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Terhi Maczulskij

Economics of Wage Differentials and Public Sector Labour Markets

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Editors
Tuomo Takala
Jyväskylä University School of Business and Economics
Pekka Olsbo, Ville Korkiakangas
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ABSTRACT

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Finnish summary
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This thesis examines wage differentials and public sector labour markets in Finland. The focus is on the relationship between wages and local labour market conditions, public sector work as an occupational choice and public-private sector wage differentials. The five empirical studies are preceded by an introductory chapter in which the background, aims and main findings of the thesis are presented.

The first study investigates the influence of past and current labour market conditions on wages for three different skill-groups: primary, secondary and highly educated individuals. The study includes full-time private sector employees in the 1991-2004 period, using matched employer-employee data from Finland. The second study examines the relationship between local labour market conditions and public-private sector wage differentials in the 1990-2004 period. The study employs micro-level data that represent a seven per cent random sample of the 2001 Finnish census. These data are also employed in the third study, which examines public-private sector wage differentials across different skill quantiles during the post-recession period after 1995. The fourth study investigates the impact of higher education on the likelihood of becoming a public sector worker. The study employs data on Finnish identical twins, which constitutes a good control for unobserved heterogeneity. The fifth study examines the genetic and environmental contributions of working in the public sector and public-private sector wage gaps using data on the same Finnish twins. In contrast to the third study, unobserved heterogeneity is now controlled for in the wage gap analysis.

The results can be summarised as follows. First, the effect of unemployment on wages is heterogeneous across skill and employer groups. The results suggest that the wages of the primary and highly educated are more dependent on current labour market conditions, whereas signs of full commitment risk sharing are found for the secondary educated. Accordingly, the public-private sector wage differential is counter-cyclical in Finland. This cyclical pattern is the result of local labour market conditions that have different effects on private and public sector wages. Second, working in the public sector is an endogenous career choice. This choice is strongly affected by the employee's educational attainment and unobserved genetic characteristics. These characteristics include, for example, risk-taking behaviour, ability and preferences. Third, the mean results do not indicate any inequalities with respect to the pay offered by the two sectors. However, pay gaps may exist at both ends of the earnings distribution.

Keywords: wage curve, implicit contracts, public sector employment, wage differentials, unobserved heterogeneity

Author's address

Terhi Maczulskij
School of Business and Economics
University of Jyväskylä
terhi.a1.maczulskij@jyu.fi

Supervisors

Professor Jaakko Pehkonen
School of Business and Economics
University of Jyväskylä

Professor Ari Hyytinen
School of Business and Economics
University of Jyväskylä

Reviewers

Pekka Ilmakunnas
Aalto University, School of Business
Helsinki, Finland

Antti Kauhanen
The Research Institute of the Finnish Economy (ETLA)
Helsinki, Finland

Opponent

Pekka Ilmakunnas
Aalto University, School of Business
Helsinki, Finland

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CONTENTS

CHAPTER 1
INTRODUCTION

1 Background

Empirical research has devoted considerable attention to wage differentials and public sector labour markets. Typically, three interesting questions have been examined in the literature. First, how are wages determined? Second, are there differences between the pay earned by public and private sector employees? Third, what types of individuals are attracted to public sector jobs, and what attributes makes those jobs appealing? Figure 1 presents the framework of the thesis, which concentrates on four elements of earnings determination and wage differentials between public and private sector employees: individual-level factors, firm-level factors, local labour market conditions and collective agreements.[1]

From an individual-level perspective, earnings are typically explained in terms of an individual's acquired knowledge, such as education and work experience (e.g., Becker, 1962; Mincer, 1974). This means that workers with higher levels of education and more work experience tend to have higher wages. The two most common explanations for these correlations have been the human capital and job-market signalling models (e.g., Weiss, 1995). The classic human capital theory assumes that the time spent in school or on the job increases wages by directly increasing the employee's productivity (Becker, 1962). In the job-market signalling model, the potential employees send a signal regarding their ability level to the employer by acquiring certain educational credentials, as employers generally are willing to pay higher wages to better workers (Spence, 1973). A particular challenge in the labour economics literature is that the object of primary interest, unobserved ability, can only be measured using proxies. Furthermore, several studies find that non-economic attributes, such as

[1] See also Farber (1997), who identifies four dimensions that differentiate jobs (and thus wages). These dimensions are task, employer, location and individual.

attractiveness (e.g., Hamermesh and Biddle, 1994), height (e.g., Judge and Cable, 2004) social skills (e.g., Persico, Postlewaite and Silverman, 2004) and personality (e.g., Almlund *et al*., 2011), are rewarded in the labour market. While acquired knowledge and other individual-level attributes affect earnings directly, self-selection into a certain occupation may affect earnings indirectly. According to economic theories, an individual will choose a certain socio-economic status or occupation to maximise his or her utility (e.g., Knight, 1921; Roy, 1951). This utility may include financial benefits in addition to non-monetary benefits, such as improved job security, longer holidays and independence. In some cases, individuals may be willing to receive lower pay in exchange for otherwise preferable job amenities.

Furthermore, earnings are affected by factors that are independent of individual's capabilities and preferences. These factors include local labour market conditions, variables related to a job or industry-specific attributes and the general wage determination mechanism.

Local labour market conditions may affect an individual's wages through several different mechanisms. The Harris-Todaro model is an example of a wage determination concept, designed to explain the positive relationship between local labour market conditions and wages. The model assumes that the positive relationship is due to compensating wage differentials across regions (Harris and Todaro, 1970). The wage curve theory, in turn, assumes that the relationship between the local unemployment rate and wages should be negative (Blanchflower and Oswald, 1994). Regional differences are important, and individuals who live in regions with high unemployment should earn less than individuals who live in regions with low unemployment. While the wage curve model assumes that an individual's wages exclusively depend on the contemporaneous unemployment rate, the implicit contracts model assumes that the previous labour market conditions experienced by a worker affect his or her wages through worker mobility and search costs considerations (Beaudry and DiNardo, 1991).

No wage determination or pay gap analysis should be conducted without considering firms-specific attributes. One of the most important issues concerns the positive relationship between employer size and wages (see, e.g., Oi and Idson, 1999 for a survey). Numerous studies have also shown large differences in earnings for similar workers across industries. Substantial industry wage differentials remain even after controlling for a wide range of individual-level characteristics, geographic location and firm-level characteristics (e.g., Krueger and Summers, 1988; Lucifora, 1993; Gannon and Nolan, 2004). Several explanations have been offered to explain the wage differentials between different types of firms and industries. The efficiency wage model hypothesises that firms can reduce shirking by raising wages (e.g., Shapiro and Stiglitz, 1984; Krueger and Summers; 1988). The rent-sharing model assumes that firms in profitable sectors are able to share rents with their employees, thus giving rise to wage gaps between profitable and less profitable sectors (e.g., Katz and Summers, 1989). Yet another theory assumes that more productive employees

are matched with more able firms to minimise monitoring costs (see, e.g., Oi and Idson, 1999 for a survey).[2]

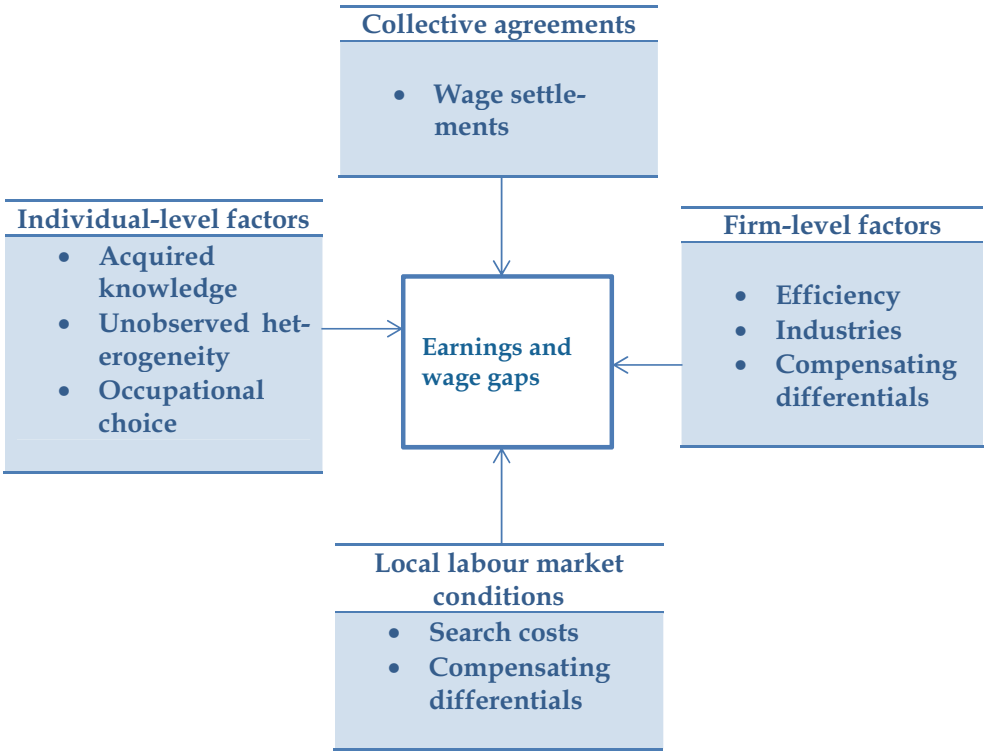

FIGURE 1 Framework of the thesis

General wage settlements are also important in the wage determination process. Minimum wages are set by law in many countries. A number of studies in the literature have examined the effects of minimum wages on both employment and wage dispersion (see, e.g., OECD Employment Outlook, 1998). For example, an increase in the minimum wage level is suggested to have a negative effect on earned income for low-wage workers (Neumark, Schweitzer and Wascher, 2004). Although these employees gain from an increase in the minimum wage, their hours and employment decline, and the combined effect to these changes on earned income is negative. Finland has no minimum wage regulations, but the law requires all employers, including non-unionised ones, to pay certain wage scales that are agreed to in collective bargaining agreements.

[2] Lucifora (1993) suggests that inter-industry wage dispersion can be explained by either compensating wage differentials or unobserved individual characteristics. The latter assumption may reflect the monitoring costs theory. Most recently, Fox (2009) argues that the firm-size wage gaps simply increase with job responsibilities.

Furthermore, union status has been shown to account for a significant fraction of the wage variance (e.g., Duncan and Stafford, 1980; Card, 1992). Unionism is also important factor in explaining the wage differential between public and private sector employees (e.g., Lucifora and Meurs, 2006). Typically, the level of union coverage in the public sector may increase the wages of those working at lower skill levels. Moreover, the level of union coverage is lower in the private sector, thus creating wage inequality between public and private sector employees working in low-end jobs. However, unionism is unlikely to be an important factor in explaining wage inequality in Finland, where the labour markets are heavily unionised, with one of the highest rates of union membership in the industrialised world (70 per cent; see the OECD for a recent country comparison).

1.1 Aims of the thesis

This thesis consists of five separate essays, each of which focuses on different aspects of earnings and wage gaps as presented in Figure 1. More precisely, the first essay investigates the role of past and current labour market conditions on wages for three different skill-groups: primary, secondary and the highly educated. The specification simultaneously controls for time-invariant individual heterogeneity and firm-specific heterogeneity. The second essay broadens the analysis by examining the wage flexibility between public and private sector employees. Here, the particular emphasis is on studying the relationship between local unemployment rates and public-private sector wage differentials among otherwise observationally equivalent workers. The third essay evaluates individual-level earnings differentials across different skill quantiles. The framework of this essay utilises two important concepts of the wage determination process; self-selection into public sector jobs and inter-industry wage differentials. The fourth essay improves the understanding of public sector work as an occupation choice. The particular emphasis here is on studying the impact of higher education on the likelihood of becoming a public sector worker. The essay employs data on identical twins, which constitutes a good control for unobserved heterogeneity. The fifth essay further provides information on self-selection into public sector occupations and public-private sector wage gaps. The essay first examines the genetic and environmental contributions to choosing public sector work. The second analysis estimates individual-level earnings differentials. Unlike in the third essay, we are able to control for both the effects of family background and those of genetic factors (such as intelligence) when estimating the wage gaps.

The structure of this introductory chapter is as follows. Section 2 provides an overview of the Finnish labour markets. It presents the evolution of public sector employment, aggregate public-private sector earnings differentials and the wage setting mechanism. Section 3 presents a review of earlier findings on wage flexibility, the public sector as an occupational choice and public-private sector earnings differentials. The last section provides an overview of the five

empirical studies included in this thesis. The studies are summarised based on the main objectives, data used and the results.

2 Labour markets in Finland

2.1 Employment and wages in the public sector

The Finnish public sector is large, both in terms of its number of employees and its share of GDP. Public sector services are extensive and are funded with tax revenues. The overall tax rate is high, at 43 per cent in 2011 (Statistics Finland, 2012a). The entire public sector consists of the central and local government sectors and the church. Central government operations are associated with the provision of important and indispensable services in the social, business and civic services sectors. The largest personnel groups in the state's on-budget entities are defence, rescue and police services personnel and those employed by universities. These personnel groups account for over 50 per cent of all employees in the central government sector (Finnish public sector as employer, 2006). As in most European countries, Finland has privatised a significant number of former state monopolies over the last two decades: the number of central government personnel fell from over 213,000 employees in 1990 to 87,000 in 2011. Most of this decline is due to the conversion of government agencies and departments into unincorporated state enterprises, incorporated state companies and municipal companies (Statistics Finland, 2012b; Finnish public sector as employer, 2006). Currently, the central government employs approximately four per cent of the total employed workforce in Finland.

The local government sector, in turn, provides basic public services for municipal residents. Unlike the central government, the number of local government personnel has more than doubled over the past 30 years. This increase is due to increases in statutory welfare services, particularly in the 1970s and 1980s. Over 80 per cent of all local government personnel work in the health care, social services or educational sectors (excluding universities), providing statutory basic local government services (Finnish public sector as employer, 2006). In 2011, approximately 18 per cent of the employed workforce was employed by the local government sector. However, the share of local employees varies substantially across municipalities, from less than ten per cent in to over 50 per cent (Statistics Finland, 2012c). Typically, the local government sector is an important employer in regions where labour markets perform relatively poorly. Thus, the share of local government (and total public sector) employment is particularly high in regions where the average unemployment rate is higher.

Figure 2 demonstrates how public sector employment is distributed across Finnish regions at the NUTS3 Level. In 2011, approximately 21 per cent of the total employed workforce was employed in the public sector in Finland. While the shares of public sector employment in total employment are below 20 per

cent in the Åland Islands, Uusimaa (Helsinki region) and Pirkanmaa, nearly 30 per cent of all employees are employed in the public sector in Kainuu and Lapland. For the sake of comparison, the regional unemployment rates are low in Uusimaa (5.8 per cent) and the Åland Islands (2.7 per cent) and high in Kainuu (8.3 per cent) and Lapland (10.2 per cent), compared to the aggregate unemployment rate of 7.8 per cent in 2011 (Statistics Finland, 2012b).

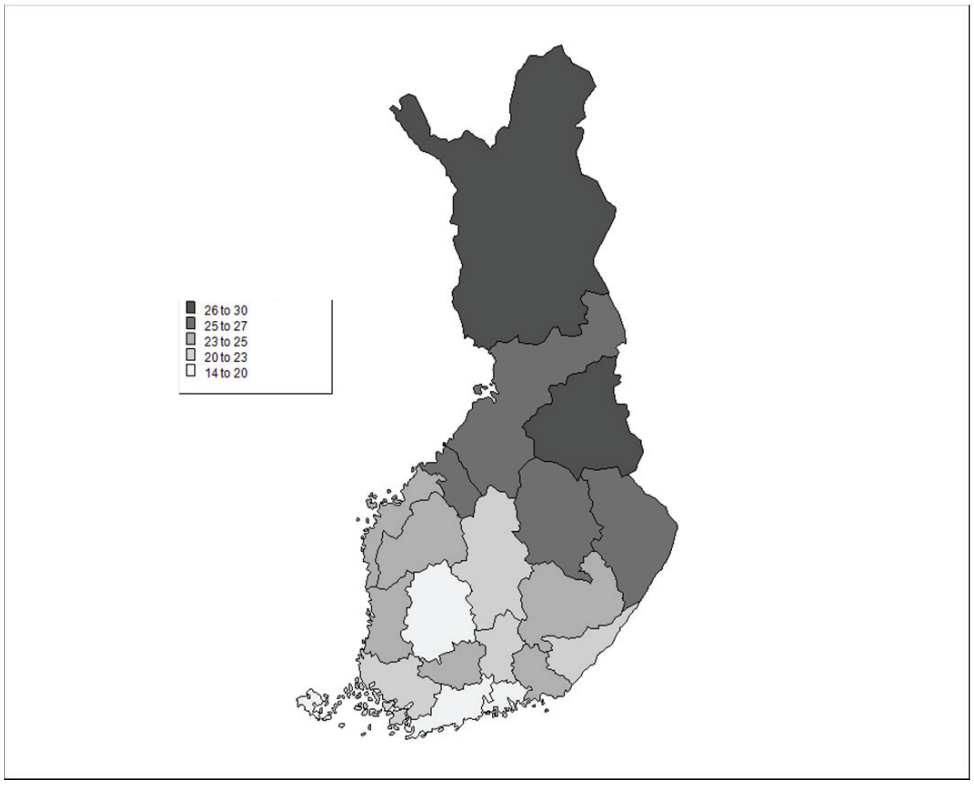

FIGURE 2 Public share of total employment (%) in NUTS3 regions in 2011 (Source: Statistics Finland, 2012c)

The average monthly earnings for full-time employees in the public and private sectors by gender are reported in Table 1 (Statistics Finland, 2012d). Public sector employees earn approximately seven per cent less than employees in the private sector (2900 versus 3100 euros per month). The wage comparison by gender shows that the average wage differential for males is positive (three per cent), while females earn two per cent less in the public sector. The aggregate public-private sector wage gap conceals the fact that within the public sector, there is a significant differential between central and local government wages. For both males and females, central government employees earn substantially more than private sector employees (11 per cent), whereas the wage gap is negative for local government employees (two to three per cent).

TABLE 1 Average monthly earnings for full-time employees in the public and private sectors by gender in 2010, euros

	Total	Men	Women
Private sector	3 108	3 338	2 759
Public sector	2 897	3 431	2 710
Central government	3 411	3 714	3 072
Local government	2 792	3 262	2 663

Source: Statistics Finland 2012d

To demonstrate how the public sector composition of the Finnish labour market has evolved over time, Figure 3 reports the public share of total employment (left y-axis) and the aggregate public-private sector wage differential (right y-axis) over the period from 1975-2011 (Statistics Finland 2012b and 2012d). The upper panel presents the situation for the total public sector, while the middle and lower panels present the employment shares and wage differentials for the central and local government sectors, respectively. Until the beginning of the 1990s, there was a marked rise in public sector employment accompanying the general expansion of the public sector. The proportion of public sector employees rose by over one-half between 1975 and 1993. This trend was mainly due to an expansion of local government rather than the expansion of central government services. The share of central government employees in the total employed workforce was stable (eight to nine per cent) during the years from 1975 to 1993, while the share of local government employees rose from 11 per cent in 1975 to nearly 20 per cent in 1993. The share of public sector employment has decreased over the past two decades, due to privatisations that primarily occurred in the 1990s. This decreasing trend was mostly due to a decline in central government employment.

It is important to note that the sharp rise in public sector employment in the early 1990s was mainly generated by the deep recession in Finland.[3] An increase in public sector employment relative to private sector employment during periods of high unemployment is thus frequently the result of expansionary fiscal policies aimed at creating jobs during recessions and an overall decrease in the demand for private sector jobs.

[3] The recession was caused by the poorly managed financial deregulation of the 1980s, bad fiscal policy, the collapse of the Soviet Union, which led to a 70 per cent drop in trade with Russia, an overall sharp decline in aggregate demand, and a slowdown in the economies of Western Europe (e.g., Kiander, 2001; Gorodnichenko, Mendoza and Tesar, 2012). For example, the unemployment rate increased sharply from three per cent in 1990 to 17 per cent in 1994 (Labour Force Survey). Moreover, the growth rate declined dramatically, by over 10 per cent (National Accounts).

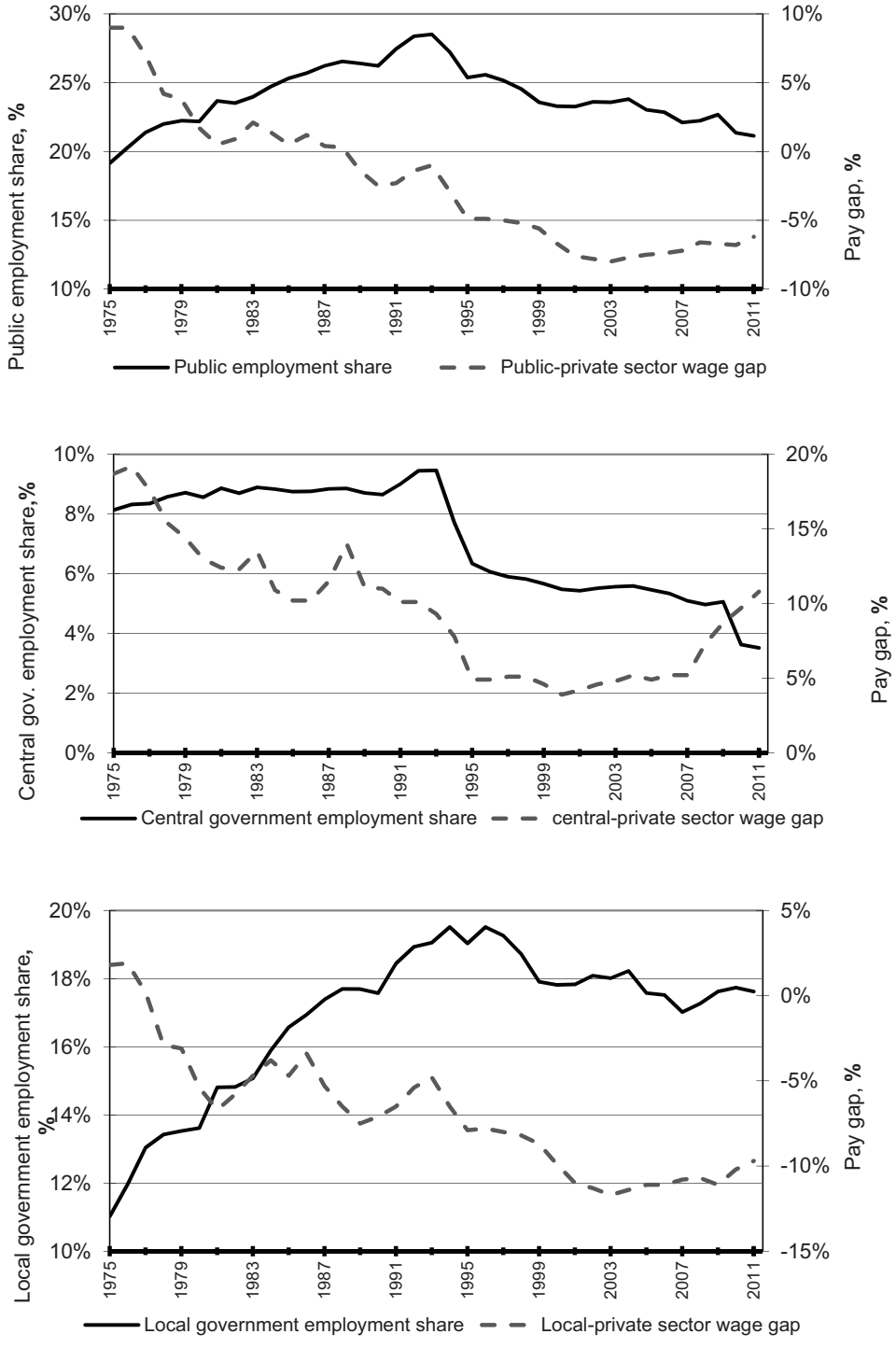

FIGURE 3 Public share of total employment and public-private sector wage gaps (Source: Statistics Finland, 2012b)

The aggregate public-private sector wage differentials have also evolved over time. As Table 1 indicated, there is a significant differential between central and local government wages. This differential is clearly visible in Figure 3, which also depicts some narrowing of the gap since the middle of the 1970s. There is a positive gap between central government and private sector wages throughout the period. In 1975, the wage differential was nearly 20 per cent, and it declined to approximately five per cent in 2007, while it began to increase again during the financial crisis in the late 2000s. In 2011, the average central government employee earned approximately 11 per cent more than his or her private sector counterpart.

The wage differential is generally negative for employees in the local government sector. In 1975, the gap was slightly positive, but there was a decreasing trend in the wage gap throughout the period. By the end of 2011, local government employees earned ten per cent less than private sector employees. The total aggregate wage gap, in turn, declined from a positive figure (nine per cent) in 1975 to a negative figure (negative six per cent) in 2011.

Two interesting observations are shown in Figure 3. First, there is some evidence that the public-private sector wage differential moves counter-cyclically with state of the economy. This means that during economic downturns, the relative position of public sector employees increases, while the public sector earnings premium decreases during upturns (e.g., Disney and Gosling, 1998 and 2008; Melly, 2005; Bargain and Melly, 2008). This counter-cyclical pattern is primarily explained by labour market conditions that affect private sector wages, but only marginally affect public sector wages (e.g., Card, 1995; Ilkkaracan and Selim, 2003; Sanz-de-Galdeano and Turunen, 2006).

Second, there is a negative relationship between the average wage differentials and the share of public sector employment during the 1970s and 1980s. Before the 1970s, the public sector employed a large proportion of highly paid workers, such as those working for the central government as civil servants. The expansion of statutory welfare services, primarily in the local government sector, led to a substantial increase in lower paid occupations, including nurses and those working in other social service occupations. Average public sector earnings thus decreased, as the number of local government occupations increased.

Although the average private sector employee earns more than her public sector counterpart, employee quality with respect to education is significantly higher in the public sector. Figure 4 summarises the composition of workers' educational attainment in the private, central and local government sectors. Nearly 30 per cent of employees in the central government sector have at least a university degree and over 40 per cent have some level of higher education, including polytechnics, i.e., university of applied sciences (Statistics Finland, 2011). There is no specific educational route to central government employment, but a higher university degree is often required for specialist duties (Finnish public sector as employer, 2006). In the local government sector, nearly 20 per cent of employees have at least a university degree and 35 per cent have

at least a polytechnic degree (Kuntatyönantajat, 2012). In this sector, the qualifications for many jobs are specified in the law and require a specific educational background. For example, the employment of health care professionals is regulated by legislation on the exercise of occupations (Finnish public sector as employer, 2006). The educational level in both the central and local government sectors is thus high relative to the private sector, where over 60 per cent of employees have attained no more than lower secondary education (Statistics Finland, 2011).

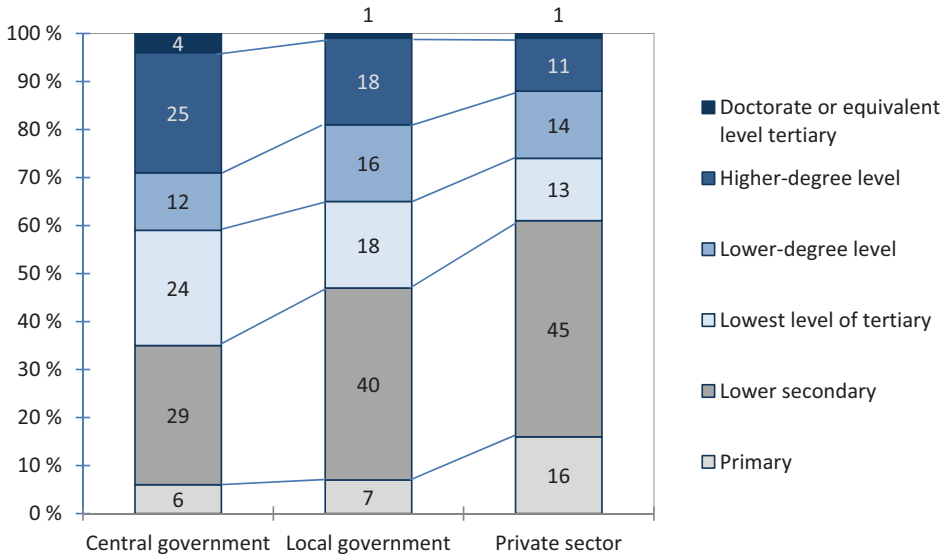

FIGURE 4 Education by sector in 2011 (Sources: Statistics Finland, 2011; Kuntatyönantajat, 2012)

2.2 Centralised wage setting

The Finnish labour market is heavily unionised, having one of the highest rates of union membership in the industrialised world, with membership in trade unions being approximately 70 per cent of all employees (see OECD for a recent country comparison). Union membership is even higher among the public sector employees at 80 per cent. There are three main central labour confederations on the employee side (Työmarkkina-avain, 2007). The largest of these is the Confederation of Finnish Trade Unions, SAK. This confederation has over one million members, who work in a wide range of occupations, including childminders, flight attendants, bus drivers, waiters, builders and paper mill employees. Furthermore, one quarter of SAK members work in the public sector (SAK, 2012).

The second confederation on employee side is the Finnish Confederation of Salaried Employees, STTK, representing approximately 600 000 professional employees that are covered by contracts (STTK and Finnish Labour markets in 2012). The members of STTK-affiliated unions are employed in various occupations, including nurses, technical engineers, police officers, secretaries and salesmen. The third confederation, AKAVA, the Confederation of Unions for Professional and Managerial Staff, is a trade union confederation for those with university, professional or other high-level education, with over 500 000 members (Working together for success and security, 2010).

