

where M is the number of hirings or matches during the period, V is job vacancies during the period and U is the number of unemployed during the period. It is usually assumed that m is increasing and concave in both its arguments and $m(0, V) = m(U, 0) = 0$. The matching function is in most theoretical contributions assumed to exhibit constant returns to scale. Constant returns to scale implies a proportional increase in hirings given a change in vacancies and unemployment. The functional form usually used is the Cobb-Douglas form

$$M_t = \delta V_t^{\alpha} U_t^{\beta}, \tag{2}$$

where $\alpha + \beta = 1$, if there are constant returns to scale, otherwise not. The Cobb-Douglas functional form is very popular in empirical applications, but critique has been presented against it because there are no micro foundations for it in the existing literature. Alternative specifications suggested are e.g. translog and CES functional forms.

The matching function describes how the actual match between vacancies and job-seekers takes place at each moment in time. If there are no frictions in the matching process, i.e. if unemployed and vacancies are instantaneously matched, this number is the minimum of vacancies and unemployed. Obviously, if there are frictions, the number of matches will be lower (Petrongolo and Pissarides, 2001). Increased inefficiency in the matching process implies less matches at the same level of vacancies.

One of the main critiques against the Cobb-Douglas functional form of the aggregate matching function is the lack of micro foundations. There are several studies justifying the use of the aggregate matching function but none justifying the extensive use of the Cobb-Douglas functional form. Another problem with the matching function is misspecification which stems from the poor availability of data. Among others Broersma and Van Ours (1999) discuss the problems

arising from using vacancy outflow as the match measure while using unemployed as the search measure. If vacancy outflow is the match measure used, all job seekers should be the search measure used instead of only unemployed. If unemployed are used the results will be biased. The problem here is that there hardly ever is data on all job seekers since there is no way of measuring these. Only recently has the literature begun to deal with these issues.

2.3 Empirical studies

A vast amount of empirical studies have been conducted using the matching function and the Beveridge curve as analytical tools. Early contributions in the field generally only estimated the Beveridge curve. The advantage of this approach is that only stock data, not flow data, is needed. It is, however, hard to make inference about the matching function solely based on the Beveridge curve, and this, in combination with a growing understanding of the link between the matching function and the Beveridge curve, has led to most of the empirical literature since the late 80s directly estimating the matching function. The general trend appears to be that the matching function has grown in popularity over time while the attention towards the Beveridge curve has diminished. The availability of sufficient data has also been a challenge and along with availability of more extensive data new aspects of the relationships at hand have been estimated and analyzed.

The matching function can be analyzed from many angles. In this survey I overview studies on the aggregate matching function and the Beveridge curve as well as stock-flow matching and a few disaggregate studies. The key emphasis is put on aggregate studies since so much has been done at this level. Regional matching functions are also popular in the literature, but I do not survey them in depth here, since this thesis does not estimate regional matching. The interested reader is advised to turn to Petrongolo and Pissarides (2001) for a thorough presentation of regional matching.

2.3.1 Aggregate studies

The aggregate matching function has been extensively studied empirically. Data sets for many countries have been utilized and the results achieved have been surprisingly similar. The absolute majority of studies in the field have been simple log-linear regression models, which implies a Cobb-Douglas matching function if the foundation for the Beveridge curve is the aggregate matching function. Edin and Holmlund (1991) estimated the Beveridge curve for Swe-

den while e.g. Budd et al. (1988), Wall and Zoega (1997), Jackman and Roper (1987) and Jackman et al. (1989) have estimated it for Britain. Jackman (1990) has constructed the Beveridge curve using Finnish data in a multi-country study.

The Beveridge curve has shifted outward for most European countries during the past 30 years. This shift corresponds to the increase in unemployment that has taken place. Reasons suggested for the shift are mismatch (Jackman et al., 1989), the growth in proportion of long-term unemployed (Budd et al., 1988), the generosity of the unemployment insurance system (Jackman et al., 1989) and active labor market policies (Jackman et al., 1990). As can be seen in figure 2, the Finnish Beveridge curve has also shifted outward during the past 20 years.

Aggregate matching functions have also been studied extensively. Examples are Blanchard and Diamond (1989), who have used US data, Pissarides (1986), Layard et al. (1994) and Coles and Smith (1996), who have studied British data and Burda and Wyplosz (1994), who have utilized data for many continental European countries.

Most international studies find evidence of constant returns to scale in the matching function, for example Blanchard and Diamond (1989) and Petrongolo and Pissarides (2001). There are also other studies e.g. Edin and Holmlund (1991) and Anderson and Burgess (2000), which indicate that there would be decreasing or increasing returns to scale. When using aggregate data the estimated functions usually satisfy constant returns to scale while disaggregate data mostly evidence mildly increasing returns to scale. Evidence of increasing returns to scale are also presented by Yashiv (2000) and Warren (1996) when using a more flexible translog form on Israeli and US data.

There are, generally, two ways of measuring matching: as unemployment outflow or as vacancy outflow. When vacancy outflow is the match measure used the vacancy coefficient is generally larger than the unemployment coefficient and usually lies within the range 0.5-0.9, while the unemployment coefficient is smaller. The opposite is true when unemployment outflow is used as the match measure.

The majority of all studies use OLS- or IV-techniques when estimating the matching function and the Beveridge curve. The apparent drawback of this method is that most macroeconomic time series are non-stationary, which invalidates the estimates received with regular regression analysis. Albaek and Hansen (2004) is an exception in the literature, as they utilize cointegrated VAR-analysis on matching issues using Danish data between 1974 and 1988.

They find evidence for both a Beveridge curve and a matching function, which is homogenous of degree one, when they model shifts in the Beveridge curve and the matching function as smooth transition functions. They suggest that mismatch as opposed to reallocation is the cause of the outward shift of the Beveridge curve.

In essay 1 of this thesis the aggregate matching function is estimated both before and after the crisis in the early 90s. The main difference to earlier studies lies in that I study the difference in aggregate matching during stable and turbulent times using a method, cointegrated VAR-analysis, that takes into account the non-stationarity of the time series.

2.3.2 Stock-flow matching studies

Stock-flow matching is quite new in the literature. Stock-flow matching was introduced because of problems with the aggregate matching function. It has been suggested to be the solution both for misspecifiation issues as well as micro foundation problems of the aggregate matching function.

Stock-flow matching is, opposed to regular matching, not random. Instead the key idea is that when a worker becomes unemployed he scans the available vacancies. At this point the unemployed is a part of the unemployment inflow while the vacancies he scans are a part of the vacancy stock. If the unemployed finds a job that interests him he applies for it and if the employer chooses him he will move out of the unemployment pool. In this case unemployment inflow has matched with vacancy stock. If he does not find employment, in the next period he will belong to the unemployment stock, but since he has scanned all vacancies in the market in the previous period he only waits for new vacancies to arrive in the market. Hence the unemployment stock matches with vacancy inflow and vacancy stock matches with unemployment inflow.

Not many studies have been done on stock-flow matching. Coles (1994) and Coles (1999) introduced the idea of stock-flow matching but these papers are strictly theoretical. Coles and Petrongolo (2002), Coles and Smith (1998) and Gregg and Petrongolo (2005) are the only papers estimating empirically if there are some foundations for stock-flow matching. Coles and Smith (1998) estimate log-linear matching functions according to duration classes with OLS. Their main result is that both vacancy stock and vacancy inflow affect unemployment outflow for short durations, but for longer durations only vacancy inflow has a significant effect. Gregg and Petrongolo (2005) use non-linear least squares when they estimate outflow equations for unemployed workers and vacancies. They also estimate the determinants of unemployment exit rates for

two different duration classes. They find evidence of higher matching rates for inflows than for stocks. Coles and Petrongolo (2002) again estimate average re-employment rates for an unemployed worker. They find that stock-flow matching with spatial mismatch provides a good fit using non-linear least squares. Hence the overall impression from estimates using OLS and NLLS on British data seems to be in favor of stock-flow matching both at an aggregate and a disaggregate level.

In this thesis essay 2 deals with stock-flow matching by estimating if there is support for stock-flow matching both at a dissagregate level and at an aggregate level using cointegrated VAR-analysis on Finnish matching data. The key difference to earlier studies lies in the method used as well as the approach and the data. I test whether stock-flow matching can be seen as a micro foundation of the aggregate matching function instead as a misspecification as suggested in earlier work. Disaggregate level evidence in favor of stock-flow matching along with similar aggregate level evidence would suggest that the traditional aggregate matching function is misspecified; it receives a better fit if inflow variables are added. Disaggregate level stock-flow evidence along with aggregate level evidence of the traditional matching function would again suggest that stock-flow matching could be a micro fondation of the aggregate matching function.

2.3.3 Disaggregate studies

The aggregate matching function is considered to be a good general measure of the functioning of the labor market. For policy purposes it is, however, often of interest to look under the surface. Because of this the matching function has repeatedly been disaggregated in one direction or the other.