The four employer confederations are: the Confederation of Finnish Industries (private sector) and three confederations on the public sector side; the Office for the Government as Employer, the Commission for Local Authority Employers and the Church of Finland Negotiating Commission. In the public sector, all agreements for central and local government employees are made between the employer confederations and the bargaining agents.

Industrial relations are regulated by collective agreements that, in turn, regulate the minimum conditions for the job in question and establish labour peace. Collective wage bargaining, in which the government plays a prominent role, has been used in the Finnish labour market since 1968. In all cases, the employer associations and trade unions sign their own collective agreements. Before 2001, collective labour contracts were binding for non-union members in private sector industries where over half of the employees were union members. In 2001, a new three-member board (Board for confirmation of erga omnes applicability) was established for the purpose of confirming the erga omnes applicability of collective agreements in the private sector. Currently, approximately 90 per cent of all employees are covered by collective agreements (Työehtosopimusten kattavuus Suomessa vuonna 2008, 2011).

Although centralised agreements have also been the main mode of wage bargaining during the present decade, there has been a growing tendency towards local-level wage bargaining. This reflects, to some extent, the desire of private sector employers to allow for greater decision-making authority on pay rises at the company level. This has been motivated by a need to boost and ensure the firm's competitiveness in global markets. In the public sector, the shift towards local (authority) level bargaining stems from the introduction of new pay schemes that are based on job evaluations and performance appraisal schemes. The broad objective of such pay schemes has been to improve the competitiveness of the public sector in the labour market. Since the beginning of 2008, the new pay system has been applied across the entire public sector where employee remuneration consists of a job-specific and a personal pay component. The personal pay component can account for up to 48 per cent of the job-specific pay. The old pay system, based on tenured positions and seniority, is thus gradually changing.

3 Review of recent empirical literature

3.1 *Wage curve and implicit contracts*

The international research on the responsiveness of wages to changing labour market conditions dates back several decades, with the theories making connections to migration, regional differences, within-firm shocks and worker mobility. The debate over the cyclicality of real wages thus has a long history, replete with conflicting hypotheses and inconclusive empirical evidence (see Malcomson, 1999, for a review).

One of the theories assumes that the relationship between the unemployment rate and wages should be positive. The Harris–Todaro model is an economic model employed to explain some of the issues concerning rural-urban migration. The central assumption of the model is that the migration decision is based on the expected income differentials between rural and urban areas rather than wage differentials alone. The reason is that there is always some unemployment in urban areas. The probability of finding a job in an urban area is thus taken into account in determining expected income. In other words, the unemployment rate in the model acts as an additional factor in the migration decision. The model implies that high urban unemployment is economically rational if expected urban income exceeds expected rural income (Harris and Todaro, 1970). Their model thus assumes that the relationship between the unemployment rate and wages should be positive due to compensating wage differentials across regions. Supporting empirical evidence for this relationship has been found in Hall (1972), Marston (1985) and Topel (1986).

An inverse relationship between wages and local unemployment rates has been found for many countries. The wage curve theory, originally proposed by Blanchflower and Oswald (1994), assumes that workers who are employed in areas with high unemployment earn less than their counterparts who are located in regions with lower unemployment. The most convincing explanations for the negative relationship between unemployment rate and wages are likely the union model and efficiency wage theory. In the union model, increased unemployment acts as a deterrent to trade unions that are concerned with the number of jobs. It is therefore possible that unions are less concerned with pay than employment, and lower negotiated wage levels could arise. The efficiency wage theory also relies on the deterrent effect. The theory assumes that in depressed labour markets, workers are frightened of loosing their jobs and put more effort into the job, even at a lower pay level (see also Shapiro and Stiglitz, 1984). Therefore, firms can reduce pay when unemployment increases, while still maintaining a motivated labour force.

Blanchflower and Oswald (1994) find that, for most countries, a ten per cent increase in the unemployment rate is associated with an earnings cut of one per cent, and this result is later referred to as being close to an 'empirical law of economics' (see also Card, 1995). Nijkamp and Poot (2005) apply a meta-

analysis approach to study the wage curve using information from 208 studies. They find that the relationship between the unemployment rate and wages is negative; a ten per cent increase in the unemployment rate decreases wages by 0.7 per cent. There is some evidence on wage curve in the Finnish labour markets. Both Parjanne (1997) and Pekkarinen (2001) find a negative relationship between regional unemployment rates and wages in Finland and Parjanne (1997) also observed that the wage curve was particularly strong during the recession in the early 1990s.

A recent suggestion is that wage flexibility can be divided into two aspects (Faggio and Nickell, 2005). The first is the responsiveness of wages to prevailing labour market conditions, and the second is related to the responsiveness of wages to idiosyncratic shocks within firms. These shocks affect the firms' productivity or the demand for their output. The wage curve and implicit contracts literatures concentrate on the first aspect of wage flexibility by unraveling the relationship between the labour market conditions and wages from a worker mobility perspective (see Malcomson, 1999, for a review).

In labour economics, an implicit contract is an agreement between an employer and an employee. Employees dislike uncertainty in income and fear of being laid off. Firms, in turn, are willing to increase their profits and need committed labour. The theory assumes that because firms are risk-neutral and employees are risk-averse, trade between the two groups is possible. In essence, firms are willing to reduce worker risk in exchance for a committed work force (e.g., Baily, 1974). Therefore, unemployment is regarded as insurance for the firms and a deterrent for the employees. The contract is self-enforcing, which means that neither an employer nor an employee is willing to breach the contract, as both would be worse off otherwise.

Figure 5 presents the theories of implicit contracts model and spot market wage setting during an employee's working tenure. The spot market model (i.e., the wage curve) assumes that an individual's wages depend only on the contemporaneous level of unemployment rate. The implicit contracts model, in turn, assumes that the previous labour market conditions experienced by workers affect their wages. The implicit contracts model can be divided into two different cases. First, a *full-commitment risk-sharing* model indicates that wages are determined by the time the worker was hired. Second, a *risk-sharing implicit contracts model with worker mobility* assumes that the tightest labour market conditions since the worker was hired are important. If the analysis supports the spot market model, then workers are mobile between firms but mobility is strongly related to the cycle. If the analysis supports the full-commitment risk-sharing model, the contracts are binding for a worker and it is costly to change employers. If the analysis supports the risk-sharing implicit contracts model with worker mobility, then the contracts are only binding for the employer, and it is costless for employees to change firms.

Beaudry and DiNardo (1991), followed by McDonald and Worswick (1999), Seltzer and Merrett (2000), Grant (2003) and Devereux and Hart (2007), discuss and test the relevance of the spot market model and the implicit con-

tract models. Beaudry and DiNardo (1991) develop a model and derive testable predictions for wage determination. By using individual data from the Current Population Survey and the Panel Study of Income Dynamics, they find that the implicit contract model with costless mobility more accurately describes the US labour market than do the other models. McDonald and Worswick (1999), who base their analysis on data from 11 cross-sectional surveys from Canada, find results consistent with those of Beaudry and DiNardo (1991) in terms of the effect of the minimum unemployment rate. Seltzer and Merrett (2000) find, contrary to the implications of the tested contract models, a positive relationship between the current wage and the minimum unemployment rate since an employee was hired in Australia, and they find no significant correlation with the initial conditions. Their data consist of the personnel records of a single firm. Grant (2003) uses data from six cohorts of the National Longitudinal Surveys from the US that cover over 3 decades. Grants' results support both the implicit contracts with costless mobility and the spot market models, the latter having a stronger effect. He argues that wages likely follow a more general contracting model that predicts partial wage insurance against negative labour demand shocks connected to partial wage responsiveness to current labour market conditions. Devereux and Hart (2007) use the New Earnings Survey Panel from the UK for the period 1976 to 2001 and only find support for the spot market wage model. They also add a fourth aspect to the implicit contracts. Namely, if the contract is nonbinding for the firm, it will cut the real wage in adverse conditions that would otherwise lead to the worker being fired, and the wage is responsive to weakest labour market condition.

Kilponen and Santavirta (2010) find implicit contracts for blue-collar workers in Finland. They use linked worker-firm panel data with over 900 000 observations and find evidence of nonbinding contracts but also find evidence of the spot market effect. Their findings also suggest that the wage elasticities become weaker with stronger import competition.

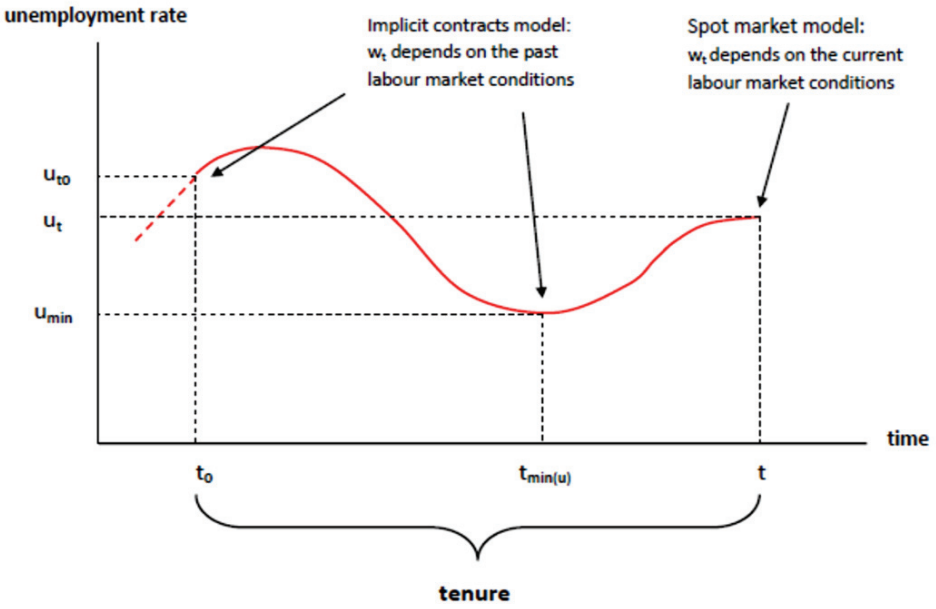

FIGURE 5 Spot market and implicit contracts models

3.2 Public sector as an occupational choice

One interesting question in studies of public sector labour markets is what types of individuals are more attracted to public than private sector employment. This issue can be analysed in the context of Roy's (1951) model. This model assumes that workers have skills in each occupation, but they can only use one skill or another. Therefore, workers select occupations (e.g., working sector) on the basis of income maximisation, leading to the self-selection of workers into productive activities. This original approach only considers financial utility, although many studies have shown that, for example, non-pecuniary benefits are often more important to public sector workers than private sector workers (Crewson, 1997; Karl and Sutton, 1998; Houston, 2000). The Roy model can be extended to evaluate the choice of working sector that is based on an individual's utility as follows (e.g., Heckman, 1979)

$$I_i^* = \gamma Z_i + \varepsilon_i \ , \ \ I_i = 1 \ \ if \ \ I_i^* \geq 0; \ I_i = 0 \ \ if \ \ I_i^* < 0 \tag{1}$$

where I_i^* is an unobserved variable that reflects the utility of an individual working in the public sector, I_i is a binary variable that takes a value of one for the public sector and zero otherwise. γ is a vector of unknown parameters, and

ε_i is an error term. Z_i is the matrix of variables determining the employee's sector choice. The individual will choose public sector work if

$$\Pr(I_i^* > 0) = \Pr(\varepsilon_i > -\gamma Z_i) = \Phi(\gamma Z_i) \quad (2)$$

where $\Phi(\gamma Z_i)$ is the cumulative distribution function of the standard normal distribution. The key challenge in this context is to define Z_i, i.e., find the characteristics that are associated with the probability of being a public sector employee. Currently, this branch of the literature includes both economic and socioeconomic, as well as human resource management, studies. These studies provide a fairly uniform picture: public and private sector employees differ in many of their attributes. These attributes, which are summarised in Table 2, can be categorised into six main groups as follows:

1) Demographic factors
2) Wealth and other income
3) Family background factors
4) Regional characteristics
5) Job-specific characteristics
6) Psychological attributes

The first group includes an individual's demographic factors, mostly indicating that older individuals and workers with higher educational attainment, such as university or higher occupation-specific education, are more likely to be employed in the public sector (e.g., Bellante and Link, 1981; Kanellopoulos, 1997; Lassibille, 1998; Adamchick and Bedi, 2000; Christofides and Pashardes, 2002; Falaris, 2004; Chatterji, Mumford and Smith, 2011). These findings have also received some criticism. The public sector generally has a higher demand for qualified employees to accomplish the required tasks. Therefore, typical work tasks in the public sector require specific types of education, which may lead individuals to choose their education and working sector simultaneously (e.g., Dustmann and van Soest, 1998).[4] The positive relationship between age and public sector work is, in turn, suggested to reflect the possibility that younger individuals have not accumulated the experience and connections required to secure a job in the public sector (e.g., Dustmann and van Soest, 1998). However, the lack of mobility between sectors implies that the effect of age is a cohort, rather than a pure year, effect (Christofides and Pashardes, 2002).

[4] Dustmann and van Soest (1998) treated education as endogenous by controlling for it using parents' education and socio-economic status. Their results indicate that once education was allowed to be endogenous, the positive relationship between higher education and public sector work became negligible. The authors thus conclude that the positive relationship found in standard models simply reflects unobserved heterogeneity.

Government employment has also been suggested to be preferred by the 'protected' groups of veterans, non-whites and women (Blank, 1985; Gyourgo and Tracy, 1986) and individuals who are from minor ethnic groups (Bellante and Link, 1981; Falaris, 2004). In addition, married individuals are more likely to choose public sector employment over private sector employment (Stelcner, Van der Gaag and Vijverberg, 1989; Kanellopoulos, 1997; Jovanovic and Lokshin, 2004), and there is a significant positive effect of the presence of children on the probability of public sector employment for males (Jovanovik and Lokshin, 2004).

The second group concerns other income and wealth, but the findings regarding their relationship with public sector work are conflicting. While some authors find that public sector employees are less likely to have other income and capital compared to private sector employees (Lassibille, 1998; Christofides and Pashardes, 2002), the opposite relationship has also been reported (García-Perez and Jimeno, 2007). The latter finding is argued to reflect the possibility that because entry into the public sector is regulated through public examinations, which typically involve several years of preparation, individuals in the public sector are not financially constrained and, likely, earn a higher non-labour income (García-Perez and Jimeno, 2007).

The third group includes familial social networks. These connections may affect an individual's choice to enter public sector occupations, for example, through job market information from their parents. Empirical findings indicate that individuals who had a parent working for a general government were more likely than others to have a public sector job (e.g., Dustmann and van Soest, 1998; Lewis and Frank, 2002). A similar pattern occurs if a spouse was employed in the public sector (Christofides and Pashardes, 2002; García-Perez and Jimeno, 2007). However, there is a possibility that being married to a public sector employee may in some cases be the result, rather than a cause, of being a public sector employee (García-Perez and Jimeno, 2007).

The fourth group concerns regional attributes. The common finding is that incentives to select a public sector job are higher in regions where the markets perform more poorly (e.g., Kanellopoulos, 1997; García-Perez and Jimeno, 2007). There are two possible explanations for this phenomenon. First, the share of public sector employment is generally higher in lower productivity regions. Second, the job search process is strongly related to the business cycle. This means that during an economic slowdown, people search for jobs more intensely in the public sector when the demand conditions and prospects for wage increases are worse in the private sector (Krueger, 1988; Pagani, 2003).

The fifth group includes job-specific characteristics and job satisfaction. Crewson (1997), followed by Karl and Sutton (1998) and Houston (2000), discuss and examine the job values of public and private sector employees. All of the results indicate that the key factor in an employee's job choices is not always monetary, and public sector workers value non-pecuniary benefits more highly. For example, Houston's results show that public employees are more likely to place a higher value on the intrinsic rewards from work that is important and

provides a feeling of accomplishment. Private sector workers are, in turn, more likely to place a higher value on such extrinsic reward motivators as higher income and short working hours. Van Ophem (1993) also finds empirical evidence on the importance of job-specific attributes in the selection process. His findings indicate that individuals with changing working hours and individuals occupying jobs with good working conditions are more likely to be observed in the public sector. Gyourko and Tracy (1988), Belman and Heywood (2004) and Heitmueller (2006) report similar evidence for union membership, which is more profound in the public than in the private sector.

The recent economic literature assesses public-private sector differentials in terms of subjective well-being outcomes (e.g., Heywood, Siebert and Wei, 2002; Clark and Senik, 2006, Luechinger, Stutzer and Winkelman, 2006; Ghinetti, 2007; Demoussis and Giannakopoulos, 2007). These studies show that many countries exhibit substantial differences in job satisfaction levels between the public and private sectors. Although the results of the public-private satisfaction gap likely strongly depends on the country-specific institutional framework, the majority of these studies find that public sector employees are generally more satisfied with their jobs than their private sector counterparts (see Weisshaar, 2010, for a review). For example, Demoussis and Giannakopoulos (2007) show that the public–private job satisfaction gap primarily concerns job security, working times, working hours, and earnings. Interestingly, Heywood *et al*. (2002) find that when the individual worker effects (sorting) are controlled for, the higher satisfaction of public sector workers becomes insignificant. This result suggests that the higher level of satisfaction expressed by public sector workers largely seems to be a consequence of sorting.

The sixth group concerns psychological (or non-measurable) features. One important factor in this group is ability. There is little evidence on how ability is distributed between public and private -sector employees. Beggs and Chapman (1982), in their analysis of clerical-level public sector employees in Australia, find that employees with high levels of ability are the most likely to exit public sector jobs. Nickell and Quintini (2005) find that the quality of male public sector employees has declined in the UK. Corcoran, Evans and Schwab (2004), Lakdawalla (2006) and Bacolod (2007) provide similar evidence of the decreased ability of female teachers in the US public sector.[5] Pfeifer (2011) also finds, using survey data for German master's students in Economics and Management, that better students, as measured by their expected final grades, are more likely to choose private sector jobs. The second factor relates to the employee's motives. Public service motivation (PSM) is an important issue in public administration and is generally understood as an employee's desire to work for the public interest, to do good for others and shape the well-being of society (e.g., Perry and Wise, 1990; Perry and Hondeghem, 2008). The existence of PSM

[5] Nickell and Quintini (2005), Corcoran *et al*. (2004) and Bacolod (2007) primarily used achievement score data (such as standardized test scores) as measure of quality or ability. Bacolod (2007) measured quality also by using information on undergraduate institution selectivity and positive assortative mating characteristics. Lakdawalla (2006) used relative schooling and experience-adjusted wages as measures of ability.

indicates that individuals employed in public organisations have different motivations than those employed in private organisations (Houston, 2000). The third factor relates to the employee's risk-taking behaviour. Empirical findings indicate that public sector jobs are more attractive for risk-averse individuals (Bellante and Link, 1981; Christofides and Pashardes, 2002; Hartog, Ferrer-i-Carbonell and Jonker, 2002, and most recently Pfeifer, 2011). This finding may be a consequence of public sector employees valuing jobs with high job security to a greater extent.

Based on the empirical findings summarised in Table 2, there is likely non-random selection into public sector occupations. This problem that arises from self-selection is particularly important in studies that examine public-private sector wage differentials. The traditional approach to address selection bias is the use of the Heckman correction method (Heckman, 1979). The estimation is performed in two stages. In the first stage, a model for the probability of being a public sector worker is formulated. The selection equation includes a set of explanatory variables and at least one predictor that is not related to wages. The model, which is estimated using a probit regression, yields predicted individual probabilities of being a public sector employee. In the next stage, the transformation of these fitted values (inverse Mills ratios) is used as an additional variable in the wage equation model. Thus, this method statistically controls for observed variables that affect wages and may also be correlated with the selection process.

Another solution to the endogeneity problem is instrumental variable (IV) estimation. An instrument is a variable that is excluded from the vector of covariates in the wage equation and is correlated with the endogenous explanatory variable, conditional on the other covariates (Angrist and Krueger, 2001). Good instruments must satisfy two conditions: (1) the instrument should not be correlated with the error term in the explanatory equation, and (2) the instrument should be correlated with the endogenous variable of interest. The former relates to the validity and the latter to the quality of the instrument variable. The IV-method used in this study is performed using two-stage least squares (2SLS). In the first stage, the endogenous covariate (i.e., public sector work) is regressed on the entire set of exogenous covariates in the model and excluded instruments. In the second stage, the wage equation is estimated, except that the endogenous variable is replaced by the predicted values from the first stage.

Although the choice of working in the public sector is influenced by many observed factors, such as gender, race and educational background, unobserved factors are likely the most important. These include, for example, ability, vocational preferences, differences in ability to bear risk and personality. Typically, the data lack reliable proxies for these unobservables, but data on identical twins are able to address this shortcoming. Identical twins are identical with respect to their genetic inheritance, and if they are raised together, they also share the same family background: many of the unobservables are driven by genetic and family effects. A third method used in this study is a within-twin pair method. This method involves regressing the

dependent variable on the covariates, both of which are the differences in values of variables between siblings 1 and 2. This within-twin pair method is an efficient tool for estimating the effect of public sector work on earnings, as it conditions out the endogeneity problem of the employment sector caused by family background and genetic effects and between-twin differences in other explanatory covariates.

TABLE 2 Summary of characteristics that are associated with public sector employment

Group	Characteristics	Literature
Demographic factors	• Higher age and education • Females, veterans, being from ethnic minorities • Non-single, presence of children	Bellante and Link (1981), Blank (1985), Gyourgo and Tracy (1986), Stelcner *et al*. (1989), Kanellopoulos (1997), Lassibille (1998), Adamchick and Bedi (2000), Christofides and Pashardes (2002), Falaris (2004), Jovanovik and Lokshin (2004), Chatterji *et al*. (2011).
Wealth	• Have less other income (?)	Lassibille (1998), Christofides and Pashardes (2002), García-Perez and Jimeno (2007)
Family-of-origin	• Parent, spouse or other relative has worked for the government	Dustmann and van Soest (1998), Lewis and Frank (2002), Christofides and Pashardes (2002), García-Perez and Jimeno (2007)
Regional aspects	• Regions with high unemployment	Krueger (1988), Kanellopoulos (1997), Pagani (2003), García-Perez and Jimeno (2007)
Job-specific attributes	• Value on non-monetary benefits • Non-monotony work, better work conditions, union membership • Job-satisfaction	Gyourgo and Tracy (1986), Van Ophem (1993), Crewson (1997), Karl and Sutton (1998), Houston (2000), Heywood *et al*. (2002), Belman and Heywood (2004), Heitmueller (2006), Clark and Senik (2006), Luechinger et al. (2006), Ghinetti (2007), Demoussis and Giannakopoulos (2007), Weisshaar (2010)
Psychological features	• Lower ability or quality • High public service motivation • Risk-aversion	Bellante and Link (1981), Beggs and Chapman (1982), Perry and Wise (1990), Houston (2000), Christofides and Pashardes (2002), Hartog *et al*. (2002), Corcoran *et al*. (2004), Nickell and Quintini (2005), Lakdawalla (2006), Bacolod (2007), Perry and Hondeghem (2008), Pfeifer (2011)

3.3 Public-private sector wage differentials

The empirical literature has devoted considerable attention to public-private sector wage differentials. There are two main surveys on this theme for developed countries. Ehrenberg and Schwartz (1986) provide evidence of public-private sector wage gaps using information from 23 studies, whereas Gregory and Borland (1999) provide evidence of wage gaps by surveying 34 studies. These surveys provide a fairly uniform picture: the public-private sector wage differential is typically positive, at least for females. For example, Gregory and Borland (1999) find that there is a public sector wage premium of between three to 11 per cent. They also find that the premium is high for females, but not always statistically significant for males. The higher public sector wage premiums for females may reflect a lower degree of gender discrimination in public sector labour markets.

Cross-country studies include Blanchflower (1996), who analyses 15 OECD member countries, Giordano *et al*. (2011), who analyses ten selected euro area countries, and Panizza (2001), Panizza and Qiang (2005) and Mizala, Romaguera and Gallegos (2011), who examine the relevance of the public sector wage premium for samples of various Latin American countries. Blanchflower (1996) finds that 11 of the countries have a positive public sector wage premium (four to 25 per cent), while Norway has a wage penalty (negative seven per cent). Giordano *et al*. (2011) find a public sector wage premium for male workers, together with a much higher public sector premium for female workers.[6] Interestingly, in every country studied, the public sector pay premium is higher compared to small private sector firms than large private sector firms. Nonetheless, there are notable differences in wage gaps across countries. Table 3 summarises the core findings on wage gaps by surveying both cross-country studies and a number of studies conducted for individual countries.

There are some studies that find a negative wage differential for males and a positive wage differential for females. Korkeamäki (1999) finds that males earn approximately three to five per cent less in the public sector in Finland (see also Uusitalo, 1999), while females earn a small pay premium. Cai and Liu (2011), for Australia, and Akhmedjonov and Izgi (2012), for Turkey, report similar evidence, with the exception that Turkish females earn a substantial premium (60 per cent) in the public sector. Jürges (2002) and Melly (2005) find that in Germany, males earn two to seven per cent less in the public sector, while females earn eight to 12 per cent more in the public sector.[7]

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[6] The results from Latin American countries generally provide a similar picture (see, Panizza, 2001; Panizza and Qiang, 2005). Contrary to other studies, Mizala *et al.* (2011) use a matching approach to evaluate the earnings differential between public and private sector employees. Their findings indicate that the most qualified public sector employees face a wage penalty; the wage gap decreases towards the upper percentiles of the earnings distribution.

[7] See also Dustmann and Van Soest (1998), who study the public-private sector earnings differentials for German males. For all educational groups, they find that potential wages are on average higher in the private sector than in the public sector, but this advantage falls with age and education level.

Positive public sector wage premiums for both males and females are reported in Austria (Giordano *et al*., 2011), Belgium (Giordano *et al*., 2011), Canada (Shapiro and Stelcner, 1989; Mueller, 1998; Prescott and Wandshneiner, 1999), the UK (Disney and Gosling, 1998; Bender and Elliot, 2002; Lucifora and Meurs, 2006)[8], Greece (Papapetrou, 2006a; 2006b; Giordano *et al*., 2011)[9], Italy (Lucifora and Meurs, 2006; Depalo and Giordano, 2011; Giordano *et al*., 2011), France (Lucifora and Meurs, 2006; Giordano *et al*., 2011), Spain (Lassibille, 1998; Garsía-Pérez and Jimeno, 2007; Giordano *et al*., 2011), Cyprus (Christofides and Pashardes, 2002), Ireland (Giordano *et al*., 2011), Portugal (Giordano *et al*., 2011), Slovenia (Giordano *et al*., 2011) and India (Glinskaya and Lokshin, 2007). The wage gaps for males are generally low in Austria, Belgium, the UK and France (two to seven er cent), while male public sector employees earn a substantial premium in Portugal, Spain and Greece (13-27 per cent). The wage differentials are again higher for females, and the premiums vary between seven per cent (France and Belgium) and 30-50 per cent (Spain and Cyprus).

Recently, a large number of studies has been published on transitional economies. These include Adamchik and Bedi (2000), using Polish data, Brainerd (2002), using data on Russia, Jovanovic and Lokshin (2003), who use the Serbia and Montenegro Labour Force Survey (former Yugoslavia), Falaris (2004), using data from Bulgaria, Jovanovic and Lokshin (2004), who study the state-private sector wage differentials in Moscow, and Gorodnichenko and Sabirianova (2007) using data from Ukraine. These analyses generally demonstrate that public-private sector wage differentials are negative for both genders. While the negative wage gaps are no more than ten per cent in Poland, the wage gaps are substantial in Ukraine, reaching as much as 36 per cent. Adamchik and Bedi (2000) are concerned about these wage gaps. They argue that the widening wage differentials may promote moonlighting among public sector employees. Jovanovic and Lokshin (2003, 2004) suggest that part of these negative gaps may be offset by the benefits public sector employees receive, such as insurance in the form of greater job security. If non-wage benefits in the public sector are high, some workers may prefer working in that sector even if wages are higher in the private sector. Gorodnichenko and Sabirianova (2007), in turn, argue that bribery is the most likely explanation for the wage differences.[10] This explanation is consistent with Van Rijckeghem and Weder (2001), who find a negative relationship between corruption indices and relative civil-service pay using data on 31 developing countries.

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8 Recent evidence from Britain (Chatterji *et al*., 2011) reports a small pay disadvantage for males of approximately two per cent.

9 An earlier study on Greece (Kanellopulos, 1997) finds a negative pay gap for males.

10 They find that, after correcting for the endogeneity of working sector, controlling for unobservable characteristics and accounting for differences in hours of work, union participation, job security, fringe benefits, bonuses, job satisfaction, and secondary employment, the wage differential remains negative. More important, they show that the levels of consumer expenditures and asset holdings are essentially identical for workers in both sectors. This finding unequivocally indicates the presence of additional, non-reported monetary compensation that allows employees in the public and private sectors to enjoy similar levels of consumption.

Increasingly, other studies use quantile regressions to examine whether the public-private sector earnings differentials vary along the earnings distribution. A common feature accounted for in most studies is that the least skilled workers are compensated with higher rewards in the public sector, whereas the reward declines along the wage distribution, and in many cases senior public employees earn less than their private sector counterparts. These studies include, for instance, Mueller (1998), on Canada, Blackaby *et al*. (1999), on the UK, Jürges (2002) and Melly (2005), on Germany, Hyder and Reilly (2005), on Pakistan, Papapetrou (2006a; 2006b), on Greece, Lucifora and Meurs (2006), on France, the UK and Italy, and Cai and Liu (2011), on Australia. Various explanations are offered for this pattern in the structure of the pay gap. Bender and Elliot (1999) suggest that there is a need for the government to act as a 'fair' employer by offering higher wages to less-skilled workers (see also Lucifora and Meurs, 2006). In addition, the level of union coverage in the public sector may also increase the wages of those working at lower skill levels. Lucifora and Meurs (2006) suggest that political considerations may suppress wages in the upper part parts of the earnings distribution because voters dislike seeing public sector employees being awarded high wage rates.