The matching function has been studied at the disaggregate level for the following categories 1) Geographical sectors, 2) Industries and 3) Occupations. Geographically smaller areas are interesting to study since they capture the differences between regions and the importance of distance. Coles and Smith (1996), Anderson and Burgess (2000) and Burgess and Profit (2001) have analyzed matching for different regions. Finnish studies in the field are Ilmakunnas and Pesola (2003), which analyzes matching for different regions using stochastic production frontiers, and Kangasharju et al. (2004) who use a long panel to estimate matching for 173 work-to-travel areas. This field has been interesting to study in Finland since there are so large regional dispersions.

Industrial and occupational matching has not received as much attention as regional matching. The reason for this might be that it is more difficult to grasp why it is informative to disaggregate in this way. The ideas behind the

two disaggregation principles are, however, very similar. The purpose is to capture differences between the occupations or industries in order to analyze if these contrasts are explanations for differing unemployment developments for the groups. Industries are more difficult to study as small matching markets because there are many tasks within one industry that can also be performed in another industry. For example all support functions are quite similar across all categories. This difficulty might be the reason for the scarcity of studies in the field. Blanchard and Diamond (1990) have studied industrial differences.

Occupational matching has not either been extensively studied. Fahr and Sunde (2004) is the only available study on occupational matching. Also Entorf (1998), Van Ours and Ridder (1995), Berman (1997) and Broersma and Van Ours (1999) use information on occupations, but Entorf (1998) does not analyze the effects of occupations, while Van Ours and Ridder (1995) and Berman (1997) distinguish between occupation-industry categories and Broersma and Van Ours (1999) only uses the occupational level data to analyze an aggregate framework. Fahr and Sunde (2004) is hence the only study concentrating on pure occupations. They use German annual data for the period 1980-94 containing data on vacancies, unemployed and hirings based on if the person comes from out of labor force, unemployment or from employment. They are consequently able to conduct a basic matching analysis, which spreads a lot of light on occupational matching, it being the first study in the field.

Fahr and Sunde (2004) find that some occupations have relatively high elasticities of matches with respect to the stock of job seekers, while others have a relatively low elasticity. Technical jobs belong to the former group while low skill jobs belong to the latter. The elasticities with respect to vacancies vary much less but there is also some heterogeneity across the groups here.

The third essay of this thesis estimates occupational matching for nine prespecified groups. Finnish post-crisis data is used in a setup utilizing cointegrated VAR-analysis. The differences to earlier work in the field lie in a superior method used, a more recent time period and monthly instead of annual data and Finnish data instead of German data, which the only earlier contribution utilizes.

3 Outline and main results of the essays

Labor market matching has earned its position as one of the key tools for macroeconomists when analyzing the labor market. It is easy to grasp and it seems to fit the data quite well for all data sets. There are, however, some

drawbacks. Most studies don't take into account the non-stationarity of the time series and very few analyze misspecification of the variables. Ignoring such issues is hazardous for the analysis.

Even if there is a large amount of studies available on labor market matching especially at the aggregate level, most of them use British and American data. This is of course interesting, but does not help in understanding particularities in other markets. There is a small number of relevant Finnish studies on the matching function. Ilmakunnas and Pesola (2003) and Kangasharju et al. (2004) both conduct analyses using regionally disaggregated data. Earlier studies exist, but leave a lot to wish for. For example both Pehkonen (1998) and Rantala (1995) study the matching function indirectly through the frameworks of active labor market policies and regional work force differences.

This doctoral thesis consists of 3 essays. All three essays are independent but at the same time they are natural continuations of each other. The data periods studied are in the first essay the period 1982:1-2002:3 while in the second and third essays the data periods begin in 1994:1 and end in 2004:3 and 2005:2, respectively. The reason for different end dates in the data series is that the data sets were collected at different points in time. The start date of 1994:1 in the two latter essays was decided upon based on data availability in the first case and stability issues in the second. The essay collection is built around three themes of labor market matching;

- Is the labor market matching process different before and after the economic crisis and can this be an explanation for the persistent unemployment? (*essay 1*)
- Is stock-flow matching a micro foundation of the aggregate matching function? (*essay 2*)
- Are there differences in matching for different occupations and how important is empirically corresponding variables for reliable results? (*essay 3)*

An important guideline for this essay collection is the use of proper methods. A major drawback of the main bulk of matching studies is that non-stationarity of the time series is ignored. Ignoring non-stationarity implies unreliable results. The general aim of this thesis is to shed light on the Finnish unemployment puzzle through the matching framework while tackling non-stationarity using proper methods. The method used is Cointegrated Vector Autoregression (VAR) analysis. In cointegrated VAR-analysis long-run stationary relations are

estimated as cointegrating relations with the starting point in non-stationary time series. Short-run variations are separated from long-run relations and both effects are prevalent in the analysis. This method has only once earlier been applied to the matching framework by Albaek and Hansen (2004) on Danish data, but it has never been used for evaluating changes, micro foundations, variable misspecification and occupational matching.