While there are a number of individual- and cross-country studies of public-private sector wage differentials, the evidence on pay gaps across regions within a country is much more limited. Henley and Thomas (2001), Dell'Aringa, Lucifora and Origo (2007), Bell *et al*. (2007) and García-Pérez and Jimeno (2007) are the exceptions. Dell'Aringa *et al*. (2007) study the wage gaps across Italian regions, with almost full employment rates and labour shortages for some occupations in most of the northern regions, paired with high unemployment rates in the south. They show that there are significant differences in public-private wage differentials across Italian regions and that this can be partly explained by local labour market conditions affecting the private sector and only marginally affecting the public sector. In particular, the pay gaps are lower in regions centred in northern Italy (from five to ten per cent), while the pay gaps are higher in regions located in southern Italy (from ten to 25 per cent) where the labour markets perform more poorly. Henley and Thomas (2001) and Bell *et al*. (2007) find similar patterns in the UK.

One of the issues regarding public-private sector wage differentials concerns self-selection bias. If the sorting of employees between the public and private sectors is due to unobserved characteristics (such as risk-aversion and productivity), OLS estimations of the wage differential could yield biased results. Many studies have found that while OLS estimates reveal a large public sector wage premium, this premium disappears when controlling for selection bias. These studies include Van der Gaag and Vijverberg (1988), on the Ivory Coast, Stelcner *et al*. (1989), on Peru, Van Ophem (1993), on the Netherlands and Bargain and Melly (2008), on France.

The literature thus provides varying empirical evidence regarding the existence of pay gaps in the labour markets. The results are summarised as follows:

- The public sector premium tends to be higher for females than for males; this is likely the result of a lower gender wage gap in the public than in the private sector.

- The public sector premium is typically higher for workers who are located at the low end of the earnings distribution; in fact, workers with high educational attainment may suffer a public sector penalty.

- At the country level, the public sector pay premiums are typically higher in regions with high unemployment.

- Evidence from transitional economies indicates that employees in the public sector are paid less than employees in the private sector. Potential explanations for this include bribery and higher non-monetary benefits that may compensate for otherwise lower public sector pay.

- The public sector wage 'premiums' and 'penalties' are frequently due to sorting.

- The public sector premium is higher when compared to small private sector firms than large private sector firms, at least in the euro area.

TABLE 3 Summary of findings on public-private sector wage gaps

Core findings	Country	Wage gap, men (%)	Wage gap, women (%)	Literature
Negative wage gap for males, positive for females	Australia	-3 to -5	3-4	Cai and Liu (2011)
	Britain	-2	5	Chatterji *et al*. (2011)
	Finland	-3 to -5	0-1	Korkeamäki (1999)
	Finland	-3 to -4	(males only)	Uusitalo (1999)
	Germany	-2 to -4	11-12	Jürges (2002)
	Germany	-7	8	Melly (2005)
	Greece	-16	37	Kanellopoulos (1997)
	Turkey	-6	60	Akhmedjonov and Izgi (2012)
Positive wage gap for both genders	Austria	4	15	Giordano *et al*. (2011)
	Belgium	3	7	Giordano *et al*. (2011)
	Britain	4-5	14-24	Disney and Gosling (1998)
	Britain	0-7	4-11	Bender and Elliot (2002)
	Britain	2	8	Lucifora and Meurs (2006)
	Canada	4-6	9-12	Shapiro and Stelcner (1989)
	Canada	3	8	Mueller (1998)
	Canada	14-15	16-25	Prescott and Wandshneider (1999)
	Cyprus	5-8	17-50	Christofides and Pashardes (2002)
	France	2	7	Lucifora and Meurs (2006)
	France	4	7	Giordano *et al*. (2011)
	Germany	3	21	Giordano *et al*. (2011)
	Greece	13	15	Papapetrou (2006a)
	Greece	14	29	Papapetrou (2006b)
	Greece	18	30	Giordano et al. (2011)
	India	61-96	70-102	Glinskaya and Lokshin (2007)
	Ireland	18	22	Giordano *et al*. (2011)
	Italy	1	4	Lucifora and Meurs (2006)

TABLE 3 (Continues) Summary of findings on public-private sector wage gaps

Core findings	Country	Wage gap, men (%)	Wage gap, women (%)	Literature
Positive wage gap for both genders	Italy	4	15	Depalo and Giordano (2011)
	Italy	17	25	Giordano *et al*. (2011)
	Portugal	21	25	Giordano *et al*. (2011)
	Slovenia	8	13	Giordano *et al*. (2011)
	Spain	8	40	Lassibille (1998)
	Spain	27	30	Garsía-Pérez and Jimeno (2007)
	Spain	26	30	Giordano *et al*. (2011)
Negative wage gap for both genders	Poland	-7	-10	Adamchick and Bedi (2000)
	Russia	-14	-18	Jovanovic and Lokshin (2004)
	Russia	-10 to -22	-11 to -22	Brainerd (2002)
	Ukraine	-23 to -25	-23 to -36	Gorodnichenko and Sabirianova (2007)
	Yugoslavia (former)	-9	-2	Jovanovic and Lokshin (2003)

Core findings	Country	Wage gap, men (%) from q = 0.10 to q = 0.90	Wage gap, women (%) from q = 0.10 to q = 0.90	Literature
Wage gaps are higher at the low ends of the earnings distribution	Australia	from 9 to -25	from 3 to -4	Cai and Liu (2011)
	Austria	from 5 to -4	from 19 to 8	Giordano *et al*. (2011)
	Belgium	from 7 to -2	from 9 to -1	Giordano *et al*. (2011)
	Canada	from 10 to -5	from 25 to -7	Mueller (1998)
	France	from 9 to -5	from 11 to 3	Lucifora and Meurs (2006)
	France	from 10 to -6	from 16 to -1	Giordano *et al*. (2011)
	Germany	from 5 to -17	from 30 to -7	Melly (2005)
	Germany	from 7 to -7	from 45 to 0	Jürges (2002)
	Germany	from 24 to -17	from 56 to -5	Giordano *et al*. (2011)

TABLE 3 (Continues) Summary of findings on public-private sector wage gaps

Core findings	Country	Wage gap, men (%) from q = 0.10 to q = 0.90	Wage gap, women (%) from q = 0.10 to q = 0.90	Literature
Wage gaps are higher at the low ends of the earnings distribution	Greece	from 35 to -1	from 36 to 1	Papapetrou (2006a)
	Greece	from 28 to 0	from 38 to 9	Papapetrou (2006b)
	Greece	from 33 to 3	from 26 to 21	Giordano *et al*. (2011)
	Ireland	from 24 to 6	from 15 to 16	Giordano *et al*. (2011)
	Italy	from 8 to -2	from 8 to 1	Lucifora and Meurs (2006)
	Italy	from 21 to 12	from 26 to 14	Giordano *et al*. (2011)
	Pakistan	from 75 to -31	(males only)	Hyder and Reilly (2005)
	Portugal	from 25 to 19	from 16 to 19	Giordano *et al*. (2011)
	Slovenia	from 20 to -3	from 22 to -2	Giordano *et al*. (2011)
	Spain	from 26 to 19	from 27 to 24	Giordano *et al*. (2011)
	UK	from 2 to -2	from 3 to 1	Blackaby *et al*. (1999)
	UK	from 6 to -3	from 18 to 0	Lucifora and Meurs (2006)

Core finding	Country	Wage gap, both genders (%)	Literature
Wage gaps for pooled data (no gender segregation)	Australia	4	Blanchflower (1996)
	Austria	0	Blanchflower (1996)
	Canada	10	Blanchflower (1996)
	Germany	6	Blanchflower (1996)
	Ireland	9	Blanchflower (1996)
	Italy	8	Blanchflower (1996)
	Israel	0	Blanchflower (1996)
	Japan	25	Blanchflower (1996)
	Netherlands	4	Blanchflower (1996)
	New Zealand	12	Blanchflower (1996)
	Norway	-7	Blanchflower (1996)
	Spain	14	Blanchflower (1996)
	Switzerland	0	Blanchflower (1996)
	UK	4	Blanchflower (1996)

4 Overview of the thesis

4.1 Research questions and data

This thesis consists of five independently written papers that concentrate on three major themes. The first of those themes examines the relationship between earnings and local labour market conditions. The second theme focuses on an individual's choice to work in the public sector. The third theme considers the wage differentials between public and private sector employees. In particular, the research questions of the five chapters are:

Chapter 2: How do current and past labour market conditions affect the wages of primary, secondary and highly educated employees?

Chapter 3: Does the public-private sector wage gap move counter-cyclically? What is the degree of wage gap cyclicality for the local and central government sectors and at different skill-levels?

Chapter 4: Are there wage differentials between public and private sector employees? Are the wage differentials heterogeneous at different parts of the earnings distribution? Are the wage differentials affected by the industry-specific valuation of skills and endogenous selection into the public sector?

Chapter 5: Are highly educated employees more likely to self-select into public sector occupations? Is the positive relationship between education and public sector work a structural effect, or does it reflect unobserved heterogeneity?

Chapter 6: What are the genetic and shared environmental contributions to being a public sector worker? Are there wage differentials between public and private sector employees when controlling for unobserved ability and other variables related to genetics and family background?

Chapter 2 tests the relevance of the spot market (i.e., the wage curve) and implicit contracts models for skill-level wages. The spot market model assumes that an individual's wages exclusively depend on the contemporaneous unemployment rate. The implicit contracts model, in turn, assumes that the previous labour market conditions experienced by a worker affect his or her wages. Contrary to the original study by Beaudry and DiNardo (1991), our specification includes firm-specific factors, which allows us to link employees and firms over time. In addition to a rich set of observable factors, we thus simultaneously control for time-invariant individual heterogeneity and firm heterogeneity. We also consider the possibility that the contracts vary over time, as Finland experienced institutional, economic and technological changes during the research period.

The empirical analysis is conducted using linked employer-employee data (FLEED) from Finland covering the years from 1991 to 2004. The data include a 33 per cent random sample of the Finnish population aged between 16 and 69 in 1990. In addition, from 1991 onwards, a new 33 per cent random sample of Finns aged 16 is added into the data set annually. The data have background information on the employees, which can be combined with the enterprise- and establishment -level data. FLEED is constructed from a number of different administrative registers of individuals, private firms and establishments that are collected or maintained by Statistics Finland. The data sources include, for example, individual micro panel data, private sector firm and consolidated company registers, industry and financial statements and the Social Insurance Institution statistics as well as R&D and ICT inquiries. Because the method we use in this chapter (a two-level fixed-effects model) requires considerably data capacity, a new 25 per cent sample was taken from the original 33 per cent sample. Thus, our final sample consists of an 8.25 per cent random sample of the entire Finnish population over the period from 1990 to 2004.

Three skill groups are measured created based on the highest level of education completed. The education levels are constructed based on the International Standard Classification of Education (ISCED) classification. The first education level (primary education) consists of ISCED levels 1 and 2. The second education level (secondary education) consists of ISCED levels 3, 4 and 5B. The third education level (highest education) consists of ISCED level 5A. The regional unemployment rates are collected from the five Nomenclature of Territorial Units for Statistics 2 (NUTS2) regions, which are labelled according to the Labour Force Survey of Statistics Finland: Southern, Western, Eastern, Northern Finland and the Åland Islands. The analysis focuses on private sector workers between the ages of 16 and 69. The dependent variable is monthly wage and salary earnings.

Chapter 3 continues investigating the relationship between labour market conditions and wages. Unlike the previous essay, which focused on wage flexibility between different education levels, here the division is made between public and private sector employees. The earnings of private sector employees generally vary pro-cyclically. Thus, if the pay structure is less flexible in the public sector and cannot react after an economic boom or a crisis, the public-private sector wage gap will vary counter-cyclically. In essence, the earnings premium received by a public sector worker tends to increase with decreasing economic activity and decrease with increasing economic growth.

The data used in the micro analysis are based on the Longitudinal Census File and Longitudinal Employment Statistics constructed by Statistics Finland for the 1970 through 2004 period. Since 1987, the two basic files were updated annually until 2004. By using a personal identifier, data across censuses and data on parents, spouses and region of residence can be merged with the individual records. Because of data protection legislation, Statistics Finland does not provide information that enables the identification of individuals. The data represent a seven per cent random sample of the Finnish population in 2001. A re-

search period from 1990 to 2004 is selected, as the data report important background variables from 1990 onwards.

The earnings consist of wage and salary earnings. The other income subject to state taxation, such as pension income, unemployment benefits and other social security benefits, and entrepreneurial income are excluded. The regional unemployment rates are collected from the 19 NUTS3 regions according to the Labour Force Survey of Statistics Finland, with the exception that workers living in the Åland Islands are not considered in this study. The analysis is performed by estimating the augmented wage curve-model by using ordinary least squares (OLS), instrument variables (IV), and quantile regression (QR) methods. The study also exploits the longitudinal structure of the data to examine whether the results are constant over time.

Chapter 4 broadens the analysis of public-private sector wage gaps by evaluating the individual-level wage gaps at different points of the earnings distribution. The analysis is conducted using the QR method. Our specification contributes to the existing literature in three ways. First, it attempts to control for self-selection bias. Second, the specification includes industry-specific returns to human capital variables, namely education and work experience. This can be easily justified by assuming that certain skills that are essential, for example, in the production process, may not be valued in industries that manufacture different products or service lines. Third, the study uses an advanced decomposition method to assess how much of the unexplained wage gaps (i.e., the conditional wage gaps) can be attributed to specific control characteristics. The data used in this study come from same sources as in Chapter 3, with the exception that the post-recession period of 1995-2004 is chosen for the analysis.

Chapter 5 focuses on an individual's education and how it contributes to the public sector employment decision. A vast body of literature provides evidence that higher education makes a person more likely to obtain a public sector job. However, typical work tasks in the public sector require specific types of education, which may lead individuals to choose their education and employment sector simultaneously. The positive relationship found in standard models is thus criticised as reflecting unobserved heterogeneity, rather than being a structural effect. This study investigates the relevance of this critique using data on twins. The aim here is to ensure that the observed correlation between education and working in the public sector is not due to a correlation between education and an employee's family background, ability and other variables related to genetics, such as risk-aversion and vocational preferences. This is accomplished by taking advantage of the fact that identical twins have a similar family background and genetic inheritance. The analysis is performed using a conditional (FE) logit approach.

The data used in this study are based on a twin sample that is matched with the FLEED. The twin sample is the older Finnish Twin Cohort Study from the Department of Public Health at the University of Helsinki. It is a postal health survey that was conducted in 1975, 1981 and 1990 on same-gender twin pairs who were born before 1958. The twin pairs are either fraternal (dizygotic,

DZ) or identical (monozygotic, MZ) twins. The twin pairs were selected from the Central Population Registry of Finland in 1974. The third questionnaire was sent to pairs who were born between the years 1930 and 1957, who were thus between the ages of 33 and 60 years in 1990. A total of 16,179 twin pairs were contacted, and the response rate for the 1990 survey was 77 per cent. The final number of twin pairs in the sample is 12,502. The survey contains information on symptoms of illnesses and reported diseases, drug use, physical characteristics, smoking, alcohol use, leisure time physical activity and psycho-social factors. Using a personal identifier, the Twin Cohort is matched with the FLEED. The final sample consists of information on these 12,502 twin pairs (25,004 individuals) for the period from 1990 to 2004, who were 33-60 years old in 1990. Attrition from the sample is due to death, migration or aging (70 years old).

The schooling variable that is used in the main analysis comes from the FLEED and is constructed using the highest completed level of education. There are six education levels: primary or lower secondary education, upper secondary level education, lowest level tertiary education, lower-degree level tertiary education, higher-degree level tertiary education and doctorate or equivalent level tertiary education. These education levels are transformed into years based on Statistics Finland's recommendations (9, 12, 14, 16, 18 and 21 years, respectively).

Chapter 6 provides novel information on public sector labour markets by studying the genetic and environmental contributions to being a public sector worker and public-private sector earnings differentials. Based on the existing behavioural genetics literature, many of the economic outcomes are found to be broadly heritable, including educational attainment, vocational preferences and self-employment. Therefore, it is reasonable to consider public sector work as an occupational choice that is at least partly influenced by genetics. The estimated wage differentials, in turn, may be seriously biased if unobserved ability, the effects of family background and other unobserved variables related to genetics (such as attractiveness and social skills) are not controlled for in the analysis. The within twin pair method for identical twins constitutes strong controls for these variables. The data used in this chapter come from same sources as in Chapter 5. DeFries and Fulker (1985)'s method is used to decompose the variation in working in the public sector into parts explained by genetic factors and shared environment. A within twin pair (WTP) method is applied in the wage gap analysis.

4.2 Main results

The main results of the studies are summarised in Table 4. The analysis in Chapter 2 shows that increases in the initial and current unemployment rates negatively contribute to the wages of workers with primary education, particularly after EU accession, from the mid-1990s onwards. As the spot market effect is stronger, we interpret the spot market wage setting with some evidence related to the full commitment, risk sharing implicit contracts being prevalent among workers with a primary education. Interestingly, this wage setting fol-

lows the same pattern for the wages of higher educated workers, with the exception that the spot market model (i.e., the wage curve) is even more relevant to their wages than those of less-skilled workers. The results indicate that the wages of workers with secondary educations were particularly affected by initial unemployment rates, which indicates mobility costs for workers who change employers. The implicit contracts model becomes relevant in the 2000s for males, whereas the contracting model with costly mobility affects females' wages after the EU membership and disappears in the 2000s.

Our results show that only workers with primary and higher educations benefit from the decreasing spot market unemployment rate in the regions and that the wages of the secondary educated group are clearly more rigid. This decreased bargaining power of the secondary educated group, in conjunction with the finding of a decrease in routine task jobs in Finnish firms (Maliranta, 2010), could indicate the beginning of polarisation in the Finnish labour market in keeping with the model of Autor and Dorn (2011).

The findings of Chapter 3 are as follows. First, the public-private sector wage gap is strongly counter-cyclical in Finland. On average, a ten per cent increase in the unemployment rate increases the wage premium received by a public sector worker by one per cent. However, the cyclicality of the pay gap is not entirely stable over the period evaluated. The relationship between the unemployment rate and wages is highly positive and statistically significant in the yearly recession years of 1990 and 1991. This positive relationship disappears after 1991, but the local labour market wage setting again plays a role after EU accession in 1999. Clearly, the cyclical pattern primarily emerges in years with poor economic activity.

Second, separate analyses by government sector and quantiles of the wage distribution reveal that local government workers and those working at lower skill levels benefit more from an increasing unemployment rate, relative to private sector workers. Overall, the empirical results support the hypothesis that labour market conditions play an important role in determining the degree of cyclicality in public-private sector wage gaps in Finland. This is a result of local rather than economy wide labour market conditions that have different effects on private and public sector wages. On the basis of these results, people living in regions with high unemployment rates may be more likely to see public employment to take advantage of a large income premium and greater job security. This behaviour is expected to create several imbalances in the allocation of public and private sector jobs and recruitment problems in different areas and different time periods.

The results from Chapter 4 for males suggest that employees in the public sector are better off at the lower parts of the earnings distribution and worse off at the higher pay levels. This finding partially explains why transitions from the public sector to the private sector increase at higher skill levels (Borjas, 2003) and why it is generally more difficult for the public sector to attract and retain highly skilled male workers through wage policy (Lewis and Frank, 2002). The comparable results for females show that public sector employees earn a posi-

tive pay premium in each quantile and that this premium increases along the wage distribution. Our results also indicate that the roles of selection bias and industry-specific returns to skills are important in explaining the wage gaps, especially for females. In particular, the exclusion of endogenous selection from the wage equation may bias the pay gap estimates upward at the lower part of the wage distribution and downward at the upper part of the distribution.

The question of whether higher education has an effect on the likelihood of having a public sector job is examined in Chapter 5. The results show that education positively contributes to the public sector employment decision. This positive relationship remains unchanged even after controlling for unobserved heterogeneity caused by family background effects and genetics.

The findings of the analyses (Chapter 6) suggest that genetic factors account for a large share of the observed variance in working in the public sector (34-40 per cent), while the role of shared environments remains statistically indistinct from zero. Furthermore, at least one-third of this genetic variance is mediated through educational attainment.

The wage gap analysis provides interesting results. The OLS results indicate that public sector employees earn less that private sector employees. The wage gap is seven per cent for males and four per cent for females. When employees' unobserved ability and other differences related to genetics and experiences related to the family environment and family resources are held constant, the wage gaps become statistically insignificant.

TABLE 4 Summary of the studies and main results (Chapters 2-6)

Chapter	Focus	Data and methods	Main results
Chapter 2	The effect of current, initial and minimum unemployment rates on skill-level wages	• FLEED for the period from 1991 to 2004 • Private sector workers between 16-69 years of age • Two-level fixed-effects (FE)	• Initial and current unemployment rates negatively affect the wages of primary and higher educated workers • The spot market effect is stronger for the primary and higher educated groups • The initial unemployment rate negatively affect the wages of secondary educated workers
Chapter 3	The relationship between public-private sector wage gaps and labour market conditions	• Micro data for the period from 1990 to 2004, which are a seven per cent random sample of Finns in 2001 • Individuals between 18-63 years of age who were working in the public or in the private sector • OLS, IV, and QR methods	• On average, a ten per cent increase in the unemployment rate increases the public sector pay premium by one per cent • Local government workers and those employed at lower skill-levels benefit more from an increasing unemployment rate • The pay gap cyclicality primarily emerges during recessions
Chapter 4	The public-private sector wage gaps by quantiles of the distribution of wages	• Micro data for the period from 1995 to 2004, which are a seven per cent random sample of Finns in 2001 • Individuals between 18-63 years of age who were working in the public or in the private sector • QR method with endogenous selection, Oaxaca decomposition analysis	• Male workers earn more in the public sector at lower skill levels, while the reverse is true at higher skill levels • Females consistently earn more in the public sector, and the premium increases along the earnings distribution • The roles of selection and industry-specific returns to skills are important in explaining the pay gaps, especially for females

TABLE 4 (Continues) Summary of the studies and main results (Chapters 2-6)

Chapter 5	The effect of higher education on the choice of working in the public sector	• Twin data that are matched with the FLEED, for a period from 1990 to 2004 • Public and private sector workers • Twin pairs who were 33-60 years old in 1990 • Conditional (FE) logit regression	• Higher education contributes positively to the likelihood of being a public sector worker • The relationship between education and public sector work remains positive even after controlling for family background and genetic effects
Chapter 6	The genetic and environmental contributions to public sector work and public-private sector wage gaps	• Twin data that are matched with the FLEED, for a period from 1990 to 2004 • Public and private sector workers • Twin pairs who were 33-60 years old in 1990 • DF-model, OLS, WTP methods	• 34 - 40 per cent of the variation in working in the public sector can be explained by genetic factors, and this effect is partly mediated through educational outcomes • The OLS results indicate that public sector employees earn less than private sector employees • The WTP results indicate that there is no difference in the pay offered by the two sectors for males and females

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CHAPTER 2
SPOT MARKET WAGES, IMPLICIT CONTRACTS AND TECHNOLOGICAL CHANGE: SKILL-LEVEL EVIDENCE FROM FINLAND*

Abstract**

This article investigates the relevance of the theories of implicit contracts and spot market model to the skill-level wages in Finland. We use linked worker-firm panel data over the period from 1991 to 2004, which included major institutional and technological changes. We find similar patterns in the wage flexibility of primary and highly educated workers: their wages increased with the decreasing spot market unemployment rate after the EU membership still exhibiting some weak backward linkages. The wages of the secondary-educated did not follow the decreasing spot market unemployment, but instead some signs of the full commitment risk sharing were found.

Keywords: implicit contracts, spot market, unemployment, technological change

JEL classification: J30

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1 Introduction

Abraham and Haltiwanger (1995) state that the debate over the cyclicality of real wages has a long history filled with conflicting hypotheses and inconclusive empirical evidence. However, a recent suggestion is that wage flexibility can be divided into two aspects (Faggio and Nickell, 2005). The first of these aspects is a responsiveness of wages to prevailing labour market conditions, and the second relates to the responsiveness of wages to the idiosyncratic shocks within firms. These shocks occur to the firms' productivity or to the demand for their output. The wage curve (see Nijkamp and Poot, 2005 for a comprehensive survey) and implicit contracts literatures concentrate on the first aspect of wage flexibility by unravelling the relationship between the labour market conditions and wages.

Worker mobility makes the difference between the theories explaining the link between wages and unemployment rates (see Malcomson, 1999 for a review). *A spot market model* implies that the workers are mobile between firms but that the mobility is strongly related to the cycle. Therefore, the current degree of unemployment rates is crucial by negatively affecting the skill-adjusted wages. The contract models assume that the history of the labour market conditions experienced by workers affects their current wages. In *a full-commitment risk-sharing model*, wages are determined by the tightness of the labor market at the time the worker was hired, indicating the costly mobility and the binding contracts for the workers. *A risk-sharing implicit contract model with worker mobility* implies that the tightest labour market condition since the worker was hired matters. The model assumes that wages are adjusted upwards when the unemployment rate decreases but are not adjusted downwards with the higher unemployment rates, thus indicating costless mobility for the workers.

The literature provides varying empirical evidence on the existence of the implicit contract and spot market models in the labour market. These findings indicate that the implicit contract model with costless mobility more accurately describes the US and Canadian labour markets than the other models (Beaudry and DiNardo, 1991; McDonald and Worswick, 1999). However, Grant (2003) supports both the implicit contracts with costless mobility and the spot market in the US, the latter having a stronger effect. Grant argues that the wages probably follow a more general contract model that predicts partial wage insurance against negative labour demand shocks connected to partial wage responsiveness to current labour market conditions. The findings from the UK, in turn, give support only for the spot market wage setting (Devereux and Hart, 2007).

This article contributes to this general discussion in two ways. First, we test for the presence of spot market wages and implicit contracts in the wages of the private sector workers with different education levels. Second, we allow for the contracts to vary over time, which relates them to the technical and institutional changes over the research period. The recent empirical research on changes in the wage inequality and the skill composition of the workers has

certain common features. The observed increase in overall wage inequality since 1980s, particularly in the US and the UK labour markets, has been generally accounted for by the skill-biased technological change (SBTC) (see, e.g., Katz and Autor, 1999 for a survey; Chennels and van Reenen, 1999; Acemoglu, 2002). According to this view, technological advances raise the relative productivity and demand for skilled labour, which raises skilled labour's wages in every work task.

Autor *et al*. (2003) present a more nuanced view of the effects of the technological change on the labour market. According to their task-based framework, technological change decreases the demand for routine tasks, which are usually located in the middle of the skill distribution instead of the bottom of the distribution (see also Goos and Manning, 2007; Weiss, 2008; Autor and Dorn, 2011). The demands for non-routine tasks (abstract and non-routine manual), in turn, increase, and these tasks are located at the bottom and the top of the skill distribution. An increase in the demand for both high-skilled and unskilled workers and a decrease in the demand for moderately skilled labour polarise the labour market[1] and weaken the relative position of those in the middle of the skill distribution.

Our data are linked employee-employer panel data from Finland over the period of 1991 to 2004. The period is particularly interesting to test for the presence of the implicit contracts in different education groups. First, Finland faced a severe recession in the early 1990s. Second, Finland became a member of the European Union in 1995 and the Economic and Monetary Union (EMU) in 1999, thereby losing its independence in adjusting the effects of negative asymmetric shocks through exchange rates and monetary policy. Third, Finland faced a rapid increase in a new export-oriented high-tech sector led by Nokia from the middle of the 1990s onwards. Additionally the ICT-boom, a reduction after it and a recovery from the reduction, affected the conditions of the Finnish economy and the labour market.

The remainder of the article is organised as follows. Section 2 describes the linked employer-employee panel data. Section 3 presents the econometric framework of our study and the empirical results for the whole period and for different phases of the period. Section 4 concludes.

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1 Acemoglu (1999) explains the polarisation by search frictions in the labour market. If the supply of skilled labour increases, firms start to eliminate jobs in the middle of the distribution, replacing these jobs with vacancies for both highly skilled and unskilled workers.

2 Data description

Our data are an 8.25% random sample of the Finnish population between the ages of 16 and 69 over the period from 1991 to 2004. The sample is based on the Finnish Longitudinal Employer-Employee data (FLEED) of Statistics Finland. FLEED are constructed from a number of different administrative registers of individuals, private firms and establishments that are collected or maintained by Statistics Finland.

We test the wage effects of implicit contracts and the spot market for the three education levels that are based on the International Standard Classification of Education (ISCED) classification: primary education (levels 1 and 2), secondary education (levels 3, 4 and 5B) and higher education (level 5A). The dependent variable is the log of the monthly earnings that are deflated to 2004 prices using the consumer price index. In this analysis, we concentrate on the full-year and full-time workers because these employees represent the prime working population that have relatively stabile job careers. The data have incomplete information on part-time workers; therefore, we set wage restrictions at the lower end of the earnings distribution.[2] Our final sample contains 239,944 wage observations from 156,296 males and 83,648 females from the five regions over a period of 14 years. The lower proportion of females in the sample is reasonable, given that almost half of the total female labour force is employed in the public sector.