3.1 Essay 1: Finnish Evidence of Changes in Labor Market Matching

This essay models the matching process at the Finnish labor market for the period 1982:1-2002:3. Theoretical matching relationships are tested as cointegrating relations. In the essay I investigate if the persistent unemployment prevalent in Finland can be a consequence of changes in the matching process. I seek to establish, using cointegrated VAR-analysis, whether the theoretical relationships, the matching function and/or the Beveridge curve, can be found as long-term relations in the data. I also separate for long- and short-term unemployment in the analysis.

Interesting results are found using monthly Finnish data for the period 1982:1-2002:3. The data is split into two periods, one pre-crisis period (1982:1-1988:1) and one post-crisis period (1993:1-2002:3) in order to study the differences before and after the crisis. Non-stable parameters and the impossibility to find a well specified model for the whole period support the choice of two periods.

The main findings are that for the 1980s a very significant one-to-one Beveridge curve can be distinguished while for the 1990s a corresponding Cobb-Douglas matching function with a negative coefficient for unemployment is found as the long-run relation. In period one the relation error corrects in both vacancies and unemployment while in the second period the matching function error corrects in hirings only.

When separating for long- and short-term unemployment in the post-crisis period, long-term unemployment is found to have a strong negative influence on matching while short-term unemployment has a positive effect.

The implications of the findings are the following: The whole matching process has changed thoroughly, indicating two different regimes. The labor market matching has evolved from a very simple structure into a more complicated matching process with a negative effect from the number of unemployed on matching as opposed to what theory predicts. This negative effect is most probably due to the very high unemployment rate during the second period, and

it could be seen as a sign of mismatch, which also gets support from Koskela and Uusitalo (2005) who show that the jobs destroyed and created during and after the crisis were in very different disciplines. This mismatch seems to have played an important role in the persistence of Finnish unemployment and especially long-term unemployment.

The main contribution of the present essay is that I analyze how the matching framework changes after a severe economic crisis, which included rocketing unemployment rates and a possible structural break. Finland is an excellent study object for this purpose. The cointegrated VAR-method used also sheds some additional light on the matching process adding to the line of research of Albaek and Hansen (2004). I show that changes in the matching process indeed seem to explain some of the peristence of the Finnish unemployment. The fact that long-term unemployed do not match with the vacancies available makes unemployment persistent.

3.2 Essay 2: The Aggregate Matching Function and Directed Search -Finnish evidence

In this essay I argue that labor market matching should not be built on the assumption of random search. Random search implies that job seekers and vacancies that are matched at any moment in time are selected randomly from the pools of existing agents completely independently of the durations of search on either side of the match. In this essay I apply cointegrated VAR-analysis on Finnish matching data for the period 1994:1-2004:3 in order to investigate if there is empirical support for the marketplace matching model as opposed to random matching which is usually assumed. Both Lagos (2000), Coles and Smith (1998) and Coles (1999) argue that the assumption of random search is problematic in some matching environments.

I empirically test stock-flow matching both at an aggregate and a disaggregate level. I compare the traditional matching framework with stock-flow matching at an aggregate level and I also analyze the framework when disaggregating according to unemployment duration.

In the disaggregate analysis I estimate how reemployment probabilities for different durations of unemployment are related to vacancies, vacancy inflow, unemployment and unemployment inflow. For unemployment spells *shorter than a week* there is a very strong positive relationship between the reemployment probability and the vacancy stock. The reemployment probability for duration spells *longer than one week and shorter than a year* are affected strongly pos-

itively by the inflow of vacancies, but it is negatively affected by the stock of vacancies. The reemployment probability of long-term unemployed is affected positively neither by the stock of vacancies nor the inflow. Thus, unemployment inflow matches with vacancy stock while unemployment stock only matches with vacancy inflow according to stock-flow matching. As a second step the traditional aggregate matching function is estimated parallel to an aggregate stock-flow model. The data seems to fit the traditional model much better and hence there cannot be said to exist evidence in favor of aggregate stock-flow matching.