The unemployment rates are collected from the five Nomenclature of Territorial Units for Statistics 2 (NUTS2) regions, which are labelled according to the Labour Force Survey of the Statistics Finland: Southern, Western, Eastern, Northern Finland and Åland. Table 1 describes the mean values for the most important variables by gender and education level. The overall list of variables and their descriptions is given in Appendix. On average, the individuals are 36 years old and have 9-14 years of potential work experience, whereas workers report a considerable shorter mean duration in tenure (4 years). A higher proportion of men than women are married or cohabiting, which is a common finding in the literature (e.g., Matsui, 2004; Pastor, 2008). Additionally, highly educated individuals are more likely to be married than less educated individuals. Approximately 93% of the individuals were also wage earners during the previous year, while 1-3% of them were self-employed, unemployed or students. No more than 13-19% of the firms are foreign-owned, and this share is higher for the firms that employ the highly educated workers. Finally, segregation by sex is evident; men tend to work in male-dominated firms and women in female-dominated firms.

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2 The wage limits for females are 1,400 (1,750) euros per month with primary and secondary level (higher level) of education and for males are 1,600 (2,000) euros per month with primary and secondary level (higher level) of education. These limits are based on the information from Statistics Finland on mean wages at the lowest percentile for the employees' earnings distribution at that particular education level.

TABLE 1 Sample characteristics by gender and education level

	Men			Women		
	Primary	Second-ary	Higher	Primary	Second-ary	Higher
Variables						
Wage (€)	2421	2921	3935	1961	2205	3098
Initial unemp. rate (%)	14.9	14.6	14.4	14.5	14.5	13.5
Minimum unemp. rate (%)	12.2	12.0	11.7	12.0	12.0	11.4
Spot market unemp. rate (%)	13.2	13.2	12.7	13.0	13.0	12.2
Age	34.9	37.3	36.7	36.9	36.2	35.6
Potential work experience	14.0	12.4	9.8	14.4	12.2	8.8
Tenure	3.7	3.8	3.6	4.0	3.8	3.2
Share of females in a firm (%)	23.4	29.8	30.5	56.1	52.5	49.1
Married/cohabiting, dummy	.74	.79	.81	.69	.73	.71
Foreign owned firm, dummy	.13	.17	.18	.14	.16	.19
Position at previous year, dummy						
Wage earner	.92	.94	.93	.93	.93	.94
Self-employed	.02	.02	.02	.01	.01	.01
Unemployed	.03	.02	.02	.02	.02	.02
Student	.02	.01	.02	.02	.02	.02
At home with children	.00	.00	.00	.01	.01	.00
Some other position	.01	.01	.01	.01	.01	.01
Number of observations	91,164	29,303	35,829	39,091	29,736	14,821

The average monthly wages are approximately 2,400-3,900 euros for men and 2,000-3,100 euros for women, and the wages are higher for the highly educated employees. The average regional unemployment rates are at high levels due to a recession in Finland in the early 1990s, which had a long-lasting impact on the labour market.[3] The means of the unemployment measures vary between 12% and 15%, with the highest rates at the beginning of tenure for both gender and across the education levels. Evidently, all the unemployment measures are higher among less skilled workers (see also Mincer, 1991) and men. The gender difference may be based on gender segregation in occupations and differences in hours worked.

There are, however, wage and unemployment variations over time. The average real wage by education level and the aggregate spot market unemployment rate are depicted in Fig. 1. The aggregate unemployment rate was 6% in 1991 and peaked at 17% in 1993-1994. After the peak, the unemployment rate decreased steadily to 9% in 2004. The increase in the real wage for all education

[3] The recession occurred because of badly managed financial deregulation of the 1980s, the collapse of Soviet Union that led to a 70 per cent drop in trade with Russia, an overall sharp drop in aggregate demand and a slowdown in the economies of Western Europe.

levels was rather stable during the entire period but showed some deviations in the years of the deteriorated labour markets. This trend is in line with Pehkonen (2000), who scrutinised the possible changes in the functioning of the Finnish economy due to the recession of the early 1990s. Despite the dramatic declines in Gross Domestic Product (GDP) and the demand for labour, his analysis of the period from 1975 to 1996 suggests that the adjustment to a shock happened mainly via quantities not prices. He found that the nominal wages continued to rise by approximately 2% per annum, although real wages somewhat declined.

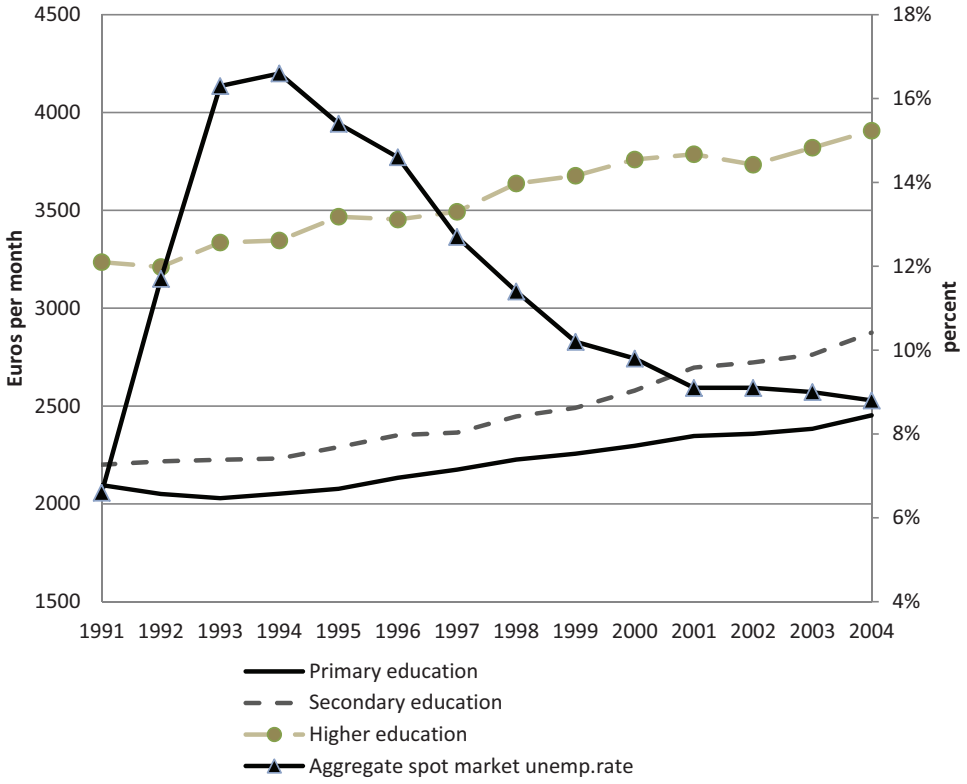

FIGURE 1 Average real wages by education level and aggregate unemployment rate in 1991-2004

3 Empirical analysis

3.1 Wage equation with two high dimensional fixed effects

The econometric model of this study follows the original idea of Beaudry and DiNardo (1991), but it is augmented with the time-invariant individual and firm-level heterogeneity controls using Cornelissen's (2008) method. The wage equation takes the following form:

$$\ln w_{ireft} = \alpha_{ireft} + \tau_f + \beta_c u_{rt} + \beta_0 u_{rt_0} \beta_{min} \min\left(u_{rt_0}, \ldots, u_{rt}\right) + \gamma X_{it} + \theta Z_{et} + \delta Y_{ft} + dt + dr + \varepsilon_{ireft} \quad (1)$$

where w_{ireft} is the monthly wage obtained by individual *i* working in region *r*, in establishment *e*, in firm *f* in year *t*. α_i denotes an individual-level fixed effect, τ_f is a firm level fixed effect, u_{rt} is the spot market unemployment rate in region *r* at year *t*, u_{rt0} refers to the regional unemployment rate at the beginning of a tenure, and min(u_{rt0},…, u_{rt}) is the minimum unemployment rate during the tenure. X is a vector of the individual, Z a vector of the establishment and Y a vector of firm characteristics. dt denotes the fixed effect for years, and dr denotes the fixed effects for regions. ε_{ireft} is a random error term.

The spot market model is consistent with $\beta_c < 0$ and $\beta_0 = \beta_{min} = 0$, i.e., a worker's wages depend only on the contemporaneous unemployment rate. In a full-commitment risk-sharing model the wages are not renegotiated over the tenure, and the model is consistent with $\beta_0 < 0$ and $\beta_c = \beta_{min} = 0$. When the contract is binding on a firm, but the workers can change employers without much cost, the implicit contracts model implies that $\beta_{min} < 0$ and $\beta_c = \beta_0 = 0$. A combination of these theories is also possible, as, e.g., in Beaudry and DiNardo (1991). McDonald and Worswick (1999) also argue that rather than providing a test between different contracting models, a nested specifications fit creates a more complex earnings profile over the business cycle than would be allowed by a single variable.

3.2 Results of the spot market and implicit contracts models

The results of the estimations are reported in Table 2. The explanatory powers of the model are high and vary between 0.50 and 0.61. Overall, the estimates are well defined and have the expected signs. For example, the return to work experience is positive and statistically significant for both genders, being higher for the highly educated. In accordance with previous evidence (e.g., Napari, 2008 from Finland), the presence of small children has a negative effect on females earnings and this effect is strongest for the highly educated women. The status of the employee during the previous year also matters. In particular, men

earn a small earnings cut if they were unemployed during the previous year, while women face a similar earnings cut if they were students. In turn, wages are unaffected by the firm's establishment year, which can be observed in an analysis of the *F*-tests at the bottom of the Table 2.

With the wage effects of the unemployment rates, there are considerable differences between education-specific outcomes. All the unemployment rates are significant for males who have attained only a primary education. The effects of the current and initial unemployment rates are negative and the minimum unemployment rate has a positive affect, which is not expected by any of the tested wage setting models. On the other hand, the opposite signs for the effects for the initial and minimum unemployment rates indicate the presence of the theory of implicit contracts with costly mobility for the worker. Because the spot market effect is strongest (-0.012 versus -0.002 and 0.003), we interpret that the spot market wage setting with some evidence related to the full-commitment risk-sharing implicit contracts are prevailing for the primary educated men. The corresponding results for women indicate that it is the initial conditions that matter with their wages with an estimate of -0.004.

The results for the employees who have attained a secondary education indicate no evidence of any kind of contracting or spot market models for men, whereas it is again the initial unemployment rate that has a negative effect on women's wages. Finally, all the unemployment rates affect the wages of the highly educated men in the same manner as for the primary educated men, which gives the strongest support to the spot market model with some friction related to the full-commitment risk-sharing implicit contracts model. With an estimate of -0.033, the results for the highly educated women indicate that only the current conditions of the labour markets affect their wages.

TABLE 2 Results on unemployment wage effects

	Men			Women		
	Primary	Secondary	Higher	Primary	Secondary	Higher
Unemployment rates						
Spot market	–.012 (.003)*	–.009 (.006)	–.020 (.007)*	–.007 (.004)	–.008 (.006)	-.033 (.016)*
Initial	–.002 (.001)*	–.000 (.002)	–.009 (.002)*	–.004 (.002)*	–.006 (.002)*	-.006 (.004)
Minimum	.003 (.001)*	.003 (.002)	.010 (.002)*	.001 (.002)	.003 (.002)	.001 (.005)
Experience	.011 (.001)*	.027 (.002)*	.042 (.002)*	.004 (.001)*	.020 (.003)*	.037 (.006)*
Experience squared	–.029 (.002)*	–.001 (.000)*	–.001 (.000)*	–.000 (.000)*	–.001 (.000)*	–.001 (.000)*
Tenure	.023 (.002)*	.012 (.003)*	.017 (.003)*	.005 (.003)*	.011 (.004)*	-.007 (.006)
Tenure squared	–.001 (.000)*	–.001 (.000)*	–.001 (.000)*	–.001 (.000)*	–.001 (.000)*	–.001 (.000)*
Married/ cohabiting	–.001 (.003)	–.007 (.006)	.004 (.007)	–.006 (.004)	–.016 (.006)*	–.011 (.011)
Children	–.003 (.003)	.005 (.005)	.008 (.006)	–.021 (.005)*	–.051 (.005)*	–.126 (.009)*
Position at previous year						
Self-employed	.002 (.006)	–.001 (.010)	–.014 (.011)	– .006 (.011)	– .010 (.014)	-.047 (.029)
Unemployed	–.014 (.005)*	-.017(.009)	–.038 (.011)*	– .014 (.008)	– .004 (.010)	–.016 (.019)
Student	–.010 (.006)	–.028 (.011)*	–.011 (.011)	– .025 (.008)*	–.021 (.011)*	–.025 (.020)
At home with children	–.036 (.059)	no	.013 (.102)	.002 (.012)	-.005 (.016)	.007 (.033)
Other position	–.010 (.009)	–.033 (.015)*	–.036 (.016)*	.017 (.013)	.017 (.017)	– .027 (.027)
Foreign owned firm	–.017 (.005)*	.018 (.009)*	.006 (.010)	.009 (.007)	-.013 .010)	–.012 (.017)
Share of women in firm	.030 (.022)	.010 (.037)	.016 (.039)	– .034 (.029)	.023 (.035)	-.045 (.064)
R^2	.61	.57	.60	.50	.54	.54
Number of obs.	91,164	29,303	35,829	39,091	29,736	14,821
Joint significace F-test:						
NUTS2	5.62*	0.96	6.91*	1.62	1.99	1.28
Field of education	3.23*	2.01	2.52*	2.05	8.58*	3.77
Establishment year	.28	1.90	1.97	1.33	1.38	0.30
Size of the firm	6.40*	2.82*	2.57*	1.63	4.16*	2.43*
Size of the plant	1.88	2.28*	2.10	2.06	0.68	0.89
Field of industry	3.72*	1.17	2.84*	.66	1.41	2.73*

Notes: * denotes test statistic significance at the 5% level. No: no observations. SE's in parenthesis.

A robustness check of these results is needed. Namely, the aggregate unemployment rate decreased continuously after 1994, and the regional unemployment rates followed this trend after 1996 with some small variations, which indicates that the difference between the minimum unemployment rate during a worker's tenure and the spot market unemployment rate tends to diminish for most observations over time. To deal with possible collinearity, we also estimate the wage equations without simultaneously controlling for all of the unemployment rate measures. The results presented in Table 3 provide a good robustness check of the model. In particular, the results indicate that the full-commitment risk-sharing model is always relevant for primary and secondary educated women, the spot market unemployment rate is always negative for the highly educated women, and the wages of the secondary educated men are independent of the tested wage setting models. The estimates for primary and higher educated men, in turn, show that the effect of the spot market model is more relevant to the workers with primary education, whereas the full-commitment risk-sharing model is more relevant to the wages of the highly educated men.

TABLE 3 Results on unemployment wage effects for all combinations

	Men						Women					
	1	2	3	4	5	6	1	2	3	4	5	6
Primary education												
Spot market	-.010*			-.010*		-.011*	-.007			-.007		-.006
Initial		-.001		-.001	-.002*			-.004*		-.004*	-.004*	
Minimum			.001		.002	.001			-.002		.000	-.001
Secondary education												
Spot market	-.007			-.007		-.009	-.007			-.007		-.006
Initial		.001		.001	.000			-.004*		-004*	-.005*	
Minimum			.002		.002	.002			-.001		.002	-.001
Higher education												
Spot market	-.012			-.012		-.016*	-.034*			-.032*		-.031*
Initial		-.005*		-.005*	-.008*			-.006		-.006	-.006	
Minimum			.003		.008	.004*			-.005		-.002	-.002

Notes: * denotes test statistic significance at the 5% level.

3.3 Differential effects in the business cycle

The share of foreign investments rose rapidly due to an increase in export-oriented high-tech industry and Finland's entry into the EU in 1995, which removed a considerable number of barriers for foreign investment. According to Huttunen (2007), this trend together with the introduction of the new technology paradigm, ICT, also led to a general shift in employment towards the highly educated labour force and it increased the wage for the highly skilled labour force (also see Conyon *et al*., 2002).

According to theory, the wage flexibility should have become a substitute for the exchange rate and monetary policy, to mitigate the negative effects of asymmetric shocks after joining the EMU (e.g., Hallett *et al*. 2000). However, instead the empirical findings suggest that joining the Euro area has not led to the higher use of labour market wage flexibility as an adjustment instrument (e.g., Maza, 2006; Babecky and Dybczak, 2008). Previous findings from Finland, however, suggest that although real wage rigidity was at high level in the late 1990s (e.g., Böckerman *et al*., 2010), wages were actually flexible in the beginning of the 2000s (Maczulskij, 2011).

To consider this possibility for the differential wage effects of the current and past labour market conditions in the different phases of the research period, we add interaction terms of year dummies and unemployment measures to the model. The results of this examination are presented in Table 4.[4] The findings indicate that the wage flexibility is not constant over time. The effect of the initial unemployment rate is negative for women with only a primary education after the EMU membership for the years 1999-2004. We also find evidence that the spot market unemployment rate affects wages – contrary to the aggregate results – from 1996 to 1999, which are the first years of EU membership. The results for secondary educated women imply that the initial unemployment rate significantly affects their wages from 1996-2001, while the spot market model is relevant to women with a higher education for the same period, with some frictions from the implicit contracts with costly mobility.

According to the results, all the contracting models are relevant to the wages of men with a primary education, depending on the phase of the research period. The costless mobility is relevant for 1991-1995, the full-commitment risk-sharing is relevant for 1996-2001 and the spot market model is relevant for the years 2002-2004. The results for men with a secondary level education are not robust across different specifications. Therefore, we conclude that none of the contracting models matter with their wages. The wages of highly educated men are, in turn, affected by the initial unemployment rate for the years 1996-2001 and the spot market unemployment rate for the years 1996-2004, with the spot market effect clearly being stronger.

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[4] To avoid a problem of collinearity with the different unemployment rates, we estimated the wage equation with all possible combinations as in Table 3. The results were basically qualitative and quantitative representative. Therefore, the results of the model that augment all three unemployment measures are presented. The complete results are available from the authors upon request.

TABLE 4 Results on unemployment wage effects for the years 1991-2004

	Men			Women		
	Primary	Secondary	High	Primary	Secondary	High
Spot market unemp. rate						
1991	– .006	.024	– .002	– .016	– .018	– .024
1992	– .003	.023	.001	– .007	– .008	– .008
1993	.000	.024	– .004	– .007	– .005	– .008
1994	– .001	.024	– .002	– .012	– .008	– .009
1995	– .001	.019	– .008	– .006	–.010	– .001
1996	– .006	– .012	– .028*	– .022*	.002	– .066*
1997	– .007	– .013	– .028*	– .020*	.002	– .067*
1998	– .009*	– .008	– .029*	– .014*	.001	– .056*
1999	– .009*	– .007	– .029*	– .016*	– .003	– .067*
2000	– .007	– .011	– .023*	– .014	.003	– .066*
2001	– .006	– .008	– .029*	– .014	– .004	– .060*
2002	– .022*	.028	– .046*	.005	.020	– .021
2003	– .023*	.028	– .053*	.005	.021	– .026
2004	– .021*	.031	– .057*	.005	.021	– .020
Initial unemp. rate						
1991	.015*	.016	– .001	– .003	– .007	.004
1992	.013*	.016	.007	.001	– .010	– .005
1993	.009*	.011	.005	.002	– .018	– .012
1994	.011*	.015	.006	.003	– .012	– .005
1995	.013*	.010	– .006	.003	– .010	.007
1996	– .003*	– .005	– .014*	– .003	– .009*	– .012
1997	– .003*	– .004	– .013*	– .003	– .009*	– .012*
1998	– .004*	– .003	– .002*	– .002	– .008*	– .008
1999	– .005*	– .003	– .013*	– .005*	– .006*	– .009
2000	– .004*	– .006	– .014*	– .006*	– .009*	– .009
2001	– .006*	– .007*	– .014*	– .007*	– .011*	– .012*
2002	.003	– .021*	– .003	– .013*	– .007	– .024
2003	.002	– .021*	– .001	– .013*	– .005	– .021
2004	.003	– .023*	.000	– .014*	– .006	– .022
Minimum unemp. rate						
1991	– .010*	– .002	.002	.004	.014	– .001
1992	– .011*	– .007	– .005	– .002	.012	.001
1993	– .007	– .004	– .002	– .002	.019*	.011
1994	– .010*	– .006	– .005	– .002	.014	.006
1995	– .012*	– .002	.009	– .004	.012	– .006
1996	.003*	.000	.011*	– .002	– .001	.004
1997	.003	– .001	.010*	– .005	– .004	.002
1998	.004*	– .006	.011*	– .006	– .005	– .002
1999	.004	– .008	.011*	– .004	– .005	.007
2000	.003	– .003	.009	– .007	– .007	.010
2001	.001	– .006	.011	– .006	– .002	.009
2002	.004	– .024*	– .006	.002	.012	.063
2003	.003	– .026*	– .007	.003	.010	.070
2004	.001	– .029*	– .005	.004	.010	.075
No. of obs.	91,164	29,303	35,829	39091	29736	14821

Notes: * denotes test statistic significance at the 5% level.

4 Conclusions

This article tests for the existence of the implicit contracts and the spot market model for different education levels in Finland over the period from 1991 to 2004. We find that increases in the initial and current unemployment rates negatively contribute to the wages of the primary educated workers, particularly from the mid 1990s onwards. Interestingly, the wage setting of the primary educated follows the same pattern as the wage setting of the highly educated workers, with the exception that the spot market model (i.e., the wage curve) is more relevant for the highly educated than for primary educated workers.)

The results indicate that particularly the wages of the highly educated men have been flexible upwards, together with the decreasing spot market unemployment rate over the research period. Still, over six years after the EU membership, there were backward linkages in wages, which indicates some mobility costs for workers who change employers. For primary educated men, we also find backward linkages in wages, which follow the full-commitment risk-sharing model after the EU membership but also indicates the costless mobility before the membership. The implicit contracts for primary educated men disappear in the 2000s, and the wages increase with the decreasing spot market unemployment rate.

For women, we also find that the wage flexibility is affected by the EU membership. The wages of primary educated women follow the spot market in the late 1990s, but the costly mobility takes a role in the early 2000s. The costly mobility holds with the secondary educated and the spot market wages with the highly educated women in the late 1990s.

It is interesting to note that only primary and higher educated groups benefit from the decreasing spot market unemployment rate in the regions and that the wages of the secondary educated group are clearly more rigid. This decreased bargaining power of the secondary educated group with the findings of the decrease in routine task jobs in the Finnish firms (Maliranta, 2010) could indicate the beginning of the polarization in the Finnish labour market. Interpreting these patterns as an evidence of the polarization of the contracting along the model of Autor and Dorn (2011) would, however, require more empirical evidence.

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Appendix A

TABLE A1 Variable description

Variable	Description
ln(Wage)	Monthly earnings (annual earnings/working months)
Unemployment rates	
Initial	Unemployment rate at start of job
Minimum	Minimum unemployment rate since start of job
Spot market	Spot market unemployment rate
Individual characteristics	
Experience	Potential work experience (age – age of graduation)
Exper_squared	Potential work experience squared
Tenure	Work experience in current job
Tenure_squared	Work experience in current job squared
Education field	
Educational	Teacher education or educational science
Humanistic	Humanities or arts
Business	Social sciences or business
Natural sciences	Natural science
Technology	Technology
Agriculture	Agriculture or forestry
Health	Health or welfare
Services	Services
Not known	Not known or unspecified
Married/cohabitimg	Individual is married or cohabiting
Children	Number of children under 7 years of age
Status of the employee at previous year	
Wage earner	Individual was a wage earner
Self-employed	Individual was a self-employed
Unemployed	Individual was an unemployed
Student	Individual was a student
Home with children	Individual was at home with children
Other position	Individual was out of the labor force for other reason
Firm-specific characteristics	
Establishment year	
Estab_76	Firm was established before 1976
Estab_80	Firm was established during 1977-1980
Estab_85	Firm was established during 1981-1985
Estab_90	Firm was established during 1986-1990
Estab_95	Firm was established during 1991-1995
Estab_98	Firm was established during 1996-1998
Estab_00	Firm was established during 1999-2000
Estab_04	Firm was established during 2001-2004

TABLE A1 (Continues) Variable description

Variable	Description
Size of the firm	Size of the firm measured as number of employees
Firmsize_4	Number of employees is less than 5
Firmsize_9	Number of employees is between 5 and 9
Firmsize_19	Number of employees is between 10 and 19
Firmsize_49	Number of employees is between 20 and 49
Firmsize_99	Number of employees is between 50 and 99
Firmsize_299	Number of employees is between 100 and 299
Firmsize_300-	Number of employees is more than 299
Foreign owned firm	Foreign ownership more than 50%
Share of women in firm	Share of women employees in the firm, %
Plant-specific characteristics	
Size of the plant	Size of the plant measured as number of employees
Plantsize_4	Number of employees is less than 5
Plantsize_9	Number of employees is between 5 and 9
Plantsize_19	Number of employees is between 10 and 19
Plantsize_49	Number of employees is between 20 and 49
Plantsize_99	Number of employees is between 50 and 99
Plantsize_100-	Number of employees is more than 99
Field of industry	
Mining	Mining and quarrying
Manufacturing	Manufacturing, publishing and printing
Electricity, water and construction	Electricity, gas, steam and hot water supply, construction
Wholesale	Wholesale trade
Retail and restaurant	Retail trade, hotels and restaurants
Transport	Land, water and air transport, supporting and auxiliry transport activities, post and telecommunication
Finance	Financial intermediation
Real estate	Real estate and renting, computer and related activities, research and development and other activities
Regional characteristics	
NUTS2-regions	
NUTS1	Southern Finland
NUTS2	Western Finland
NUTS3	Eastern Finland
NUTS4	Northern Finland
NUTS5	Åland

CHAPTER 3
PUBLIC-PRIVATE SECTOR WAGE DIFFERENTIALS AND THE BUSINESS CYCLE*

Abstract**

This paper uses microeconomic data for the period from 1990 to 2004 to examine the relationship between public-private sector wage differentials and labour market conditions in Finland. The results show that the public sector wage premium is strongly counter-cyclical. On average, a ten per cent increase in the local unemployment rate increases the public-private sector wage gap by one per cent. Separate analyses by government sector and quantiles of the distribution of wages reveal that it is local government workers and those working at lower skill levels who benefit more from increasing unemployment rate. The paper also exploits the longitudinal structure of the data to examine whether the results are constant over time. These results indicate that the cyclical pattern primarily emerges in years with deteriorated labour markets.

Keywords: public sector pay, wage curve

JEL classification: E32, J31, J45

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1 Introduction

Over the last three decades, interest in public sector labour markets has increased, leading to a number of studies that examine the wage differentials between public and private sector employees. Previous studies have primarily focused on explaining why such wage gaps exist. These include Kanellopoulos (1997), Lassibille (1998) and Christofides and Pashardes (2002), who suggest that the positive wage premium received by a public sector employee is mainly explained by better skill characteristics; Bender and Elliott (2002), who find a significant effect of job-specific attributes on wage gaps; and Mueller (1998), Lucifora and Meurs (2006) and Papapetrou (2006), who provide evidence of a higher public sector earnings premium at lower skill levels. The issue of how labour market conditions affect wage gaps has received far less attention, and the goal of this study is to fill this gap in the literature.

The role of labour market conditions may differ between the public and private sectors, as the extent of job protections and wage rigidity through formal agreements is typically higher in the public sector. Empirical literature finds that unemployment affects private sector wages, but only marginally public sector wages (e.g., Card, 1995; Ilkkaracan and Selim, 2003; Sanz-de-Galdeano and Turunen, 2006). Therefore, the public-private sector earnings differential is likely to vary counter-cyclically. Using data for comprehensive time periods, Disney and Gosling (1998) and Melly (2005) find that the wage gaps, indeed, vary over time. The interpretation of this observation is that the earnings premium received by a public sector worker tends to increase with decreasing economic activity and decrease with increasing economic growth (see also Disney and Gosling, 2008; Bargain and Melly, 2008). However, to the best of my knowledge, no study has attempted to examine this observation empirically.

From a policy perspective, it is useful to understand the extent of wage gap cyclicality. First, typical wage gap analyses using cross-sectional data are misleading, if the results significantly depend on which chosen points in the economic cycle are selected for study. Second, a strong counter-cyclical pattern in the wage gap may create several imbalances in the allocation of public and private sector jobs and recruitment problems. There are some studies that support this concern. For example, Krueger (1988) and Pagani (2003) show that the supply of public sector jobs increases as the public sector earnings premium increases. Krueger (1988) and Falch *et al*. (2009) also conclude that an increase in the public-private sector earnings differential is associated with an increase in the average quality of applicants for public sector jobs. The public sector may thus face serious problems in retaining high-quality labour, especially in periods of low unemployment. This situation constitutes a larger potential threat in an economy where the role of the public sector is strong. Therefore, the Finnish economy provides a good case study because in many ways, it is representative of modern advanced countries – high GDP per capita, a strong welfare state,

high employment, rise in service sector, a well-educated labour force and a strong tradition of public sector employment.

This paper adds to the literature by investigating the role of labour market conditions on public-private sector wage differentials. The data are individual-level micro data from Finland that cover the years from 1990 to 2004. The research period provides an excellent opportunity to examine the counter-cyclical wage gap for two reasons. First, Finland faced a severe recession and recovery period in the early 1990s, as well as a rapid ICT (information and communications technology) boom/recession at the turn of the century. Second, Finland became a member of the European Union (EU) in 1995 and the Economic and Monetary Union (EMU) in 1999, thereby losing its independence in responding to the effects of negative macroeconomic shocks through monetary policy and exchange rates.

The remainder of this paper is organised as follows. Section 2 introduces the Finnish labour markets, with the information on centralised wage setting and aggregate wage evolution both in the public and private sectors, over a period of 30 years. Section 3 outlines the econometrical framework of the study, while Section 4 summarises the dataset. The empirical results are presented in Section 5. They are based on the extended version of the wage curve model (Blanchflower and Oswald, 1994). Section 6 discusses the main results, while Section 7 concludes the paper.