Contrary to earlier studies in the field (Coles and Petrongolo (2002), Coles and Smith (1998) and Gregg and Petrongolo (2005)), I do not find support for aggregate stock-flow matching. Instead I find support for disaggregate stock-flow matching. The differences in the results could be due to methodological issues or data issues. Stock-flow matching should, based on my results, be seen as a micro foundation for the aggregate matching function, which Lagos (2000) shows theoretically, and not as a sign of misspecification of the aggregate matching function.

Stock-flow matching as a micro foundation of the aggregate matching function was suggested by Lagos (2000). He shows that directed search at the disaggregate level can be consistent with an aggregate matching function. He claims that even if agents possess some information and search is directed at the disaggregate level, aggregating over locations and restricting to steady state implies aggregate matching consistent with a standard matching function. The aggregate matching function does not have to build on random search. My empirical results reflect exactly this setup.

3.3 Essay 3: Occupational job matching of Finnish workers - time series evidence

In the third essay I estimate matching separately for nine occupational groups. An occupational group is designed so that a worker should stay within one group for his whole work life if not a complete career change takes place. Therefore, occupational groups can be seen as small matching markets, which opens up the possibility to do the analysis with time series analysis.

Additionally, misspecification arising from non-corresponding variables is dealt with in the essay. A frequent problem in empirical matching studies is the lack of corresponding variables. Both Kangasharju et al. (2004) and Broersma and Van Ours (1999) extensively discuss misspecification based on the choice

of outflow variable and how job seekers are measured. Broersma and Van Ours (1999) stress the importance that the measure of job matches should correspond to the measure of job seekers. However, due to data limitations most studies ignore non-unemployed job seekers. In this essay the issue is dealt with by introducing a new outflow measure, *vacancies filled with registered job seekers*, which corresponds to the supply side measure, *registered job seekers*, hence minimizing misspecification arising from non-corresponding variables.

In this essay data on *unemployed* as well as *all registered job seekers* are used as alternative measures of job seekers. The measure of job matches is *vacancies filled with registered job seekers,* which in earlier contributions has been either *unemployment outflow* or *vacancy outflow*. A framework utilizing *vacancy outflow* is also estimated for comparative purposes.

The estimation period for this paper is 1994:1-2005:2, i.e. it is almost identical to the one in essay 2 where the estimation period also began in 1994. Consistent with essay 1, the period between 1988 and 1993 is too turbulent to estimate matching. Hence all three essays report results that indicate that no stable results can be found for the period 1988-1993.

In this paper I show, utilizing a monthly Finnish data set that matching varies very much between groups. Matching for registered job seekers is for most occupational groups vacancy driven. The size of the vacancy coefficient, however, varies extensively from 0.2 for *Commercial* work to 1.1 for *Administration* and *Healthcare*. More vacancies do not affect the matching of registered job seekers within the *Commercial work* group very much, while the effect is very strong for *Administration* and *Healthcare*. The coefficient for job seekers, on the other hand, varies very much between the occupational groups both concerning size and sign. *Technology and science* and *Commercial work* stand out due to their large *negative* job seeker coefficients. A negative coefficient can be due to the fact that for both these groups there appears to be a very large amount of job seekers, which does not correspond to the demand in the groups. These rapidly evolving and growing sectors seem to be characterized by more mismatch than most other sectors. There is a large amount of job seekers, mainly unemployed, that do not possess the required skills and thereby only cause congestion.

In addition to the main analysis I show that using a well specified model is vital for inference. I estimate matching frameworks using both *all registered job seekers* and *unemployed* as job seeker measures parallel with using *vacancies filled with registered job seekers* and *vacancy outflow* as alternative outflow measures. Independent of which other variables are used the vacancy effect is mostly similar in all frameworks. Changing the outflow variable from the well

specified *vacancies filled with registered job seekers* to *vacancy outflow* changes the results, and specifically the job seeker coefficient, entirely. The job seeker-effect varies extensively depending on which variables are used, not allowing for any general conclusions concerning the direction of the bias from using non-corresponding variables.

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List of essays

- Essay 1: Finnish Evidence of Changes in Labor Market Matching
- Essay 2: The Aggregate Matching Function and Directed Search -Finnish Evidence
- Essay 3: How do Registered Job Seekers Really Match? -Finnish Occupational Level Evidence