2 Institutional background

The Finnish public sector is large in terms of both its number of employees and its share of GDP. Public sector services are extensive and are funded with tax revenues. The overall tax rate is high, being 43 per cent in 2011 (see Statistics Finland). The entire public sector consists of central and local government sectors and the church.

Central government operations are associated with the provision of important and indispensable services in the social, business and civic services sectors. The largest personnel groups in the state's on-budget entities are defence, rescue and police services personnel and those employed by universities. (Finnish public sector as employer, 2006). A substantial share of central government jobs are located in the Helsinki region, with the share increasing from 31 per cent in 1990 to 42 per cent in 2009 (Statistics Finland). Like most European countries, Finland has seen significant privatisation of former state monopolies over the last two decades, the number of central government personnel reducing from over 216,000 employees in 1990 to slightly fewer than 142,000 in 2009. Most of this decrease is due to the conversion of government agencies and departments into unincorporated state enterprises, incorporated state companies and municipal companies (Statistics Finland; Finnish public sector as employer, 2006). Currently, the central government sector employs approximately six per cent of the total employed labour force in Finland (Statistics Finland).

The local government sector, in turn, provides basic public services for municipal residents. Approximately 20 per cent of the employed workforce is employed by the local government sector. The share of local government employees varies substantially across municipalities, from ten per cent to approximately 50 per cent. Typically, the local government sector is an important employer in regions where labour markets perform relatively poorly. Thus, the share of local government (and total public sector) employment is particularly high in regions where the average unemployment rate is higher. In addition, the number of local government personnel has more than doubled over the past thirty years. This increase is due to increases in statutory welfare services, particularly in the 1970s and 1980s. More than 80 per cent of all local government personnel work in the health care, social services or educational sectors (excluding universities), providing statutory basic local government services (Finnish public sector as employer, 2006).

2.1 Bargaining institutions

The Finnish labour market is heavily unionised, with one of the highest rates of union membership in the industrialised world (70 per cent; see the OECD for a recent country comparison). In the public sector, the union density is even higher, at approximately 80 per cent. There are three main central labour confederations with more than 70 trade unions on the employee side and four confederations on the employer side. In the public sector, all agreements are made between the employer confederations and bargaining agents.

Since 1968, industrial relations have been regulated by collective agreements that regulate the minimum conditions for the job in question and ensure labour peace. These agreements provide the framework for branch-specific collective agreements. In all cases, the employer associations and trade unions sign their own collective agreements. Because collective labour contracts are also binding for non-union members, approximately 90 percent of all employees are covered by collective agreements.

Although centralised agreements have been the main mode of wage bargaining during the present decade, there has been a growing tendency towards local level wage bargaining. This change was motivated by the need to increase and ensure competitiveness in private firms' global markets and improve the competitive edge of the public sector in the labour market. In the public sector, the shift towards local (authority) level bargaining stems from the introduction of new pay schemes that are based on job evaluations and performance appraisal schemes. Since the beginning of 2008, the new pay system has been applied across the entire public sector, where employee remuneration consists of job-specific and personal pay components.

2.2 Public-private sector pay gaps

Figure 1 demonstrates that wages have increased, although with modest frictions, at the same pace in both the private and public sectors, the latter consist-

ing of the wages of local and central government employees, over the past four decades. This development is in line with the view that wage-wage links across different sectors and segments of labour markets tend to be tight in a developed economy (e.g., Lamo *et al*., 2012). From the perspective of the long-run wage leadership concept, the public sector appears to have wage leadership in Finland, while there is evidence of private wages causing public wages in the short run (Lamo *et al*., 2012).

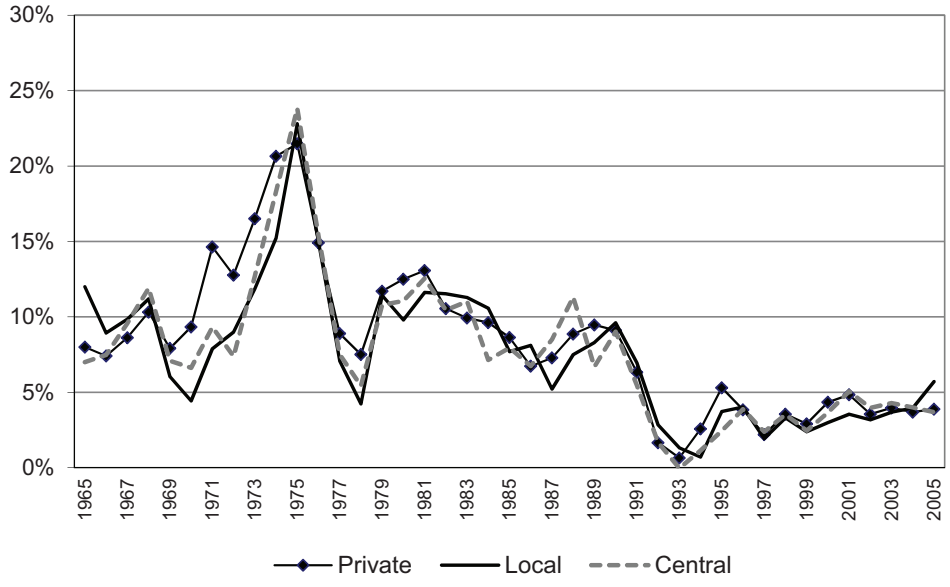

FIGURE 1 Annual wage increases, employees in local government, central government and the private sector, 1965-2005 (Source: Wage and Salary Statistics)

Average wage rates, however, differ across sectors. Figure 2 depicts the difference between the average wages in the public and private sectors between 1977 and 2008. The wage data are from the Wage and Salary Statistics and include total monthly earnings for full-time and full-year workers, excluding one-off items such as holiday and performance bonuses. The aggregate public-private sector wage gap conceals the fact that within the public sector, there is a significant differential between central and local government wages. This differential is clearly visible in the figure, which also shows some narrowing of the gap since the late 1970s. There is a positive gap between wages in the central government and private sectors throughout the period, whereas the gap is negative for employees in the local government sector. The positive gap for central government employees, however, declined from 20 per cent to approximately eight per cent, whereas the negative gap for local government employees rose from zero to ten per cent during the period evaluated. The total aggregate wage gap, which is calculated as the weighted average of local and central government

wage premiums, declined from a positive figure (eight per cent) to a negative one (minus six per cent). This declining trend in the wage gap, however, shows certain volatility in periods of changing labour markets.

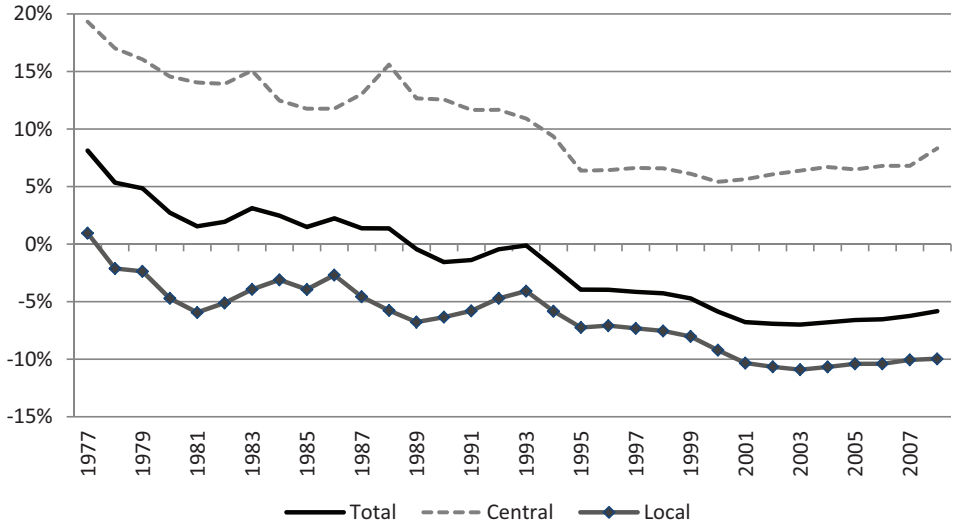

FIGURE 2 The public-private sector wage gap from 1977 to 2008 (Source: Wage and Salary Statistics)

As a first step in studying the cyclical pattern of the public sector wage premium, Figure 3 plots the annual change in the wage gap against the output rate and the change in the unemployment rate.[1] A negative relationship between the aggregate wage differential and the state of the economy can be detected. This relationship appears clearly at the turn of the 1980s-1990s, which was a period of rapid growth in the Finnish economy, followed by a severe economic recession from 1990 through 1993.[2] I also tested the cyclicality of the aggregate wage differential using some simple approaches. Based on the correlations and elasticity estimation results, I find a positive relationship between the unemployment rate and the public-private sector wage differential. For example, the correlations vary between 0.13 and 0.69, indicating that the public sector wage premium is counter-cyclical in Finland. For more information about the approaches and the results, see Appendix A.

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1 The unemployment rate is based on the Labour Force Survey, and the GDP data come from national accounts that are based on the European System of Accounts ESA95, which complies with the worldwide SNA93 (System of National Accounts) recommendations for national accounts.

2 The recession was mainly caused by the badly managed financial deregulation of the 1980s; the collapse of the Soviet Union, which led to a 70 per cent drop in trade with Russia; an overall sharp decline in aggregate demand; and a slowdown in the economies of Western Europe. The unemployment rate increased from three per cent in 1990 to 17 per cent in 1994, and the growth rate declined dramatically in 1991, with a drop of six per cent.

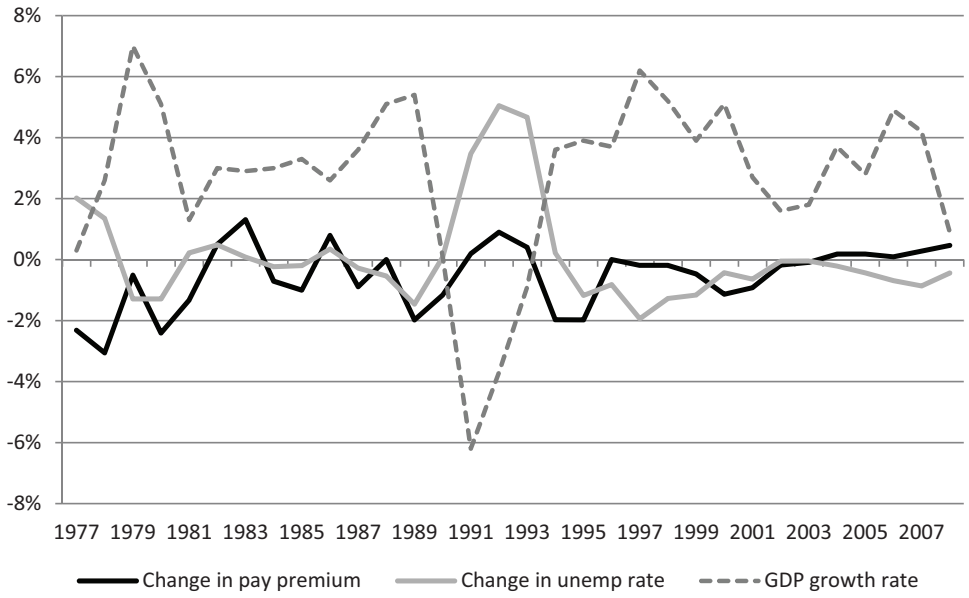

FIGURE 3 Changes in public sector wage premium and unemployment rate and GDP growth rate from 1977 to 2008 (Sources: Wage and Salary Statistics, Labour Force Survey and National Accounts)

3 A framework for analysis

The model that tests the counter-cyclicality of the wage gap follows the original idea of Blanchflower and Oswald (1994), where the logarithm of the current unemployment rate is used to explain wages together with Mincerian-type covariates. The wage curve theory is extensively tested in the literature, and the findings indicate a negative relationship between the current levels of the unemployment rate and wages (see Nijkamp and Poot, 2005 for a meta-analysis). The wage equation is estimated by ordinary least squares (OLS) and is expressed as follows:

$$\ln(w_{irt}) = \beta_0 Public_{irt} + \beta_1 \ln(u_{rt}) + \beta_2 Pub\_\ln(u_{rt}) + \beta_3 \ln(pe_{rt}/te_{rt}) + \beta_4 X_{irt} + \lambda_t + \gamma_r + \varepsilon_{irt} \quad (1)$$

where *i*, *r* and *t* are indices representing the individual, region and time, respectively. Thus, w_{irt} is the annual wage earned by individual *i* working in region *r* in year *t*. $Public_{irt}$ is a dummy variable indicating whether an individual is a public or a private sector worker (one for public, zero otherwise). u_{rt} is the current local unemployment rate in region *r* in year *t*. X_{irt} is a vector of individual and work of industry characteristics, while λ_t is a vector of year dummies, γ_r is a vector of regional dummies and ε_{irt} is a random error term. In addition to a standard wage curve equation, the logarithm of u_{rt} is also interacted with the public sector dummy. This term measures the extent to which unemployment affects the public sector wage premium.[3] Finally, the variable pe_{rt}/te_{rt} denotes the share of public sector employment (pe) in the total employed workforce (te) in region *r* in year *t*.

The vector X_{irt} includes basic human capital variables including potential work experience, work experience in the current job (i.e., tenure) and their squared terms and years of education.[4] It also includes a gender dummy (one if female, zero if male), education field (ten categories) and dummy variables representing the individual's marital status (single or non-single), children (whether the individual has dependent children) and industry of employment (nine categories). The inclusion of industry variables follows the empirical literature, which reports considerable inter-industry wage differentials among otherwise observationally equivalent workers (e.g., Vainiomäki and Laaksonen, 1995 from Finland).

The regional unemployment rates are collected from 19 NUTS3 regions according to the Labour Force Survey of Statistics Finland. In addition to regional dummies, I control for the yearly effects that are not related to changes in local labour market conditions, such as election years.[5]

Standard Keynesian models imply that fiscal policy is counter-cyclical; during period of weakened economic activity, the government increases spending to cushion economic shocks. Therefore, the share of public sector employment in the total employed labour force is included in the analysis to ensure that the positive demand effects of public wage rigidity in recession years are not counteracted by more flexible employment in the public sector. Finally, the standard errors are clustered for NUTS3 regions on the grounds that individuals within a region *r* share some common features that are not attributable to the model. Thus, the relevant variation in the empirical specifications that is

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3 See also Wunnava and Honney (1991) for their early study regarding union/nonunion wage differentials over the business cycle.

4 In his book, *Schooling, experience and earnings*, Mincer (1974) suggests that work experience should be used in the wage equation instead of age. The years of education are constructed from the highest completed education level based on the Statistics Finland classification: primary education (9 years), lower secondary education (12 years), lowest level of tertiary education (14 years), lower-degree level of tertiary education (16 years), higher-degree level of tertiary education (18 years) and doctorate or equivalent level tertiary education (21 years).

5 For example, Borjas (1984) presents a model of electoral wage cycles that are generated as a result of optimising behaviour on the part of voters, bureaucrats and the government. He finds that federal wage rates increase significantly more in election years. Johansen and Strøm (2001) report similar evidence for Norwegian local government, but not for central government.

used to identify the effects of interest is based on 285 (19 regions times 15 years) observations.

The parameters of interest are β_1 and β_2. An early theory of Harris and Todaro (1970) indicates that the relationship between unemployment and wages (parameter β_1) is positive because of compensating wage differentials across regions. This theory contrasts with Blanchflower and Oswald (1994), who argue that this relationship is negative, with a slope of -0.10 in most countries (see also Card, 1995). Nijkamp and Poot (2005) also find that the average effect of the unemployment on wages is -0.07 across 208 studies. Thus, based on these findings, β_1 is expected to have a negative sign. If the public-private sector wage gap is counter-cyclical in nature and driven by a higher economic response by private sector wages, parameter β_2 should be positive. The parameter β_1 measures, as a percentage, how much less (or more, if positive) a worker earns when the unemployment rate increases by one per cent. The parameter β_2 measures, as a percentage, how much the public-private sector wage gap increases (or decreases, if negative) when the unemployment rate increases by one per cent.

Because public and private sector employees are found to vary with respect to their characteristics, it is necessary to account for potential selection bias. Those who enter public or private sector employment may not be a random sample from the population (e.g., Kanellopoulos, 1997; Adamchik and Bedi, 2000; Christofides and Pashardes, 2002). One solution to the problem is an instrumental variable (IV) estimation. An instrument is a variable that does not belong in the vector of explanatory variables and is correlated with the endogenous explanatory variable. The instruments must satisfy two conditions: (1) the instrument should not be correlated with the error term in the explanatory equation and (2) the instrument should be correlated with the endogenous variable of interest. The former relates to the validity of the instrument and the latter to its quality. In this analysis, a set of family background variables are used to instrument for the public sector employment of an individual. This choice is justified by the literature that finds substantial family-of-origin influences on a child's career development and occupational choice (see, e.g., Whiston and Keller, 2004 for a comprehensive review), which in turn will determine to an important extent the sector in which the individual will be employed. Empirical findings by Dustmann and van Soest (1998) and Maczulskij and Pehkonen (2011) indicate that males who had a parent working for the public sector were more likely than others to have a public sector job. Lewis and Frank (2002) report similar findings for both genders. Therefore, the variables selected as instruments consist of parents' education fields and socio-economic status, including detailed information on whether the parent had previously worked for a public corporation.[6]

The interaction term between the public sector dummy and unemployment rate is also potentially endogenous and therefore needs to be instrumented. In this

[6] See also Björklund and Jäntti (2012), whose findings indicate that the role of family background on labour market outcomes is more important than previously suggested.

case, one possible solution is to create a new instrumental variable, which is an interaction term between the unemployment rate and a vector of family background variables.[7] Estimations are accomplished using two-stage least squares (2SLS). In the first stage, the two potentially endogenous variables are regressed on both the exogenous covariates in the equation and the instruments. In the second stage, the equation is estimated as usual, except that each endogenous variable is replaced with the predicted values obtained from the first stage.

4 Micro-level data

The data used in the analysis are based on the Longitudinal Census File and Longitudinal Employment Statistics constructed by Statistics Finland for the 1970 through 2004 period. Since 1987, the two basic files were updated annually until 2004. By using a personal identifier, data across censuses and data on parents, spouses and region of residence are merged with the individual records. Because of data protection legislation, Statistics Finland does not give out information that enables the identification of individuals. The data represent a seven per cent random sample of the Finnish population in 2001. A research period from 1990 to 2004 is selected because the data report important background variables annually from 1990 onward.

The dependent variable is defined as the logarithm of the individual's annual gross wage and salary earnings minus other income subject to state taxation, such as pension income, unemployment benefits and other social security benefits, and entrepreneurial income. The earnings are deflated to 2004 prices using the consumer price index. The highest income percentile subject to state taxation is given as a mean in the data, but this should not have significant influence on the results. The analysis focuses on employees who are employed either in the public or private sector in year *t*, excluding entrepreneurs. Furthermore, the analysis is confined to wage earners between 18 and 64 years of age who do not reside in the Åland Islands.[8] The data are unbalanced panel data consisting of 106,047 yearly wage observations from 60,143 males and 46,106 females from 19 regions over a period of 15 years. Approximately 30 per cent of employees are employed in the public sector.

Table 1 describes the mean values for the most important variables by sector, where the entire public sector consists of the central and local governments.

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7 The simplest form of the estimated equation is: $Y = \beta X + \alpha W + \mu (W*X) + \lambda Q + \varepsilon$. The variable X is assumed to be endogenous and instrumented by Z. Therefore, W*X is also endogenous. The solution adopted here is to create a new variable, W*Z, which is used as an instrument for W*X.

8 The Åland Islands are situated at the entrance to the Gulf of Bothnia and form an autonomous, demilitarised, monolingual Swedish-speaking region of Finland. The islands collectively constitute the smallest region of Finland, with only 0.5 per cent of its land area and population. As the inhabitants of the Åland Islands are not representative of the general population living in continental Finland, they are typically excluded from analyses.

As the table shows, average annual earnings are lower for employees in the public sector (minus eight per cent), and this pay disadvantage is higher for those working for local governments (minus 12 per cent). These wage gaps are higher compared to the wage gaps calculated from the macro data (see Figure 2) for one main reason: while the macro data included full-year and full-time employees, the individual-level micro data have information on all employees, as these data do not separate part-time employees from full-time employees. The mean of the regional unemployment rate is approximately ten per cent. A larger share of private sector employees are males (63 per cent), whereas females are typically overrepresented in the public sector (59 per cent on average). Consistent with the literature (e.g., Christofides and Pashardes, 2002), public sector workers are better educated than private sector workers (14 versus 15 years of education). There is no clear discrepancy in average potential work experience (approximately ten years), although public sector workers report a shorter tenure duration (two versus five years). The shorter tenure duration reflects the frequent use of temporary contracts in public sector jobs. Finally, more public sector workers are married or cohabiting and have children compared to private sector workers (see, e.g., Kanellopoulos, 1997; Christofides and Pashardes, 2002).

TABLE 1 Summary statistics by sector: 1990-2004

	Private sector	Public sector	Central government	Local government
Annual wage, euros	29,781	27,506	29,351	26,304
Unemployment rate, %	9.5	10.0	9.9	10.0
Female, dummy	0.37	0.59	0.39	0.72
Work experience, years	9.5	9.9	8.8	10.6
Tenure, years	4.8	2.3	2.6	2.1
Education, years	13.7	14.9	15.7	14.5
Children under 18 years old, dummy	0.44	0.52	0.50	0.54
Non-single, dummy	0.72	0.73	0.73	0.73
Number of observations	74,188	31,859	12,566	19,293

Note: Overall list of variables is given in Appendix B.

5 Cyclicality of the pay gap

The estimation strategy is first to test the counter-cyclicality of the wage differential using both OLS and IV estimation methods. In the latter, the aim is to estimate the causal effect of business cycles (unemployment rate) on public-private sector wage gaps that is not biased due to self-selection. The robustness of the main results is tested in three ways. First, in the light of institutional and

economic changes during the research period, I allow the results to vary over time. Second, I examine whether the results are robust across the individuals' earnings distribution. Third, I examine to which extent the results reflects local labour market conditions and the overall economic conditions. The public sector is also divided into central and local government sectors; thus, three wage equations are estimated in each specification. Males and females are, in turn, treated as one group because nearly all the specifications yielded parameter estimates that were statistically similar for both genders.

5.1 OLS and IV estimations results

Table 2 displays the results of the standard OLS method. The unemployment rate has a negative and highly significant effect on individual earnings. The wage curve estimate is on average -0.10, which indicates that a ten per cent increase in the unemployment rate decreases wages by one per cent. This result is in accordance with the 'empirical law of economics' (e.g., Blanchflower and Oswald, 1991; Card, 1995), but slightly higher compared to another study from Finland (Pekkarinen, 2001), in which the wage curve was -0.04.

The estimates for the interaction term between the unemployment rate and the public sector dummy (parameter β_2) are all positive. These findings support the hypothesis of a counter-cyclical wage differential and highlight its immediate response to changes in the pace of economic growth. The result yields an estimated coefficient of 0.10 for the entire sample. This result indicates that a ten per cent increase in the unemployment rate increases the public sector pay premium by one per cent. If one looks at the results for sub-groups, the effect is lowest for the central government wage premium (0.7 per cent) and highest for the local government wage premium (1.3 per cent).[9]

To comment briefly on the results for the other control variables, one item is of particular interest, namely the positive and significant effect of qualifications. The results indicate that an additional year of education yields a return of approximately ten per cent, which is in accordance with other Finnish evidence (e.g., Uusitalo, 1999; Asplund, 2000; Tokila and Tervo, 2010). In addition, previous work experience has a positive effect on individual earnings. Gender has a distinct effect; females earn less than males. Being married or cohabiting increases individual wages (by one to two per cent), while having children decreases wages (by approximately five per cent).[10]

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[9] In some studies, the unemployment rate is considered as a lagged indicator for an economic state (e.g., Holm-Hadulla et al., 2010). To test this notion empirically, the previous year's unemployment rate was used in the analysis instead of the current unemployment rate. This consideration was also important from another point of view: wage contracts are usually made for a year onwards. All of the wage curve estimates were similar to the main findings. The estimates for the interaction terms varied between 0.04 and 0.08. The unemployment effects on wage gaps were thus slightly smaller but still qualitatively similar to the results obtained using the current unemployment rate. More information is available from the author upon request.

[10] At first glance, it seems that public sector employees receive a significant wage disadvantage compared to private sector employees (minus 17 to 25 per cent), but in the presence of the interaction term between the public sector dummy and the unem-

The IV estimation method is next combined with the OLS method. The Wooldridge tests for cluster-robust standard errors indicate that self-selection is not particularly important for central or local government employees. This contrasts with other Finnish studies that find, using the Heckman correction method, that public sector employment is potentially endogenous (Korkeamäki, 1999; Maczulskij and Pehkonen, 2011). Because the use of the IV method produces estimates that are statistically similar to those of the OLS method, the IV-method is not used in subsequent analyses. [11]

TABLE 2 Earnings equations: results for public-private (PP), central covernment-private (CP) and local government-private (LP) sector workers from OLS estimations

Variable	PP	CP	LP
Public	-0.263 (0.039)***	-0.183 (0.033)***	-0.289 (0.053)***
ln(u)	-0.109 (0.019)***	-0.086 (0.017)***	-0.091 (0.015)***
Pub_ln(u)	0.104 (0.014)***	0.068 (0.021)***	0.127 (0.014)***
ln(pe/te)	0.002 (0.085)	0.038 (0.101)	0.054 (0.067)
Education	0.106 (0.002)***	0.100 (0.002)***	0.112 (0.002)***
Exper	0.052 (0.004)***	0.053 (0.004)***	0.054 (0.005)***
Exper_sqr	-0.100 (0.008)***	-0.104 (0.009)***	-0.105 (0.009)***
Tenure	0.003 (0.004)	0.014 (0.002)***	0.003 (0.005)
Tenure_sqr	0.013 (0.014)	-0.021 (0.010)**	0.013 (0.016)
Female	-0.316 (0.003)***	-0.320 (0.005)***	-0.309 (0.006)***
Non-single	0.014 (0.006)**	0.024 (0.007)***	0.014 (0.009)
Children	-0.053 (0.006)***	-0.042 (0.007)***	-0.058 (0.009)***
Other covariates	yes	yes	yes
R^2	0.38	0.41	0.40
N	106 047	86 754	93 48 1

Notes: ***, **: statistically significant at least at the 1 and 5 % significance levels. The dependent variable is the log of annual earnings. Other covariates include ten education field dummies, nine industry dummies, 19 region dummies, and 15 year dummies. Standard errors are clustered by region (NUTS3 level).

ployment rate, the estimate for the public sector dummy itself should not be over-interpreted. Without controlling for the interaction term, the return to public sector employment drops to minus four per cent that accords with other Finnish evidence (e.g., Korkeamäki, 1999; Uusitalo, 1999; Maczulskij and Pehkonen, 2011).

11 I also tested the validity and over-identification of the instruments in the IV estimations using the Sargan test. This test indicates whether the instruments are uncorrelated with the error term and whether the excluded instruments are correctly excluded from the wage equation. Because the Sargan test is unavailable with cluster-robust standard errors, the test was performed with non-robust errors. Therefore, the results should be treated with care. In all cases, the over-identification tests do not support the null hypothesis, which suggest that the instruments are not valid. In essence, it is possible that the assumption of employment sector endogeneity is not correctly rejected. One explanation for the invalid instruments is the possible correlation between parents' background variables and individual's unobserved ability that is included in the error term.

TABLE 3 Earnings equations: results for public-private (PP), central covernment-private (CP) and local government-private (LP) sector workers from IV estimations

Variable	PP	CP	LP
Public	-0.234 (0.188)	-0.192 (0.186)	-0.104 (0.199)
ln(u)	-0.118 (0.019)***	-0.084 (0.013)***	-0.094 (0.018)***
Pub_ln(u)	0.136 (0.077)*	0.049 (0.069)	0.134 (0.098)
ln(pe/te)	0.009 (0.082)	0.034 (0.099)	0.060 (0.066)
Education	0.104 (0.002)***	0.101 (0.002)***	0.111 (0.003)***
Exper	0.051 (0.004)***	0.053 (0.003)***	0.052 (0.005)***
Exper_sqr	-0.098 (0.008)***	-0.104 (0.009)***	-0.102 (0.010)***
Tenure	0.006 (0.005)	0.013 (0.002)***	0.008 (0.008)
Tenure_sqr	0.003 (0.016)	-0.019 (0.011)*	-0.005 (0.027)
Female	-0.316 (0.003)***	-0.320 (0.006)***	-0.311 (0.005)***
Non-single	0.015 (0.006)**	0.024 (0.007)***	0.015 (0.008)**
Children	-0.054 (0.006)***	-0.041 (0.006)***	-0.059 (0.008)***
Other covariates	yes	yes	yes
Wooldridge's F-test	1.17	0.19	1.57
Sargan statistics	1051.1***	979.1***	908.7***
Shea's partial R^2 (Public)	0.020	0.024	0.011
Shea's partial R^2 (Pub_ln(u))	0.032	0.035	0.026
R^2	0.38	0.41	0.39
N	106 047	86 754	93 481

Notes: ***, **, *: statistically significant at least at the 1 %, 5% and 10% significance levels. The dependent variable is the log of annual earnings. Other covariates include ten education field dummies, nine industry dummies, 19 region dummies, and 15 year dummies. Standard errors are clustered by region (NUTS3 level).

5.2 Robustness analysis

Three robustness checks are presented here. First, I consider the possibility that the results vary over time, which may mean that they are related to the institutional, technological and economical changes that occurred during the research period. The period from 1990 to 2004 is particularly interesting because Finland joined EU in 1995, which decreased barriers to direct investments in Finland. During the same period, Finland experienced an increase in the new export-oriented, high-tech sector led by Nokia from the middle 1990s. In 1999, Finland joined EMU with other 11 countries and lost its independence in reacting to negative macroeconomic effects through exchange rates and monetary policy. In addition, in the early 1990s and 2000s, Finland experienced two recessions, the former having long-lasting impacts on Finnish labour markets.

To test the cyclicality of wage differentials at different points in time, Equation (1) is augmented with interactions between the unemployment rate and year dummies and their interactions with the public sector dummy. The

results are reported in Table 4 and provide indication of the specific relationship between institutional and economic changes with the wage adjustment. The findings suggest that the wage curve was not entirely stable over the period evaluated. The relationship between the unemployment rate and wages was negative and statistically significant for the early recession years from 1990 to 1992. The period after 1992 saw relatively low and stable wage growth. This pattern may be due to the beginning of the low-inflation economic environment in the wake of the Maastricht Treaty in 1992 (e.g., Holm-Hadulla *et al*., 2010), and overall wage rigidity in Finland during the years of increasing economic growth after the recession (e.g., Albaek *et al*., 2000; Böckerman *et al*., 2010). The relationship between unemployment and wages was negative again after the beginning of EMU membership and during the small ICT recession than began in 1999. According to theory, wage flexibility should become a substitute for the exchange rate and monetary policy to mitigate the negative effects of asymmetric shocks after joining the EMU (e.g., Hallett, 2000). Recent empirical findings, however, do not support this theory (Maza, 2006; Babecky and Dybczak, 2008).[12] Therefore, it seems that in Finland wages are inflexible in years of stable and increasing economic growth, while real wage decreases can be accepted during a recession.

The results regarding the counter-cyclicality of the wage differential follow the same pattern as the wage curve results. In particular, the public sector wage premium was counter-cyclical during the years 1990-1992. After 1992, the public sector wage premium was unaffected by local unemployment rates, as were wages in general. The overall public sector wage premium was counter-cyclical again from 1999 onwards, the estimate varying between 0.10 and 0.16. The wage premium experienced by central government employees was similarly affected by local unemployment rates during the years 1999-2004, and the estimates vary between 0.06 and 0.09. The effect of the unemployment rate on the local government wage premium is again the highest (estimates varying between 0.08 and 0.25) and statistically significant from 1996 onwards. Evidently, relative to private sector wages, public sector wages primarily increase during periods of weakened economic activity, and this effect is more favourable for employees in the local government sector.

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12 Maza (2006) uses nonparametric and semiparametric methods to analyse wage flexibility in Spanish regions and finds that joining the euro area has not led to increased use of labour market wage flexibility as an adjustment mechanism. Babecky and Dybczak (2008) find similar evidence by using a structural VAR (vector autoregression) approach to predict real wage flexibility for new euro area members by comparing the changes in wage flexibilities for the 12 countries that were members of the first wave joining the euro area in 1999 and 2001.

TABLE 4 Earnings equations: results for public-private (PP), central covernment-private (CP) and local government-private (LP) sector workers from OLS estimations: years 1990-2004

	PP		CP		LP	
	ln(u)	Pub_ln(u)	ln(u)	Pub_ln(u)	ln(u)	Pub_ln(u)
1990	-0.201***	0.232***	-0.101***	0.130***	-0.175***	0.375***
1991	-0.141***	0.232***	-0.108***	0.186***	-0.109***	0.298***
1992	-0.091*	0.115***	-0.055	0.105*	-0.098**	0.196***
1993	-0.059	0.041	-0.047	0.070	-0.082	0.129
1994	-0.014	-0.017	0.016	-0.013	-0.040	0.078
1995	-0.030	-0.002	-0.000	0.004	-0.002	0.037
1996	-0.045	0.027	-0.015	0.020	-0.019	0.076**
1997	-0.057	0.038	-0.047	0.048	-0.055	0.112**
1998	-0.055	0.041	-0.034	0.023	-0.051	0.118***
1999	-0.097***	0.101***	-0.058***	0.086**	-0.084***	0.160***
2000	-0.138***	0.150***	-0.085***	0.125**	-0.130***	0.210***
2001	-0.122***	0.131***	-0.063***	0.089**	-0.105***	0.188***
2002	-0.137***	0.166***	-0.088***	0.137***	-0.120***	0.219***
2003	-0.132***	0.163***	-0.077**	0.139**	-0.114***	0.215***
2004	-0.163***	0.201***	-0.079*	0.147**	-0.148***	0.253***
R^2	0.39		0.41		0.40	
N	106 047		86 754		93 481	

Notes: ***, **, *: statistically significant at least at the 1, 5 and 10 % significance levels. The dependent variable is the log of annual earnings. Other covariates include education years, work experience, tenure, the presence of children, marital status, gender, ten education field dummies, nine industry dummies, 19 region dummies, share of public sector employees in a region, and 15 year dummies. Standard errors are clustered by region (NUTS3 level).

It is also important to examine the heterogeneity in the cyclicality of the public-private sector wage differential. Could differences in the employment structure with respect to, for instance skills, between the public and private sectors explain the differences in wage gap cyclicality? To test this empirically, the estimates are allowed to vary across the employees' earnings distribution. The employees located at the top of the wage distribution are typically more educated and, in general, more experienced. The model, which is estimated using the quantile regression (QR) method, is as follows:

$$\ln(w_{irt}) = \beta_q Z_{irt} + \varepsilon_{qirt}, \quad Quant_q(\ln(w_{irt}) | Z_{irt}) = \beta_q Z_{irt} \qquad \text{where} \qquad (2)$$

$$\beta_q Z_{irt} = \beta_{0q} Public_{irt} + \beta_{1q} \ln(u_{rt}) + \beta_{2q} Pub\_\ln(u_{rt}) + \beta_{3q}(pe_{rt}/te_{rt}) + \beta_{4q} X_{irt} + \lambda_{tq} + \gamma_{rq}$$

In Equation (2), $Quant_q(\ln(w_{irt}) | Z_{irt})$ denotes the q^{th} conditional quantile of a wage given the variable vector Z_{irt}. The equations are estimated for the 0.10^{th}, …, 0.90^{th} quantiles.

Figure 4 summarises the results by plotting wage curve estimates and their interaction estimates with a public sector dummy at 10 decile intervals. The wage curve estimate obtains its largest negative value (approximately -0.10) for employees who are located at both ends of the wage distribution, that is, those with low education in general and those with higher education. The unemployment elasticity of pay is, in turn, the lowest at the 0.3th quantile (approximately -0.05). Sanz-de-Galdeano and Turunen (2006) find that in the euro area, the wages of workers at the bottom of the distribution are most responsive to local unemployment rates.

When examining the interaction term estimates, three issues are of particular interest. First, the evidence points to increased variability in wage premiums between central and local government sectors at lower skill levels. These differences in wage gap cyclicality tend to diminish along the wage distribution. Second, public sector employees benefit from an increasing unemployment rate relative to private sector employees in all quantiles, but the effect is highest at lower end jobs. Third, the results are more stable for the central government than the local government sector. For example, at the bottom of the distribution, a ten per cent increase in the unemployment rate increases the central government pay premium by 0.8 per cent and the local government pay premium by 1.6 per cent. The effects obtain their smallest values at the 0.40th quantile; 0.4 per cent for the central and 0.8 per cent for the local government sector. Finally, the effects are 0.8-0.9 per cent for both sectors at the highest part of the wage distribution.

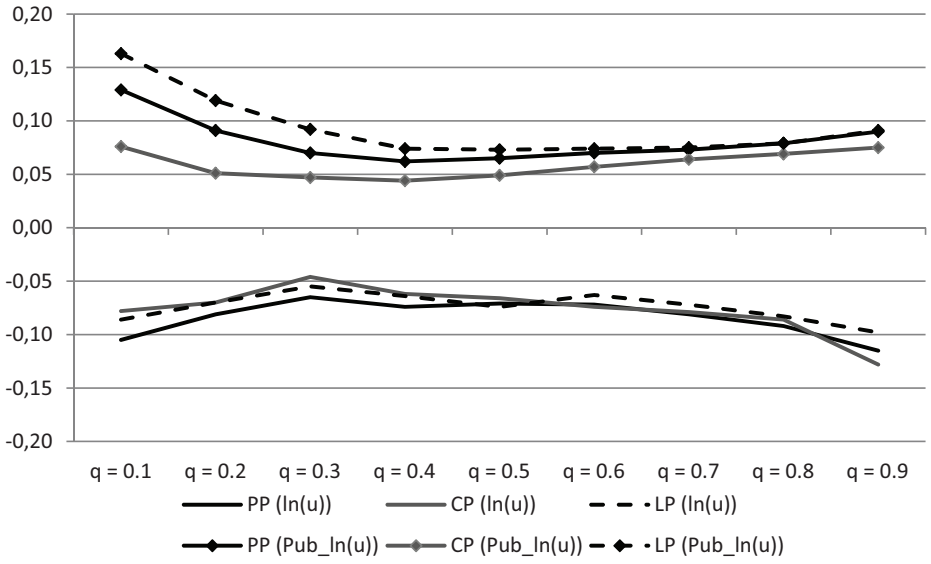

FIGURE 4 Quantile estimation results for public-private (PP), central government-private (CP) and local government-private (LP) sector workers

The third test examines whether the cyclicality of wage differentials is due to local labour market conditions or reflects overall economic conditions. In the estimation, I use the aggregate unemployment rate to capture the cycle effect and deviations of the local unemployment rate from the economy wide unemployment rate to capture the effects of local labour markets. Because deviations can take negative values, they are unspecified for logarithms. Therefore, the former variable is in logarithm form (i.e., the wage curve) and the latter is expressed in absolute values. The results are presented in Table 5. The wage curve estimate is now -0.05, which is smaller than the wage curve estimate using regional unemployment rates (-0.10). The effect of local labour market conditions on wages is statistically insignificant. These results indicate that the wages of those working in the private sector reflect national labour market conditions.

The interaction term between the aggregate unemployment rate and a public sector dummy yields statistically insignificant estimates. This finding suggests that wages in the private and public sectors respond similarly to economy wide conditions. What my results show is that the cyclicality of public sector wage premium is indeed driven by labour market conditions at the local level, and the effect is higher for local government employees. In particular, a one percentage point higher unemployment rate in a region compared to the economy wide unemployment rate increases the central government wage premium by two per cent, while this effect is twice as large for local government employees, at nearly four per cent. My results are generally in line with those of Katz and Krueger (1991). They find that in the US, while local governments are responsive to local economic conditions, the market for federal employees is mostly set outside the regional context.

In addition to the main results, the share of public sector employment seems to negatively affect individual wages. This finding is reasonable, as an increase in public sector employment relative to private sector employment is frequently the result of expansionary fiscal policies aimed at creating jobs during recessions and an overall decrease in the demand for private sector jobs. In other words, the larger the share of public sector employment in a region, the more likely it is that labour markets perform poorly in that region. Although the interpretation of this result should not be over-emphasised, it may be viewed as support for the stabilising role of public sector wage expenditures.

TABLE 5 Earnings equations: results for public-private (PP), central covernment-private (CP) and local government-private (LP) sector workers from OLS estimations: aggregate unemployment rate and deviation of local unemployment rate from aggregate unemployment rate

Variable	PP	CP	LP
Public	-0.048 (0.027)*	-0.061 (0.024)**	-0.027 (0.042)
$\ln(u_{aggregate})$	-0.051 (0.012)***	-0.049 (0.012)***	-0.053 (0.011)***
$u_{local} - u_{aggregate}$	-0.007 (0.006)	0.001 (0.007)	-0.005 (0.006)
$Pub\_\ln(u_{aggregate})$	0.011 (0.007)	0.013 (0.011)	0.012 (0.011)
$Pub\_(u_{local} - u_{aggregate})$	0.030 (0.005)***	0.020 (0.004)***	0.036 (0.006)***
ln(pe/te)	-0.545 (0.051)***	-0.649 (0.066)***	-0.554 (0.043)***
Other covariates	yes	yes	yes
R^2	0.38	0.40	0.39
N	106 047	86 754	93 481

Notes: ***, **: statistically significant at least at the 1 % and 5% significance levels. The dependent variable is the log of annual earnings. Other covariates include education years, work experience, tenure, the presence of children, marital status, gender, 10 education field dummies, 9 industry dummies, and 19 region dummies. Standard errors are clustered by region (NUTS3 level).

6 Discussion

The empirical results support the hypothesis that labour market conditions play an important role in determining the degree of cyclicality in public-private sector wage gaps in an industrialised economy. Clearly, the cyclical pattern primarily emerges in years with poor economic activity and is a result of local rather than economy wide labour market conditions that have different effects on private and public sector wages. These findings lead us to three interesting discussion topics. The first relates to the job search process between the sectors. Namely, during an economic slowdown, public sector jobs might become more attractive, and more workers will search in this sector where wages are more effectively insulated from market forces. This is in line with Krueger (1988), who shows that public sector labour supply depends on the relative wages of the public sector with respect to wages in the private sector. He also finds that the propensity to seek employment in the public sector increases with the local rate of unemployment. Pagani (2003) reports similar evidence. She finds that people search for jobs more intensely in the public sector when the demand conditions and prospects for wage increases are worse in the private sector.

The second topic concerns the actual public-private sector wage differential and, more importantly, its evolution over time. According to my results, the public sector earnings premium increases when unemployment increases, but does not decrease with a decreasing unemployment rate. This indicates that the wage advantage of public sector employees might actually increase in the long

term. At first glance, the declining trend in the aggregate pay gap in Figure 2 immediately contradicts this conclusion. However, this declining trend is calculated using raw data, i.e., unconditional wages, while conditional wage gaps should be investigated. The findings of these conditional wage gaps in Finland are limited to a few studies (Uusimäki, 1999; Korkeamäki, 1999; Maczulskij and Pehkonen, 2011). Summarising the results, the estimated public-private sector wage gap for males has shown certain degree of stability over three decades, the wage gap being approximately minus three to five per cent in all studies. In turn, the public sector earnings premium has increased among females from zero (Korkeamäki, 1999) to approximately six per cent (Maczulskij and Pehkonen, 2011), although the causes of this trend still remain unclear.[13]

The third discussion topic relates to regional differences in public-private sector wage gaps. Because the cyclicality of the public sector earnings premium is driven by local rather than economy wide conditions, there might be a statistically significant relationship between regional public-private sector wage gaps and local labour market conditions. Findings from Italy support this assumption. Dell'Aringa *et al*. (2007) show that there are substantial wage gap differences across Italian regions, and these gaps can be partly explained by local labour market conditions that affect private and public sector wages differently. As a preliminary step, it may thus be informative to study the relationship between public-private sector wage gaps and labour market conditions at the local level using a simple descriptive approach. Table 6 reports correlations between average pay gaps and unemployment rates, the indicators reflecting the averages between 1990 and 2004. Overall, Table 6 suggests that there is a positive relationship between regional sectoral wage gaps and local unemployment rates, the correlation being 0.56 and statistically significant. The corresponding coefficient for the central government-private sector wage gap is statistically zero. The correlation is again statistically significant (0.54) for a sub-sample consisting of local government and private sector employees. Thus, the wage differentials are higher in regions where local labour markets perform more poorly, as is also clearly depicted in Figure 5. In future work, this study could be extended in a number of directions. Most obviously, it would be interesting to focus on conditional public-private sector pay gaps across Finnish regions and study the consequences of these differences on regional competitiveness.

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13 Uusimäki (1999) used census data for men for the years 1975, 1980, 1985 and 1990, while Korkeamäki (1999) used individual-level micro data for the years from 1987 to 1994. Maczulskij and Pehkonen (2011) used individual-level micro data covering the years from 1995 to 2004.

TABLE 6 Correlations of average pay gaps for public-private (PP), central covernment-private (CP) and local government-private (LP) sector workers with local unemployment rates in NUTS3 regions

	PP	CP	LP
Corr(Pay gap_r, u_r)	0.56**	0.40	0.54**

Note: **: statistically significant at least at the 5% significance level.

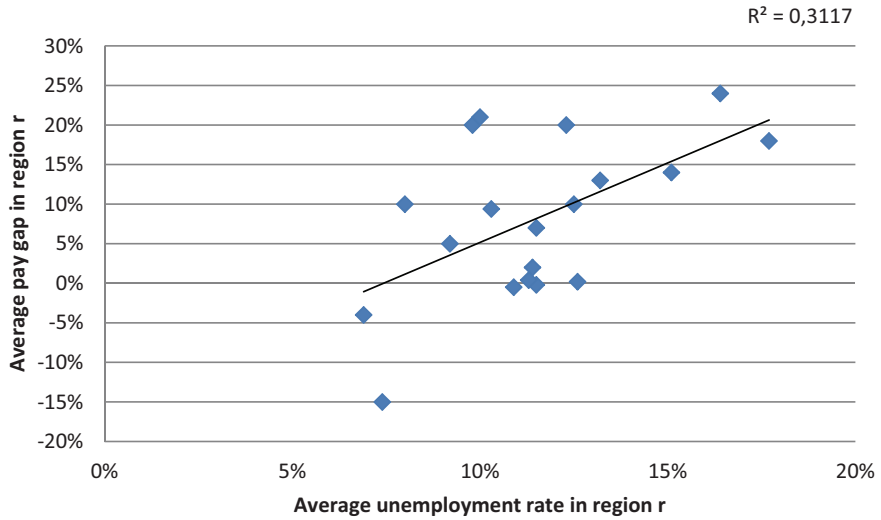

FIGURE 5 Average public-private sector wage gaps and unemployment rates in NUTS3 regions, years 1990-2004

7 Conclusions

On the basis of my results, people living in regions with high unemployment may seek more public employment to take advantage of a large income premium and greater job security. This behaviour is expected to create several imbalances in the allocation of public and private sector jobs and recruitment problems in different areas (Alesina *et al*., 2001) and different time periods. The latter concern is in line with Krueger (1988), who finds, using US data, that an increase in the federal-private sector earnings differential is associated with an increase in the average quality of applicants for federal jobs. Falch *et al.* (2009) report similar findings in Norway, indicating that the quality of public sector workers varies counter-cyclically. These trends in the US and Norway, together with the findings of this paper, could indicate the possibility for the same serious local labour market imbalances in Finland as labour market opportunities between the public and private sectors vary.

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Appendix A

A. Measuring the cyclicality of the aggregate public sector wage premium

Correlation analysis, elasticities and variance decomposition method

To describe the degree in the cyclicality of aggregate public sector earnings premium and its components (public and private sector wages), I first examine the correlations between these variables and the change in the unemployment rate. The next step is to estimate the unemployment rate elasticity on pay using the following equation:

$$\ln(y_t) = \alpha + \beta \ln(u_t) + \varepsilon_t \quad \text{(A1)}$$

where y_t is the dependent variable (public and private sector wages and the public sector wage premium) in year *t*, which is regressed against the logarithm of the aggregate unemployment rate, $\ln(u_t)$.

In the third approach, I follow Freeman (1987) and test the variation in wages between the sectors using a variance decomposition model in the following manner:

$$Var\left[log\left(\frac{W_{pu}}{W_{pr}}\right)\right] = Var(logW_{pu}) + Var(logW_{pr}) - 2Cov(logW_{pu}, logW_{pr}) \quad \text{(A2)}$$

where the left-hand side of the equation denotes the variance in the public sector wage premium, which is decomposed into three components. The first two components on the right-hand side of the equation are the variances in public and private sector wages, respectively, whereas the last component denotes the covariance between public and private sector wages.

Data and results

The aggregate data are obtained from Statistics Finland (Wage and Salary Statistics and Labour Force Survey) for a period from 1977 to 2008, but sub-sample periods from 1977 to 1989 and 1990 to 2008 are also considered. All of the calculations are made for both the raw data and their detrended version. The detrended data are created from the cycle component of the Hodrick-Prescott

(HP) filter, which uses the smoothing parameter of 6.25 for annual data (Ravn and Uhlig, 2002). The HP-filter is applied to the change in the unemployment rate (correlations), the logarithm of unemployment rate (elasticities) and the logarithm of wages (variance decomposition approach).

Table A1 presents the correlations and elasticities for the aggregate data. In a number of cases, public and private sector wages seem to follow a pro-cyclical pattern, but the effect is stronger for employees in the private sector. For example, the correlations between private sector wages and unemployment range from -0.20 to -0.72, whereas in the public sector the correlations range from zero to -0.43. However, the correlations for the detrended period from 1990 are of the opposite signs than those predicted by the hypothesis, but they fail to attain statistical significance. As hypothesised, the correlation between the unemployment rate and the public sector wage premium is positive, with the correlations varying from 0.13 to 0.69. The elasticities show the same pattern as the correlations. My results are in line with Quadrini and Trigari (2007), who study the responsiveness of wages to labour market conditions. By using aggregate survey data from the Current Population Statistics, they also find that wages in the private sector respond more to changes in economic conditions than the wages in the public sector. Instead of the unemployment rate, they used the growth rate as an indicator for an economic cycle.

Table A2 reports the results from the variance decomposition model. The results indicate that fluctuations in the wage gap are attributable to higher variability in private rather than public sector wages, except for detrended data for the 1977-1989 period. These results contrast with the findings presented by Freeman (1987). He uses aggregate data from the National Income and Product Accounts (NIPA) and finds that variations in the wage gap are equally due to fluctuations in public and private sector wages.

TABLE A1 Correlations and elasticities of real wages and public sector wage premium with unemployment

	1977–2008		1977–1989		1990–2008	
	Raw data	Detrend-ed data	Raw data	Detrend-ed data	Raw data	Detrended data
Corr(W_{pr}, Δu)	– .20	.26**	– .51	– .72**	– .47**	.17
Corr(W_{pu}, Δu)	– .17	.00	– .43	– .41	– .40	.17
Corr(W_{pu}/W_{pr}, Δu)	.28	.41**	.64**	.13	.69**	.64**
Elas($\ln W_{pr}$, lnu)	.19**	– .04**	– .34**	– .04**	– .09	– .04**
Elas($\ln W_{pu}$, lnu)	.14**	– .02	– .25**	– .02	– .07	– .01
Elas($\ln W_{pu}/\ln W_{pr}$, lnu)	– .05**	.02**	.09**	.02	.01	.03**

Note: **: statistically significant at least at the 5 % significance level. Sources: Wage and Salary Statistics and Labour Force Survey.

TABLE A2 Variance decomposition of public sector wage premium

Period	Variance of pay premium	Public pay variance	Private pay variance	Covariance
Raw data				
1977-2008	.2044	2.2335	3.6919	5.7210
1977-1989	.0523	.5180	.7796	1.2453
1990-2008	.0635	.7802	1.2037	1.9204
Detrended data				
1977-2008	.0041	.0093	.0095	.0147
1977-1989	.0050	.0097	.0047	.0094
1990-2008	.0036	.0096	.0132	.0192

Notes: All the variables have been scaled by multiplying the values by ten. Source: Wage and salary Statistics.

Appendix B

TABLE B1 Variable description

Variable	Description
ln (wage)	Annual earnings/Euros
ln(u)	Logarithm of regional (NUTS3-level) unemployment rate
Pub_ln(u)	Interaction between logarithm of regional unemployment rate with public sector dummy
ln(pe/te)	Share of public sector employees from total employees, excluding self-employed
Public	Public sector dummy: 1 if public, 0 if private
Exper	Potential work experience, calculated as age minus age at graduation
Exper_sqr	Potential work experience squared
Tenure	Work experience in current job
Tenure_sqr	Work experience in current job squared
Female	Individual is female
Non-single	Individual is married or cohabitates
Children	Individual has child/children under 18 years old
Education	Education years, defined from the completed education level
Field of education, ten levels	General, teaching, humanities, business, natural sciences, technical, agriculture and forestry, health and social, services and others/unknown
Industry, nine levels	Agriculture and forestry, manufacturing, construction, sales and hotel and restaurant, transportation, real estate and finance, education, health and others
NUTS3, 19 levels	Uusimaa, Itä-Uusimaa, Varsinais-Suomi, Satakunta, KantaHäme, Pirkanmaa, Päijät-Häme, Kymenlaakso, South Karelia, Etelä-Savo, Pohjois-Savo, North Karelia, Central Finland, South Ostrobothnia, Ostrobothnia, Central Ostrobothnia, North Ostrobothnia, Kainuu and Lapland
Year dummies	1990, …, 2004

CHAPTER 4
PUBLIC-PRIVATE SECTOR PAY GAPS IN FINLAND: A QUANTILE REGRESSION ANALYSIS*

Abstract**

This paper examines public-private sector wage differentials in Finland using a quantile regression method. We control for the endogeneity of the working sector and allow the returns of individual skills to vary between industries. The results suggest that men earn a premium of 3 percent in the public sector at the lower-end jobs. At the median and the upper end of the distribution, men's pay gap is negative, varying between 5 and 10 percent. Women, in turn, always earn more in the public sector (4-10 percent), and the premium is highest at the upper end of the earnings distribution.

Keywords: public sector employment, wage differentials

JEL classification: J31, J45

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1 Introduction

Wage differentials between workers in the public and private sectors have attracted a considerable amount of attention in empirical studies over the last three decades (see Disney 2007, for a survey). The focus of the research has been the treatment of the endogenous working sector, using the methods of Heckman (1979) and the decomposition of the observed pay gap into parts that are due to workers' characteristics and the rewards attributable to these characteristics (Oaxaca, 1973; Neuman and Oaxaca, 2004). Typically, employment in the public and private sectors has been found to be endogenously determined (e.g., Kanellopoulos, 1997; Lassibille, 1998; Adamchik and Bedi, 2000; Christofides and Pashardes, 2002; Tansel, 2005). Although the results of decomposition analyses vary from one country to another, empirical findings have two common features. First, the unexplained pay gap is positive; public sector workers earn more than their private sector counterparts. Second, the pay gaps are higher for women than for men (e.g., Shapiro and Stelcner, 1989; Kanellopoulos, 1997; Prescott and Wandschneider, 1999; Bender and Elliot, 2002; Christofides and Pashardes, 2002; Heitmueller, 2006).

Recent empirical research on pay gaps has utilised quantile regression (QR) methods that allow the pay gap to vary along the wage distribution (Mueller, 1998; Blackaby, Murphy and O'Leary, 1999; Melly, 2005; Papapetrou, 2006; Lucifora and Meurs, 2006). The results indicate that the public sector pay premium is typically highest at the lower end of the wage distribution. These QR method studies, however, do not control for endogenous selection into the public and private sectors, which can potentially bias the estimated pay gaps.

Our wage gap analysis is based on longitudinal register-based data, consisting of 396,100 wage observations, from Statistics Finland for the period 1995-2004. This study aims to contribute to the existing literature in three ways. First, we analyse the pay gaps at different points of the wage distribution while simultaneously controlling for the endogenous selection of the working sector. We adopt the selection method proposed by Buchinsky (1998b; 2001), in which a polynomial of the basic selection term is employed in a regression of the QR model. The QR method itself is less restrictive than the mean regression, allowing for more a complex examination of returns to exogenous variables. Second, we allow for the possibility that returns to certain individual attributes (human capital) may vary across employees' work industries. In this respect, our study acknowledges empirical literature that reports considerable inter-industry wage differentials (e.g., Krueger and Summers, 1988; Lucifora, 1993; Gannon and Nolan, 2004). This generalisation can be easily justified by assuming that certain skills that are essential, for example, in the production process, may not be valued in industries that manufacture different product or service lines. Third, we utilise a dummy coding to decompose the observed pay gaps into explained and unexplained parts (see Jann 2008, for a survey). This approach is a clear improvement over the basic decomposition because the coding method pro-

duces explicit estimates on the detailed contributions of the variables affecting the pay gap.

The rest of this paper is organised as follows. Section 2 describes the data and reports the average pay gaps across different earnings percentiles and between industries. Section 3 presents the econometric analysis of our study. Finally, Section 4 concludes the paper.

2 Data description and average pay gaps

The data used in the analysis are based on the various registers of Statistics Finland, including variables from the Longitudinal Census File and Longitudinal Employment Statistics from the 1970-2004 period. Data from various sources, including data on spouses and parents, have been merged using personal identifiers. The data represent a seven (7) percent random sample of the Finnish population in 2001 and comprise a comprehensive set of information on individual characteristics and the regions where the work places are located.

This study focuses on the post-recession period of 1995-2004. The dependent variable is the individual's annual wage and salary earnings (the logarithm), deflated in 2004 euros using the consumer price index. The data are truncated at the upper end of the earnings distribution because the reported annual earnings are capped at 72,000 (years 1995-2000) and 96,000 euros (years 2001-2004). The analysis is confined to those individuals who were full-year wage earners between 18 and 64 years of age with positive earnings. Self-employed individuals and individuals living in Åland Islands were excluded from the analysis. The data are unbalanced panel data including 396,100 wage observations from 209,398 males and 186,702 females. Approximately 15 percent of males and 45 percent of females are public sector workers.

Table 1 reports the means of certain individual characteristics by working sector and sex. Similar to the existing literature, public sector workers are older and, in general, better educated than private sector workers (e.g., Christofides and Pashardes, 2002; Tansel, 2005). There is no clear discrepancy in average work experience, although public sector workers report a considerably shorter mean duration in tenure, which reflects the use of temporary contracts among the public sector. Finally, a higher share of public sector workers are married or cohabiting, have children and are in upper-level occupations compared to private sector workers.

As Table 1 shows, the average annual earnings are slightly higher for employees in the private sector. This result applies for both sexes. However, the wage differential between the working sectors is not constant and varies at different wage percentiles as well by industry. These results are depicted in Table 2, which shows that workers are typically better off working in the public sector

at the lower end of the distribution,[1] whereas the reverse is true at the upper end. For females, for example, the total average pay gap is positive at the 20th percentile (6%) and negative at the 80th percentile (-7%). This pattern is particularly clear in manufacturing, trade and finance and real estate for both sexes. The pay gap also varies by industry. The gaps are large and negative in agriculture, finance and real estate, and construction. Transportation represents an opposite case, in which the gap is large and positive for both sexes. Although these findings are based on average wages, one obvious message emerges from the data: the public-private sector wage gap should be analysed by controlling for industry-specific differences in returns, and it should account for differences along the wage distribution.

TABLE 1 Sample characteristics: means by gender and sector of employment

	Men		Women	
	Public	Private	Public	Private
Annual earnings, euros	31,071	31,576	24,402	25,046
Age, years	41.6	38.2	41.9	38.8
Work experience, years	17.1	17.1	16.4	17.0
Tenure, years	2.7	9.1	1.9	8.2
Education, years	14.2	12.6	13.5	12.8
Married/cohabiting, %	.78	.77	.75	.72
Children, %	.51	.48	.54	.48
Swedish, %	.05	.05	.05	.05
Socio-economic group				
Upper level employees, %	.57	.35	.48	.34
Lower level employees, %	.08	.10	.38	.42
Manual workers, %	.35	.55	.14	.24
Number of obs.	30,446	178,952	85,166	101,536

[1] We report the wages of the 20th and 80th percentiles instead of the 10th and 90th percentiles because the upper-end earnings are truncated by Statistics Finland, as noted above, and the lower-end earnings may be downward biased due to incomplete information on part-time employment.

TABLE 2 Public-private sector pay gaps in different percentiles (%)

	Men			Women		
	20th	50th	80th	20th	50th	80th
Total sample	– 1	– 4	– 2	6	– 1	– 7
By industries						
Agriculture	– 25	– 25	– 24	– 2	– 7	– 17
Manufacturing	1	– 2	– 7	– 1	– 9	– 15
Construction	– 8	– 13	– 14	1	– 10	– 15
Trade	3	– 5	– 22	10	2	– 10
Transportation	14	12	14	6	3	12
Finance & real estate	– 7	– 18	– 20	– 7	– 16	– 13
Education	4	8	3	– 6	– 6	– 10
Health and social work	2	1	– 2	2	– 2	– 7

3 Empirical analysis of pay gaps

3.1 Wage equations and decompositions

The quantile regression (QR) model introduced by Koenker and Bassett (1978) is more flexible than mean regression because it allows for the study of the effects of the covariates on the entire conditional earnings distribution. Decomposition calculated from the mean regression may show that the average public sector worker is paid economic rents when, in fact, the pay gap may be larger at the bottom of the wage distribution compared to the top of the same distribution (e.g., Mueller, 1998). Therefore, we build our empirical analysis on the following earnings equation that is estimated by the QR method:[2]

$$\ln w_{it} = \beta_q Z_{it} + \varepsilon_{qt}, \qquad Quant_q(\ln w_{it}|Z_{it}) = \beta_q Z_{it}, \qquad \text{where} \qquad (1)$$

$$\beta_q Z_{it} = \sum_{j=1}^{J} \delta_{qj} X_{jit} + \sum_{k=1}^{K} \alpha_{qk} Ind_{kit} + \sum_{k=1}^{K} \sum_{l=1}^{L} \gamma_{qkl} HC_{lit} Ind_{kit} + \theta_q \lambda_{it}$$

In (1) w_{it} is the annual wage obtained by an individual *i* in year *t*. Ind is a categorical variable reflecting an individual's industry (agriculture, manufacturing, construction, trade, transportation, finance and real estate, education and health and social work). X stands for a vector of other observable characteristics. This includes work experience and its squared term, tenure, education years and field of education, marital status, presence of children, native language, socio-economic group, major province and year dummies. We consider the possibility

[2] The most important properties of QR is summarised in Koenker (2001). Asplund (2010), who explores the sources of increased wage differentials in the Finnish private sector, also provides a helpful description of the QR method.

that returns to certain individual attributes may vary between industries, and we augment the model with interactions between categorical variable Ind and a vector HC. The latter includes continuous variables of the Mincerian Human Capital theory (Mincer, 1974), including work experience, tenure and education years. λ_{it} refers to the selectivity term that is of an unknown functional form for a specific quantile, which can be corrected in a semi-parametric fashion (see Buchinsky, 1998b; 2001). Here, we adopt a simplified version of the approach, in which the standard Heckman selection term is estimated in the first stage by a probit model for public-private sector employment choice (e.g., Kanellopoulos, 1997; Dustmann and van Soest, 1998; Lassibille, 1998; Adamchik and Bedi, 2000; Christofides and Pashardes, 2002; Tansel, 2005). In the second stage, a polynomial of the estimated selection term is used as a regression in the QR model. $Quant_q(lnw_{it} \mid Z_{it})$ denotes the q*th* conditional quantile of a wage given variable vector *Z*. As noted earlier, we will focus on the 0.20^{th}, 0.50^{th} and 0.80^{th} quantiles in the regression analyses. Finally, ε_{qit} is a random error term, and δ, α, γ and θ are the parameters to be estimated.

The wage equations are estimated separately for the public and private sectors and by sex. Following Neuman and Oaxaca (2004), the conditional wage gaps are calculated by decomposing the difference in observed mean log wages between the public sector (pu) and the private sector (pr) as follows:

$$\ln \overline{W}_{pu}^{q} - \ln \overline{W}_{pr}^{q} = \left(\overline{z}_{pu} - \overline{Z}_{pr}\right)^{q} \widehat{\beta}_{pr}^{q} + \overline{Z}_{pu}^{q} \left(\beta_{pu} - \beta_{pr}\right)^{q} \quad (2)$$

where the first term on the right-hand side of the equation captures the total differences in the individual's characteristics (explained part) weighted by the parameters from the model for the private sector (pr). The last term measures the gap that is due to differences in the parameters (unexplained part or estimated pay gap) weighted by the means of the public sector workers (pu).

The detailed contribution of a single variable or a set of variables is typically of special interest. However, the contributions to the unexplained part depend on arbitrary scaling, i.e., the choice of the omitted base category (see Jann, 2008, for a survey). One solution, adopted here, is to estimate group models restricting the coefficients to sum to zero, i.e., through a transformation of the dummy variables. In practise this means using so-called deviation contrast coding such that for any particular categorical variable, the coefficients of each vategory reflects a deviation from the grand mean (Yun, 2005). In short, we explicitly estimate the extent to which the pay gap is due to the specific individual characteristics (parameter δ), selectivity (parameter θ), the basic return of working in a specific industry (parameter α), and how workers are rewarded for skills in these industries (parameter γ). [3]

[3] The decomposition method enables interactions between categorical and continuous variables. Therefore, we excluded all of the categorical and dummy variables from vector *HC*. The exclusion of these controls should not be a problem because the role of basic human capital variables (experience and education) accounts for a large share of an individual's wage determination process.

3.2 Wage determination by quantiles

Tables 3-4 report the results from our QR model. To save space, we do not report the parameter estimates of the categorical variables but simply show the importance of these controls by F-statistics in the lower parts of the tables. The selection term (Lambda) is statistically significant and negative for the public sector wage equation in each quantile and sex, the point estimate is approximately -0.30. This result indicates that the average pay is lower for those public sector workers who choose to work in the public sector. The selection term is positive for the private sector wage equation across different quantiles and sex. These results clearly suggest that public/private sector employment is not exogenously determined.[4]

The individual parameter estimates for wage equations are well defined and have the expected signs. For males, the return to an additional year of education is higher in the public sector than in the private sector (approximately 7% versus 5%, respectively). This result is qualitatively similar to that of Shapiro and Stelcner (1989). We also find evidence, in line with Budria (2006), that a return to schooling for males is higher at the upper end of the distribution in both working sectors. For females, the numbers are opposite: the returns are, on average, lower in the public sector than in the private sector (approximately 5% versus 6%, respectively), which is in accordance with Shapiro and Stelcner (1989) and Lassibille (1998).

In line with García-Pérez and Jimeno (2005), we find that for males, the return to tenure is higher in the public sector. The estimate is approximately 3-4 percent in the public sector and 1 percent in the private sector across different quantiles. For females, the return to tenure is approximately 1 percent in both sectors. Similar to the earlier literature, married or cohabiting men earn more than single men, and this wage effect is higher for public sector employees, as in Dustmann and van Soest (1998) and Adamchik and Bedi (2000). The presence of small children increases men's wages significantly for both sectors, with a higher effect for private sector employees. This result is in line with Kanellopoulos (1997). The reverse is true for females: being married or cohabiting and having children decreases women's wages significantly. This general finding is in line with other Finnish evidence (e.g., Napari, 2008). The negative wage effect (around 2 %) is stronger for employees in the private sector.

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4 The results from the first-stage probit model are shown in Table A1 in the Appendix. The exclusion restriction variables are age and parent's socio-economic status. The estimates are in line with international findings. For example, age is positively correlated with public sector employment (Lassibille, 1998; Adamchik and Bedi, 2000; Christofides and Pashardes, 2002). Occupation, industry and field of education have similarly expected signs, capturing existing employment differences between the public and private sectors (Kanellopoulos, 1997). In line with Lassibille (1998), public sector workers are more likely to be employed in lower productivity regions. The probability of being a public sector worker is higher among men whose parents have worked in general government, which is in agreement with Dustman and van Soest (1998) and Christofides and Pashardes (2002).

Swedish-speaking men experience small earnings cuts (approximately 1%) in the private sector across different quantiles. In the public sector, they earn a small premium at the median. Swedish-speaking women employees, in turn, earn a negative pay premium in both sectors (approximately 1- 3%). Finally, the wage equations show that occupation, field of education, industry and regional attributes are important for pay determination in both sectors and sex; see the F-test results in the lower parts of the tables. The F-tests for the industry-level interaction terms support our hypothesis that returns to skills vary between industries. This effect is more significant in the public sector wage equations and among men.

TABLE 3 Wage determination by quantiles, men

	0.20th quantile		0.50th quantile		0.80th quantile	
ln(annual pay)	Public	Private	Public	Private	Public	Private
Experience	-.008*	.013*	-.008*	.008*	-.012*	.013*
Experience squared	.021*	-.036*	.020*	-.015*	.027*	-.013
Tenure	.029*	.009*	.035*	.007*	.044*	.004*
Education	.058*	.051*	.070*	.046*	.074*	.062*
Married	.041*	.027*	.044*	.021*	.042*	.023*
Children	.013*	.025*	.020*	.027*	.019*	.028*
Swedish	.007	-.008*	.019*	-.014*	.008	-.012*
Constant	9.46*	9.33*	9.44*	9.61*	9.62*	9.58*
Lambda	-.288*	.027*	-.300*	.006	-.325*	.033*
Pseudo R^2	.32	.22	.36	.25	.42	.27
Number of obs.	30,446	178,952	30,446	178,952	30,446	178,952
Joint significance F-test:						
Occupation	362.45*	2772.75*	312.60*	4669.81*	410.18*	4234.88*
Field of education	82.62*	152.94*	100.89*	242.30*	118.28*	212.32*
Province	59.96*	455.35*	56.89*	800.22*	46.89*	689.68*
Year	116.28*	346.14*	113.64*	406.88*	126.68*	387.12*
Industry	116.26*	124.22*	96.77*	182.71*	58.70*	179.39*
Interaction terms						
Manufacturing	12.89*	3.77*	18.71*	4.22*	54.37*	10.16*
Construction	14.06*	19.70*	24.86*	2.18	67.89*	3.23*
Trade	29.70*	4.85*	28.25*	6.66*	35.97*	1.59
Transportation	23.58*	14.53*	38.01*	3.32*	60.15*	1.39
Finance and real estate	20.06*	11.67*	28.57*	8.23*	70.39*	2.87*
Education	60.27*	11.31*	76.90*	4.15*	93.42*	0.93
Health and social work	21.61*	6.29*	24.54*	1.25	36.39*	1.95

Notes: * denotes statistical significance at least at the 5 % level. Reference categories are: single, no small child/children, native language is Finnish, upper level employees, education field in business or social sciences, Southern Finland, year 1990 and agriculture industry.

TABLE 4 Wage determination by quantiles, women

	0.20th quantile		0.50th quantile		0.80th quantile	
ln(annual pay)	Public	Private	Public	Private	Public	Private
Experience	.007*	.016*	.006*	.014*	.001	-.004
Experience squared	-.013*	-.033*	-.017*	-.026*	.001	.013
Tenure	.010*	.005*	.015*	.011*	.014*	.013*
Education	.037*	.047*	.050*	.071*	.077*	.057*
Married	-.013*	-.019*	-.020*	-.017*	.042*	.023*
Children	-.022*	-.035*	-.018*	-.027*	-.018*	-.020*
Swedish	-.015*	-.034*	-.014*	-.009*	-.013*	-.005
Constant	9.72*	9.27*	9.66*	9.06*	9.40*	9.55*
Lambda	-.248*	-.047*	-.285*	.048*	-.261*	.167*
Pseudo R^2	.27	.22	.32	.26	.39	.30
Number of obs.	85,166	101,536	85,166	101,536	85,166	101,536
Joint significance F-test:						
Occupation	1366.30*	1624.13*	1029.26*	3472.94*	651.31*	3955.43*
Field of education	365.58*	196.34*	789.90*	410.75*	1036.62*	350.03*
Province	67.55*	331.85*	85.61*	849.92*	87.58*	86.90*
Year	694.19*	320.05*	596.66*	507.87*	385.99*	352.30*
Industry	260.61*	104.13*	235.87*	133.99*	69.40*	87.19*
Interaction terms						
Manufacturing	2.37	0.18	0.10	4.58*	0.41	3.50*
Construction	4.32*	0.51	8.31*	1.83	5.91*	4.84*
Trade	1.75	0.03	0.69	2.01	2.24	3.91*
Transportation	6.99*	0.24	9.38*	2.96*	5.48*	3.90*
Finance and real estate	4.61*	3.25*	6.30*	0.29	6.82*	2.90*
Education	28.66*	1.92	21.22*	0.80	10.88*	2.33
Health and social work	0.23	0.61	3.08*	4.16	2.17	2.77*

Notes: * denotes statistical significance at least at the 5 % level. Reference categories are: single, no small child/children, native language is Finnish, upper level employees, education field in business or social sciences, Southern Finland, year 1990 and agriculture industry.

3.3 Decomposing the pay gaps

Figures 1-2 depict the decomposition results for men and women. The main finding is that the public sector employees are, on average, better off at the lower parts of the earnings distribution and worse off at upper end of the wage distribution; see the first bars in the figures. The average pay gap is positive at the lowest quantile (2 % for men and 5 % for women) and negative at the median (approximately -1 %) and at the highest quantile (-6 %). The pay gaps stemming from the differences in characteristics (explained part) are positive for men and

negative for women at the median and at the highest quantile. At the lowest quantile, the differences are statistically zero; see the middle bars in the figures.

Our primary interest is in the unexplained parts of the total pay gaps; see the last bars in the figures. These results suggest that men in the public sector earn a positive pay premium at the lowest quantile (3 %), whereas the pay gap becomes negative at the median (-5 %) and at the upper part of the earnings distribution (-10 %). In sum, the public sector pay advantage is centred at those jobs where the pay is the lowest. These results are in line with those of Mueller (1998), Blackaby *et al*. (1999), Lucifora and Meurs (2006), and Papapetrou (2006). The comparable results for women show that public sector workers earn a positive pay premium in each quantile. The premium increases along the earnings distribution, with a 4 percent pay gap at the lowest quantile, 7 percent at the median and 10 percent at the highest quantile. These results, demonstrating that women are always overpaid in the public sector, are in accordance with those of Mueller (1998) and Lucifora and Meurs (2006), especially at those jobs where the pay is the highest, which is not expected by the other international findings.

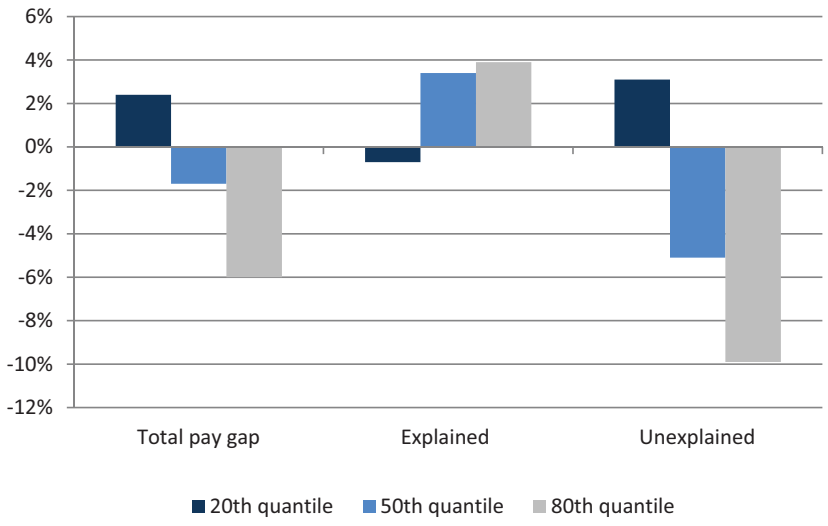

FIGURE 1 Decomposition analysis for men

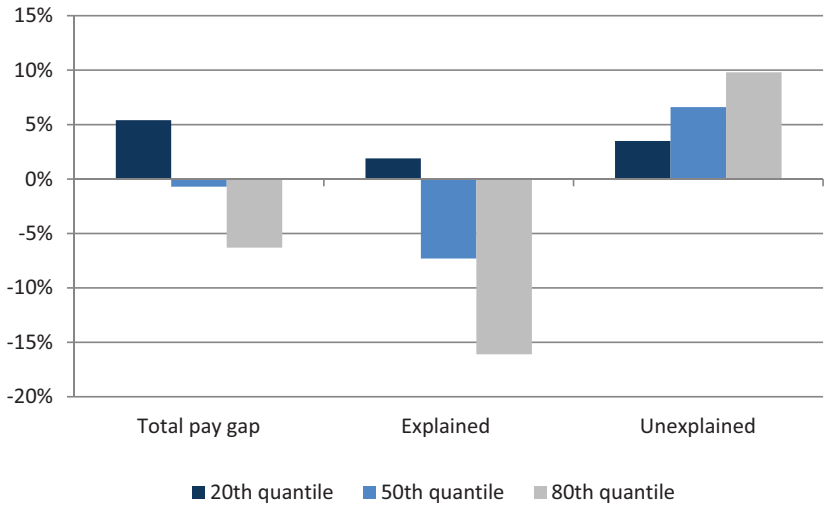

FIGURE 2 Decomposition analysis for women

Tables 5-6 provide detailed information on the role of observable characteristics and their related returns in the wage gaps. The main finding is that employees in the public sector are better educated, are in upper-level occupations and have attained education in fields that pay more in all quantiles. However, they have less work experience and fewer tenure years, and they are employed in industries that generally pay less. The effect of industry is highly negative at the highest quantile for both sexes (approximately -11 %). The results confirm earlier findings that stress the role of individual attributes in explaining public-private pay differentials. The results also show that skills differ between industries. In particular, public sector workers are more skilled (in terms of work experience, tenure and education) in manufacturing and education, whereas private sector workers are more skilled in health and social work and trade. Private sector women are also more skilled in finance and real estate, whereas the reverse is true for men.

The estimated pay gaps for men are mainly due to four characteristics: education, occupation, field of education and industry. The public sector pays more for education, especially at those jobs where the pay level is the highest. However, private sector returns to occupation, field of education and industry exceed those in the public sector. A considerable part of this finding is accounted for by the role of industry (approximately -17%). The pay gaps for women are, in turn, mainly due to experience, education and industry. The public sector pays more for education at the highest quantile but pays less for experience in all quantiles, and this effect is higher at the lower end of the earnings distribution. The industry-affiliation follows the same pattern as for men. The within-industry results suggest that public sector employees are particularly worse off in finance and real estate, and better off in health and social work. The effects are stronger at the lowest quantile in both industries and higher for men.

TABLE 5 Detailed decomposition analysis for men

	0.20th quantile		0.50th quantile		0.80th quantile	
	Ex-plained	Un-explained	Ex-plained	Un-explained	Ex-plained	Un-explained
Experience + tenure	– 4.2*	2.2*	– 3.8*	0.7	– 3.8*	– 2.5*
Education	7.6*	8.4*	8.4*	11.2*	8.5*	14.5*
Occu+field of education	3.2*	– 3.3*	4.3*	– 5.3*	4.8*	– 5.6*
Demographic	0.1*	0.5	0.1*	1.6*	0.1*	1.1*
Regional	– 0.6*	– 0.3*	– 0.7*	– 0.7*	– 0.9*	– 1.0*
Industry	– 1.7	– 16.5*	– 2.7	– 16.6*	– 10.9*	– 14.8*
Interaction terms						
Agriculture *HC	– 0.1	– 0.4	– 0.5*	0.3	0.3	– 0.6
Manufacturing*HC	– 1.0*	0.2	1.9*	0.3	7.6*	2.2*
Construction*HC	– 0.2*	– 0.3	– 0.4*	0.2	– 0.5*	– 0.3
Trade*HC	– 2.1*	– 0.4*	– 4.1*	– 0.6*	– 4.1*	– 0.6*
Transportation*HC	0.0	– 1.6*	– 0.4*	– 2.8*	– 0.3*	– 1.1*
Finance and real estate*HC	3.2*	– 7.7*	2.7*	– 5.5*	1.7*	– 2.2*
Education*HC	2.0	4.8*	3.7	2.4	2.1	– 1.4*
Health and social work*HC	– 4.8*	12.0*	– 3.4*	12.0*	– 1.8	9.7*
Selection	– 2.1*	– 19.1*	– 1.6*	– 20.6*	1.1	– 24.8*
Constant		24.6*		18.3*		17.5*
Total	– 0.7	3.1*	3.4*	– 5.1*	3.9*	– 9.9*
Total pay gap	2.4 % *		– 1.7 % *		– 6.0 % *	

Note: * denotes statistical significance at least at the 5 % level.

TABLE 6 Detailed decomposition analysis for women

	0.20th quantile		0.50th quantile		0.80th quantile	
	Ex-plained	Un-explained	Ex-plained	Un-explained	Ex-plained	Un-explained
Experience + tenure	– 4.0*	– 5.5*	– 5.0*	– 4.7*	– 5.4*	– 0.8
Education	3.6*	– 6.8*	4.2*	3.0	4.4*	28.8*
Occu+field of education	3.1*	0.0	2.6*	0.3	2.2*	0.1
Demographic	– 0.3*	1.3*	– 0.2*	0.3	– 0.2*	0.1
Regional	– 0.5*	– 0.7*	– 0.8*	– 1.3*	– 1.2*	– 2.1*
Industry	10.8*	– 22.7*	– 2.4	–17.8*	–12.6*	– 2.3
Interaction terms						
Agriculture *HC	0.0	– 0.1	0.1	– 0.3*	– 0.1	0.0
Manufacturing*HC	4.8*	– 0.2*	7.4	0.1	5.0*	0.0
Construction*HC	– 0.1	0.0	0.0	0.1*	0.0	0.1*
Trade*HC	0.5	0.0	– 0.2	– 0.4*	– 5.6*	– 0.8*
Transportation*HC	1.2*	0.3*	0.5*	0.3*	0.0	0.2*
Finance and real estate*HC	- 4.9*	– 2.1*	– 2.5*	– 0.7*	– 2.2*	– 0.1*
Education*HC	4.0*	1.1	3.5*	1.8*	1.3	2.0
Health and social work*HC	– 16.1*	8.4*	– 16.1*	6.9*	– 5.4	– 1.4*
Selection	– 0.2	– 10.1*	1.6*	– 15.9*	3.7*	– 19.8*
Constant		40.6*		35.0*		5.8
Total	1.9	3.5*	– 7.3*	6.7*	– 16.1*	9.8*
Total pay gap	5.4 % *		– 0.6 % *		– 6.3 % *	

Note: * denotes statistical significance at least at the 5 % level.

3.4 The role of selection bias and industry-specific prices

Finally, we examine the extent of possible bias arising in estimated pay gaps in a case where the interaction and selection terms are omitted from the wage equations. The results are depicted in Table 7. The first row reports the estimated pay gaps obtained from a basic QR model. In the second row, the model is augmented with a selection term, and in the third row, the model controls for the industry-specific interaction terms. The fourth row reports the result from a model that simultaneously controls both the endogenous selection and industry-specific interaction terms (i.e., the results from Tables 5 and 6). The general finding is that the omission of these two controls treats male and female workers differently. The overall results for males remain practically unchanged: the selection term slightly improves the relative position of public sector male workers, whereas industry-specific interaction terms decrease it. The results for females show more variability, although the role of industry-specific interaction terms follows the same pattern as for men. Our experiments indicate that the exclusion of endogenous selection from the wage equation biases the pay gap

estimates upward at the lower part of the wage distribution and downward at the upper part of the distribution. Because our basic model yields estimates that are generally in line with international evidence (i.e., the pay gaps are lower at higher parts of the earnings distribution), our tentative conclusion is that the estimated pay gaps in previous international studies may be biased upward at the lowest quantile and biased downward at the highest quantile.

TABLE 7 Pay gap estimates by different specifications

	Men			Women		
	q=.20	q=.50	q=.80	q=.20	q=.50	q=.80
Basic model	2.7 *	– 3.2 *	– 7.3 *	8.8 *	2.6 *	– 1.8 *
Basic model + selection	3.9 *	– 1.8 *	– 5.6 *	– 2.9 *	0.1	8.7 *
Basic model + industry	3.6 *	– 3.7 *	– 9.2 *	7.7 *	1.6 *	– 3.5 *
Basic model + selection + industry	3.1 *	– 5.1 *	– 9.9 *	3.5 *	6.7 *	9.8 *

Note: * denotes statistical significance at least at the 5 % level.

4 Conclusions

This study analyses public and private sector pay gaps using data for the period 1995-2004. We simultaneously control for three important factors in the analysis. First, we estimate earnings equations by a quantile regression method that allows the pay gap to vary along the earnings distribution. Second, we control for endogenous selection into the public and private sectors. Third, we consider the possibility that returns to skills differ between industries. By applying the new decomposition method by Jann (2008, for a survey), we produce detailed estimates on the determinants of the pay gaps. The results imply that the omission of the endogenously determined working sector might bias numerical estimates. We find that the bias is particularly strong among female workers. The role of inter-industry variations in returns to skills is also important, and it decreases the estimated pay advantages for public sector employees.

When does it pay to work in the public sector? Our QR results suggest that public sector female employees earn a premium in each quantile, and the premium is largest at the highest wage levels. Our results for men suggest that employees in the public sector are better off at the lower parts of the earnings distribution and worse off at the higher pay levels. This finding partially explains why transitions from the public sector to the private sector increase at higher skill levels (Borjas, 2003) and why it is generally harder for the public sector to attract and retain highly skilled male workers by means of a wage policy (Lewis and Frank, 2002). Our analysis suggests that the industry also matters. In particular, public sector workers are relatively better rewarded in health and social work, and private sector workers are better rewarded in finance and real estate.

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Appendix A

TABLE A1 Probit estimates for public sector choice

	Men	Women
Experience	.078*	-.016
Experience squared	-.201*	-.003
Age	.100*	.060*
Age squared	-.061*	-.028*
Tenure	-.233*	-.216*
Education	-.024	-.066*
Married	-.044*	-.011
Children	-.026*	-.033*
Swedish	.068*	-.147*
Field of education		
General and other	.429*	.257*
Teaching	.067	.821*
Humanities and arts	-.171*	-.081*
Business, social sciences and law	(Ref.)	(Ref.)
Natural sciences	.283*	.219*
Technical	.342*	.435*
Agriculture and forestry	.360*	.401*
Health and social services	.453*	.259*
Services	.541*	.567*
Occupation		
High level	(Ref.)	(Ref.)
Medium level	-.323*	-.115*
Manual workers	.161*	.000
Industry		
Agriculture and forestry	(Ref.)	(Ref.)
Manufacturing	-2.750*	-4.846*
Construction	-1.165*	-2.262*
Trade, accommodation and food services	-2.170*	-4.567*
Transportation and storage	-2.562*	-4.933*
Finance and real estate	-1.610*	-3.550*
Education	.225	-.966*
Health and social work	.830*	-.157

TABLE A1 (Continues) Probit estimates for public sector choice

	Men	Women
Major province		
Southern Finland	(Ref.)	(Ref.)
Western Finland	.010	.112*
Eastern Finland	.251*	.217*
Northern Finland	.241*	.203*
Parent's socio-economic status		
Mom, other or unknown	(Ref.)	(Ref.)
Mom, self-employed	.046*	.031
Mom, manual worker	-.002	-.045*
Mom, general government	.100*	.001
Dad, other or unknown	(Ref.)	(Ref.)
Dad, self-employed	.089*	.035
Dad, manual worker	-.098*	-.064*
Dad, general government	.112*	.047
Interaction terms	yes	yes
Year dummies	yes	yes
Constant	-2.708*	-2.708*
N	209,398	186,702
Pseudo R^2	.50	.66
Log likelihood	-43,797.76	- 43,389.49
Sensitivity	58.56 %	90.63 %

Note: * denotes statistical significance at least at the 5 % level.

CHAPTER 5
EDUCATION AND THE CHOICE OF WORKING IN THE PUBLIC SECTOR

Abstract[*]

A vast body of literature provides evidence that higher education induces the decision to seek a public sector job. This finding can be criticised to be due to unobserved heterogeneity, such as factors related to family background, ability and preferences. This article investigates this critique using data on Finnish identical twins, who have a similar family background and are similar in their genetic inheritance. The analysis shows that once both shared family background and genetic effects are controlled for, the effect of education on the propensity to obtain a public sector job is statistically significant for both genders. The results thus indicate that higher education plays an important role in determining whether an individual becomes a public or a private sector employee, and that the impact is purely structural in nature.

Keywords: public sector employment, education, unobserved heterogeneity

JEL classification: I21, J45

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1 Introduction

The prevailing opinion in labour economics is that neither public nor private sector employment status should be treated as exogenous. Early studies by Bellante and Link (1981) and Blank (1985) from the US directly estimate the extent to which workers with different characteristics are more or less likely to choose a public versus a private sector job. These scholars find strong evidence that higher education increases the likelihood of obtaining a job in the public sector. This positive relationship has also been reported for several other countries, including Peru (Stelcner, Van der Gaag and Vijverberg, 1989), the Netherlands (Van Ophem, 1993), Greece (Kanellopoulos, 1997), Poland (Adamchik and Bedi, 2000), Cyprus (Christofides and Pashardes, 2002), the UK (Bender and Elliot, 2002) and Turkey (Tansel, 2005).

Typical work tasks in the public sector require specific types of education, which may lead individuals to choose their educational attainment and employment sector simultaneously (Dustmann and Van Soest, 1998). The positive relationship between education and working in the public sector is thus posited to be driven by the higher demand in the public sector for qualified employees to accomplish the required tasks. In their extended switching regression framework using data for German males, Dustmann and Van Soest (1998) treat education as endogenous by controlling for it using an individual's family background variables, which included the parents' levels of education and socio-economic status. They find that once one allows for the endogeneity of education, education no longer has an impact on the likelihood of working in the public sector. Therefore, the authors conclude that the positive relationship found in standard models is not structural but rather reflects unobserved heterogeneity.

This article examines the relationship between higher education and the choice of working in the public sector using data on twins. The main objective is to re-assess the framework of Dustmann and Van Soest (1998), in which the authors controlled for education using individuals' parental background variables. The contribution of my article is, in turn, to ensure that the observed correlation between education and public sector employment is not due to a correlation between education and an employee's family background *and* genetics. This aim is accomplished by exploiting the fact that identical twins have a similar family background and are similar in their genetic inheritance (e.g., Goldberger, 1979). The family background refers to the environment in which both twins were raised, as well as any other factors to which both twins were equally exposed. The similarity in genetics is typically used in reference to ability, but it might also reflect similarities in personal traits and preferences. To simultaneously control for the effects of family background and genetics (i.e., the family-specific fixed effects), the conditional logit regression method (e.g., Magnac, 2004) for twin data is applied in this study.

The data come from two sources: the sample of twins from Finland is linked to worker-firm panel data that cover the years 1990 to 2004. The data include 15,290 male and 21,468 female twin-year observations; approximately 40 per cent of the twin pairs are identical. The results for a sample that treats all twins as individuals show a clear positive relationship between education and public sector employment. Once the shared family background is controlled for, the positive relationship between education and public sector work disappears for females but remains statistically significant for males. In a specification where both shared family background *and* genetic effects are held constant, the effect of education is statistically significant for both genders and becomes even stronger in terms of the magnitude of the point estimate.

The remainder of the article is organised as follows. Section 2 presents a review of the literature that contributes to this study. Section 3 describes the datasets. Section 4 presents the econometric framework of the study, the empirical results of the analysis and the robustness tests. Finally, section 5 concludes the paper.

2 Literature

According to the critique of Dustmann and Van Soest (1998), the effect of education on the likelihood of working in the public sector is not the result of a structural effect; instead, this relationship simply reflects unobserved heterogeneity. In other words, the correlation between education and public sector work is simply due to the correlation between education and some unobserved characteristics. This heterogeneity problem may arise from several sources, as illustrated in Figure 1. The figure shows a diagram of the unobserved exogenous variables (in ovals), from which arrows point to the observed endogenous variables (in boxes); in this case, the endogenous variables are education and public sector work.

The first source of unobserved heterogeneity is related to a person's family background. A vast body of literature indicates that parental education, family income, parents' socio-economic status and location of residence predict children's educational outcomes (see, e.g., Eccles and Davis-Kean, 2005). Becker (1991) presents a more nuanced view of the relationship between family and children's education. He hypothesises that parental investment in children's education is due to the parents' altruistic behaviours towards their children, i.e., caring about their children's welfare. Familial social networks affect not only schooling but also the choices that individuals make to enter public sector employment; for example, parents may provide job market information to their children. Empirical findings by Dustmann and van Soest (1998) from Germany and Maczulskij and Pehkonen (2011) from Finland support this view. They find that males who had a parent working in the general government sector were more likely than other males to have a public sector job. Lewis and Frank (2002) report similar findings for both genders in the US.

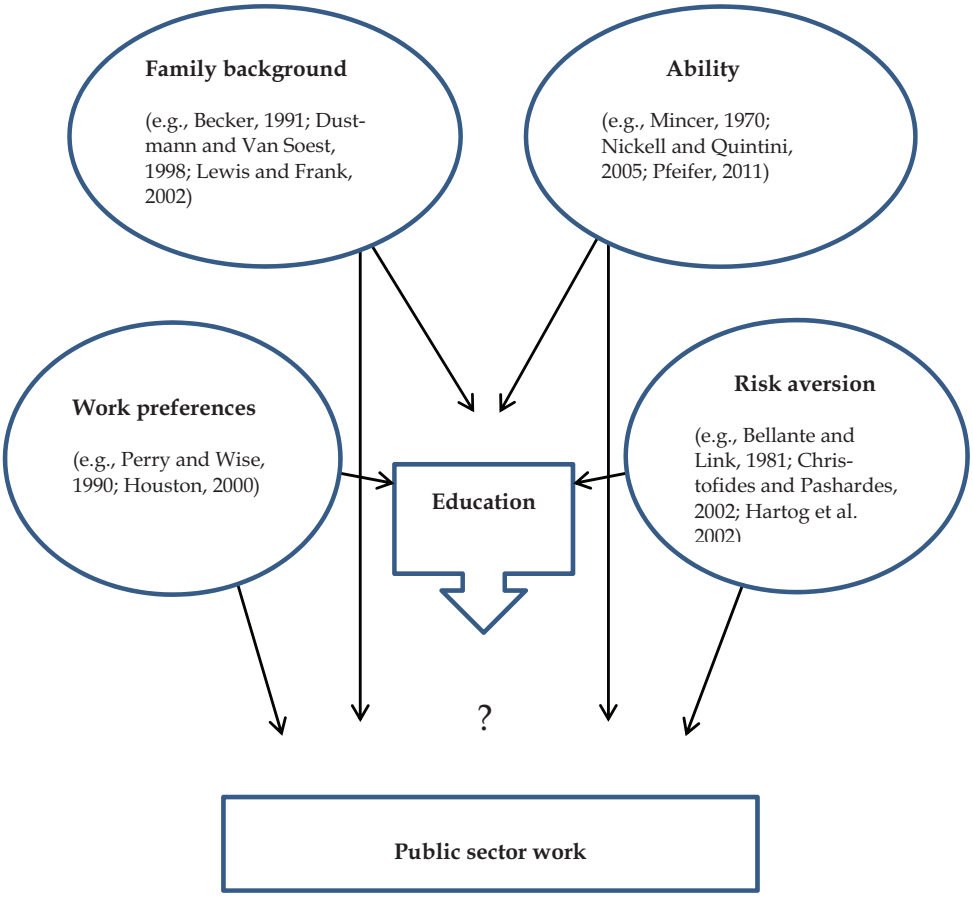

FIGURE 1 Family background, ability, risk-aversion and work preferences: their effects on education and public sector work

The second source of unobserved factors relates to innate ability. As is well established, ability is positively correlated with education. We refer back to Mincer (1970), who constructs a theory of income distribution based on the theory of human capital. An important link in his argument is that given the same opportunities in the capital market, individuals with higher ability will acquire more education than less able individuals. There is little empirical evidence regarding how ability is distributed between public and private sector employees. In their study based on UK data, Nickell and Quintini (2005) find that the ability of male employees has decreased in the public sector. The same phenomenon did not appear to be true of female workers, although evidence of the lower ability of female teachers in the public sector is widely reported (e.g., Corcoran et al., 2004; Lakdawalla, 2006; Bacolod, 2007). Pfeifer (2011) analyses survey data from master's students in economics and management. Their results suggest that better students, as measured by their expected final grades, are less likely to choose public sector jobs.

The third potential source of unobserved heterogeneity is related to an individual's work preferences. Public service motivation (PSM) has been an important issue in public administration and refers to an individual's motivation to contribute to the public interest, to help others and to improve the societal well-being (e.g., Perry and Wise, 1990; Houston, 2000). In other words, when an employee has a desire to work, for example, as a schoolteacher or a police officer, he or she requires specific types of education to obtain such jobs. Therefore, work preferences have a direct causal effect not only on public sector work but also on education.

The fourth source of heterogeneity lies in risk attitudes between individuals. In general, risk-averse individuals are more likely than others to choose public sector work, as reported in the US (Bellante and Link, 1981), Cyprus (Christofides and Pashardes, 2002), Netherlands (Hartog *et al*., 2002) and Germany (Pfeifer, 2011).[1] This finding may be a consequence of public sector employees more likely valuing jobs with high job security (e.g., Demoussis and Giannakopoulos, 2007). In addition, human capital investments are also risky decisions. The findings regarding the relationship between risk attitudes and schooling are mixed; see, for example, Hartog, Ferrer-i-Carbonell and Jonker (2002) and Belzil and Leonardi (2007). In their study using panel data from Italy, Belzil and Leonardi (2007) find no clear connection between risk attitudes and education; in contrast, Hartog *et al.* (2002) use three different datasets from the Netherlands, and find that higher education is negatively associated with risk aversion.

Thus, referring to Figure 1, the four potential sources of unobserved disturbances are family background, ability, occupational preferences and risk preferences. Because identical twins have similar family backgrounds (if raised together) and genetic inheritances, such as innate ability, (e.g., Goldberger, 1979), these two sources of disturbances can be conditioned out from the analysis. I am thus able to estimate the impact of education on the likelihood of becoming a public sector employee that is not due to correlations between education and family background and ability.

The behavioural genetics literature provides convincing empirical evidence on the extent of heritable effects on occupational preferences (e.g., Betsworth *et al*. 1994; Nicolaou and Shane, 2010) and attitudes towards risks (e.g., Cesarini *et al*., 2009; Zhong *et al*., 2009). For example, approximately 36 per cent of variation in vocational interests in the US can be explained by genetic factors

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1 Bellante and Link (1981) examined risk aversion using an index that is formulated on the basis of answers to questions involving the condition and insurance of automobile owners, the use of seat belts, medical coverage and smoking and drinking habits. Christofides and Pashardes (2002) used life insurance and loan repayment variables as proxies for attitudes for risk. Hartog *et al.* (2002) measured risk aversion by asking individuals to state their reservation price for a lottery ticket, with a specified probability of winning a prize of particular magnitude. Using expected utility theory, Hartog *et al.* then calculated the Arrow-Pratt measure for risk aversion. In his analysis, Pfeifer (2011) used a 2004 wave from the longitudinal survey of private households and persons in Germany that included questions about individual risk-taking behaviour in general and specifically concerning the respondent's career.

(Betsworth *et al*., 1994), while the genetic component explaining occupational variation, for example, whether one is self-employed, a manager, a teacher or a sales worker, varies between 30-48 per cent (Nicolaou and Shane, 2010). The findings regarding the heritability of risk preferences show that the genetic component of economic risk preference is high, representing 14-25 per cent of the variation in Sweden (Cesarini *et al*., 2009) and 57 per cent in China (Zhong *et al*., 2009). These findings indicate that the similarity in genetics may drive similar risk preferences and occupational interests. In my study, the unobserved heterogeneity associated with these factors can be potentially eliminated from the analysis in addition to family background and ability (see Figure 1).

3 Data

3.1 Data sources

The twin sample is based on the older Finnish Twin Cohort Study from the Department of Public Health at the University of Helsinki, which has been matched to Finnish Longitudinal Employer-Employee Data (FLEED) of Statistics Finland.

The original Twin Cohort Study is a postal health survey that was conducted in 1975, 1981 and 1990 on same-gender twin pairs who were born before 1958. The twin pairs were selected from the Central Population Registry of Finland in 1974. The third questionnaire was sent to pairs who were born between the years 1930 and 1957; thus, these pairs were between the ages of 33 and 60 years in 1990. A total of 16,179 twin pairs were contacted, and the response rate for the 1990 survey was 77 per cent. The number of twin pairs in the sample is 12,502, for a total of 25,004 individuals (Kaprio *et al*. 1979). The twin pairs are either fraternal (dizygotic, DZ) or identical (monozygotic, MZ).[2] The survey contains information on symptoms of illnesses and reported diseases, drug use, physical characteristics, smoking, alcohol use, leisure time physical activity and psycho-social factors.

The FLEED data cover nearly all Finns between the ages of 16 and 70 for the period from 1988 to 2004. The data are constructed from a number of different administrative registers on individuals, firms and establishments that are collected or maintained by Statistics Finland. Using a personal identifier variable, the Twin Cohort Study is matched with the FLEED. The twin data consists of

[2] Identical (MZ) twins are conceived from a single fertilised egg and fraternal (DZ) twins are conceived from two separate eggs. MZ twins share 100 per cent of their genes, while DZ twins share 50 per cent of their genes on average. The zygosity of the twin pairs was determined based on their answers to the questions regarding similarity in appearance in childhood. A subsample was reclassified using 11 blood markers. The blood-based classification largely agreed with the survey-based classification, with a 1.7 per cent probability of misclassification of a blood marker concordant pair (Kaprio *et al*., 1979).

information on those 12,502 twin pairs (25,004 individuals) for the period from 1990 to 2004.

To check the representativeness of the twin sample with regard to the general population in Finland, I use a longitudinal register-based dataset (LRBD), representing a seven per cent random sample of the entire Finnish population in 2001. The data are based on the Longitudinal Census File and Longitudinal Employment Statistics constructed by Statistics Finland for the period of 1970 through 2004. Beginning in 1987, the two basic files were updated annually until 2004. The data contain background information on individuals, as well as parents, spouses and region of residence.

3.2 Descriptive statistics of the twin sample

The analysis concentrates on twin pairs who are both employed at year *t* with positive annual earnings either in the public or in the private sector. Entrepreneurs and individuals with missing information are excluded, and the final sample consists of 893 male and 1,211 female twin pairs. In total, the data include 15,290 male and 21,468 female twin yearly observations over the period from 1990 to 2004.[3] All of the subjects in the sample are at least 33 years old, and approximately 40 per cent of them are identical twins. When calculating from person-year observations in the sample, 18 per cent of the males and 51 per cent of the females work in the public sector. The share of identical twin pairs in which one sibling works in the public sector and the other works in the private sector is 21 per cent among male twins and 35 per cent among female twins.

Table 1 reports the means for basic individual characteristics by working sector and gender. These statistics are compared with the LRBD sample for the same year (1990 to 2004) and age (from 33 to 60 years old in 1990) as the twin data. Years of education is defined as the highest completed education level based on the Statistics Finland classification.[4] Column (1) presents the variable means for the sample of LRBD, column (2) presents the variable means for the sample of all twins and column (3) presents the similar means within identical twin pairs, in which one twin sibling works in the public sector and the other twin works in the private sector.

Table 1 shows that public sector employees are more educated than private sector employees. This result is consistent with other international studies (e.g., Bellante and Link 1981, Blank 1985, Kanellopoulos 1997, Adamchik and Bedi 2000, Christofides and Pashardes 2002). Public sector male twins have completed 14.3 years of schooling. Private sector male twin employees are less educated, averaging 12.2 years of schooling. The analogous means for female

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3 The data are unbalanced because not every pair is observed every year, i.e., there are gaps in the data.

4 Nine years for primary education (or level of education unknown), 12 years for lower secondary education, 14 years for the lowest level of tertiary education, 16 years for the lower-degree level of tertiary education, 18 years for the higher-degree level of tertiary education and 21 years for a doctorate or equivalent level of tertiary education.

twins are 12.8 years and 11.4 years of schooling. The *t*-statistics indicate statistically significant differences in these means at the one per cent level. The individuals in the sample are 47-48 years old on average. There is no clear discrepancy in marital status, although public sector employees are more likely to have children compared to private sector employees (see also Kanellopoulos 1997, Christofides and Pashardes 2002). Interestingly, male public sector employees are less likely to own a house compared to male private sector employees, while the reverse is true for females. Kanellopoulos (1997) reports the opposite for Greek employees.

The means are broadly similar to the statistics for the general population, except that twins have more children compared to the population in general; see columns (1) and (2). This difference should not have a significant influence on the representativeness of the results, because the twin data are, in general, quite representative of the general Finnish population (Kaprio *et al*., 1979).[5]

The statistics from column (3) provide three interesting observations. First, when the differences between employees in the public and private sectors are examined *within* identical twin pairs, education no longer appears to be a significant factor in explaining public sector employment, which is consistent with the work of Dustmann and Van Soest (1998). Second, the differences in other individual characteristics between the employees in the public and private sectors also become insignificant for males. This finding suggests that male employees in the public sector do not differ from those in the private sector, indicating that males may choose the sector of employment randomly. Third, some differences in the individual characteristics between the public and private sector employees remain or become statistically significant for females. In fact, among otherwise genetically equivalent employees, those females who have children and are non-single are more likely to be found in the public sector.

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5 Differences in the means of characteristics might reflect a potential bias due to response. Earlier literature shows that non-respondents are typically less educated, more likely to be single, more likely to be house renters and more likely to have fewer children compared to individuals who respond to surveys (e.g., Abraham, Maitland and Bianchi, 2006). The differences in characteristics between twin data and other population surveys may also be due to sampling bias, which is unlikely to be the case in this study because individuals that were chosen to participate in the survey were exclusively Finnish twins.

TABLE 1 Means for basic individual characteristics (standard deviations in parenthesis)

	LRBD			Twin data					
	Sample of all Finns (1)			Sample of all Finnish twins (2)			Within MZ twin pairs (3)		
Men	Public	Private	Diff. *t*-stat [a]	Public	Private	Diff. *t*-stat [a]	Public	Private	Diff. *t*-stat [b]
Education years	13.3 (11.03)	12.0 (8.79)	32.63***	14.3 (11.26)	12.2 (9.39)	9.98***	13.4 (10.46)	12.5 (9.46)	1.59
Age	48.0 (16.47)	47.7 (15.89)	4.80***	47.7 (15.76)	47.2 (16.17)	1.49	46.8 (13.93)	46.8 (13.93)	0.00
Non-single	0.82 (1.059)	0.81 (1.100)	0.96	0.85	0.83	0.85	0.84 (0.94)	0.76 (1.20)	1.38
Underage children	0.44 (1.282)	0.43 (1.281)	1.76	0.56	0.49	2.55**	0.61 (1.15)	0.55 (1.24)	0.86
House	0.81 (1.058)	0.82 (1.063)	1.70	0.84	0.89	2.38**	0.86 (0.93)	0.87 (0.90)	0.28
Observations	85,856	218,547		2,789	12,501		608	608	
Women									
Education years	12.5 (8.73)	11.3 (7.60)	42.80***	12.8 (8.43)	11.4 (7.88)	11.76***	12.0 (8.23)	11.7 (7.28)	1.24
Age	48.3 (16.26)	48.0 (15.33)	5.24***	47.4 (15.44)	47.0 (15.32)	1.72	48.0 (15.71)	48.0 (15.71)	0.00
Non-single	0.74 (1.289)	0.73 (1.248)	3.39***	0.72	0.71	0.57	0.74 (1.32)	0.63 (1.48)	2.02**
Underage children	0.40 (1.261)	0.35 (1.195)	11.10***	0.45	0.41	2.39**	0.45 (1.27)	0.36 (1.12)	2.01**
House	0.81 (1.125)	0.79 (1.118)	4.39***	0.86	0.83	2.06**	0.84 (1.09)	0.84 (1.03)	0.17
Observations	197,081	168,809		10,891	10,577		1,479	1,479	

a Standard errors are robust for the within-individual correlation
b Standard errors are robust for the within-twin pair correlation
*** and ** denote statistical significance at least at the 1% and 5% levels.

4 Empirical analysis

4.1 Econometric model

The dependent variable in this study, Public_{ift}, is equal to one if twin i ($i = 1,2$) raised in family f ($f = 1,\ldots,F$) works in the public sector in year t ($t = 1990,\ldots,2004$), and it is equal to zero otherwise. To examine the determinants of Public_{ift}, I use the unobserved propensity of an individual to work in the public sector. The assumption is that public sector attainment is determined by an unobserved latent variable Public^*_{ift}, such that $\text{Public}_{ift} = 1$ if $\text{Public}^*_{ift} > 0$ and $\text{Public}_{ift} = 0$ if $\text{Public}^*_{ift} \leq 0$. In particular, latent public sector employment can be expressed as follows:

$$\text{Public}^*_{ift} = \theta_f + \beta \text{Educ}_{ift} + \alpha X_{ift} + \gamma S_{if,1990} + \varepsilon_{ift} \quad (1)$$

where ø_f is so-called family-specific fixed effect that includes factors related to family background and genetics. Educ_{ift} is education years, X_{ift} is a vector of additional individual control variables, $S_{if,1990}$ is a vector of survey control variables from the 1990 questionnaire and β, a and γ are parameters. Finally, ε_{ift} is an unobservable error term that has a standard logistic distribution with a mean of zero and a variance of one. This term captures all of the unobservable time-varying individual characteristics that affect the likelihood of public sector employment.

The vector X_{ift} includes age and its square, cohort (seven categories: born in 1927-1929, 1930-1934, 1935-1939, 1940-1944, 1945-1949, 1950-1954 and 1955-1957), field of education (six categories: general or unknown, teaching or humanistic or arts, business or social sciences, natural sciences or technology, forestry or agriculture and health or social work or services), marital status (single or non-single), presence of underage children, house ownership and year dummies. Some of these variables may be regarded as "bad controls" (e.g., Angrist and Pischke, 2009), which means that the variables were not fixed at the time the regressor of interest (education) was determined. For example, marital status, presence of children and house ownership may be the outcomes of higher education, which is the variable of primary interest. In the sociological literature, for instance, education is treated as one of the explanatory factors of fertility behaviour (e.g., Mare and Maralani, 2006). The possibility that these bad controls could affect the analysis is accounted for in robustness tests.

$S_{if,1990}$ contains information from the 1990 questionnaire on drinking patterns, smoking habits, a measure of aerobic exercise MET intensity (Metabolic Equivalent of Task) and health (an index that ranges from 1 to 24 and is defined using information on weight, number of diagnosed diseases, medication use and whether the subject has chest pains and breathing problems). In addition,

dummies for an individual's own influence on working methods and monotony of work are included into the model. The causal effect of these job-specific characteristics is, however, problematic. For instance, there is a possibility that working in a less monotonous job may be the result, rather than cause, of being an employee in certain sector. The empirical evidence has devoted considerable attention to the differences in job-specific characteristics and job satisfaction between the public and private sector workplaces (e.g., Van Ophem, 1993; Demoussis and Giannakopoulos, 2007; Weisshaar, 2010, for a review). For example, Van Ophem (1993) finds that changing working hours and better work conditions make public sector jobs more appealing to some individuals. In light of earlier literature, it is thus interesting to examine the relationship between certain job-specific characteristics and public sector work in our twin data.

The family-specific fixed effect, $ø_f$, includes family background variables and genetic inheritance. Family background includes, for example, the transmission of labour market information from parents to children, family income and identical shocks that two children in the same family would both experience. In Figure 1, these factors are represented by the box labelled *Family background*. The genetic inheritance component includes ability (see Figure 1, box *Ability*) and may also include factors that reflect individual's risk-taking behaviour and work preferences (boxes *Risk-aversion* and *Work preferences*). The assumption is that $ø_f$ is time-invariant and is similar for identical twins (independent on *t* and *i*) but varies between families (dependent on *f*).

The aim of this study is to estimate an effect of education on the likelihood of working in the public sector that is not biased due to family background and genetic inheritance; see Figure 1. This aim is accomplished using a conditional (fixed effects) logit regression approach (e.g., Magnac, 2004), in which the fixed effect factor is the family, denoted by *f*. The results are reported both for fraternal and for identical twins. Identical twins have the same genetic makeup and share the same family background. This specification provides an estimate of the effect of schooling on public sector participation (β) that is not biased by the omission of the ability and family background variables. The specification for identical twins is also assumed to condition out factors related to risk and work preferences, as these attributes are found to be broadly heritable and thus quite similar for identical twins (e.g., Betsworth *et al*., 1994; Cesarini *et al*., 2009). Fraternal twins, in turn, are not identical in their genetic inheritance, but they share the same family background. This specification provides an estimate that could be biased by the omission of genetic factors but not by the omission of family background. The standard errors are clustered for yearly twin pairs to take into account that observations of twins *i* in a family *f* may be correlated.

4.2 Main results

Tables 2 and 3 report the results for males and females separately. In addition to the conditional logit regression estimates, the tables also report the estimates from a standard logit regression that treats all of the subjects as individuals.

Unobserved family-specific heterogeneity is controlled for in the conditional logit model by conditioning out $\varnothing_f$, but not in the standard logit model.

In Tables 2 and 3, column (1) reports the standard logit regression estimates for a sample of the general population (LRBD data), and column (2) reports similar estimates for the twin sample without the survey variables; the model is augmented with these survey variables in column (3). Finally, columns (4) and (5) report the conditional logit regression estimates for fraternal and identical twins, respectively. Thus, column (4) presents the effects of education on public sector employment choice when family background is controlled for, while column (5) presents similar effects when both family background and genetic factors are controlled for. It must be noted that age, cohort and year dummies are automatically dropped from the specifications reported in columns (4) and (5), because there is no within-twin-pair variation in these variables. All parameter estimates are presented as odds ratios. In other words, an estimate that is greater than one contributes positively to the likelihood of obtaining a job in the public sector.

The results indicate that higher education makes a person more likely to obtain a public sector job. The estimate for the twin sample is 1.24 for males and 1.22 for females; both are statistically significant at the one per cent level. The results are qualitatively and quantitatively consistent with the findings for the general population sample, which indicates that the twin sample is quite representative; see columns (1) and (2) in Tables 2 and 3. The introduction of survey variables slightly improves the statistical performance of the model for both genders, but the estimates of education remain essentially unchanged; see column (3) of Tables 2 and 3.

The conditional logit results for fraternal twins in column (4) in Tables 2 and 3 suggest that when shared family background variables are controlled for, the effect of education becomes statistically insignificant for females. This finding indicates that the correlation between schooling and public sector employment may be due to the correlation between education and family background characteristics (see also Dustmann and Van Soest, 1998). Interestingly, this pattern does not hold for males. In fact, the estimate of education increases from 1.24 to 1.49 and is statistically significant. The conditional logit results for identical twins in column (5) of Tables 2 and 3 show that once both family background and genetic factors are controlled for, the effect of education becomes statistically significant for females with the point estimate reaching 1.73 and remains positive for males with the point estimate further increasing to 1.76. Evidently, higher education induces the decision to seek public sector employment; this finding contrasts with the conclusion of Dustmann and Van Soest (1998). In fact, educational attainment seems to be one of the most important (observed) factors in determining whether one chooses public sector employment; indeed, the estimates of most of the other control variables fail to reach statistical significance. The results in column (5) indicate that, in addition to years of schooling, one's education field is also a good predictor for whether one eventually works in the public or private sector. When both the family

background and genetic effects are controlled for, having an education in the natural sciences, technology, forestry or agriculture decreases the likelihood of working in the public sector for both genders.

Other control variables that seem to have an impact are home ownership, presence of children and health. In particular, owning a house is negatively correlated with public sector employment for males. Individuals who own a house most likely have more other income and wealth than those who do not own a house. This result is consistent with work by Lassibille (1998) and Christofides and Pashardes (2002), who find that public sector employees are less likely to have other income and capital. The presence of underage children increases the likelihood of working in the public sector for females. This result is consistent with Kanellopoulos (1997). In addition, the measured health index decreases the likelihood of working in the public sector among females.[6] No clear evidence on the role of survey controls is found for males.

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6 The standard logit model produces statistically significant relationships between non-smoking and responsible drinking habits and the likelihood of working in the public sector for females. The finding regarding smoking is consistent with Bang and Kim (2001), who used a sample from the third National Health and Nutrition Examination (NHANES III) from the US. They found that the lowest prevalence of cigarette smoking by occupation is observed among teachers and within industries that are mainly observed in the public sector, including educational services and health practitioner offices. Interestingly, the standard logit estimates indicate that monotony of work is positively related to private sector jobs for both genders, and that females holding jobs in which they have influence over their own working methods are more likely to be observed in the public sector. This latter result resembles Van Ophem (1993), who finds that individuals with changing working hours are more likely to be working in the public sector.

TABLE 2 Standard logit and conditional logit results for men (z-statistics in parenthesis)

	Sample of LRBD treated as individuals (1)	Twins treated as individuals (2)	Twins treated as individuals (3)	Within DZ twins (4)	Within MZ twins (5)
Education years	1.21 (33.64)***	1.24 (5.75)***	1.24 (5.69)***	1.49 (2.71)***	1.76 (3.37)***
Age	0.98 (0.97)	1.08 (0.98)	1.08 (0.98)		
Age squared	1.05 (3.65)***	1.00 (0.16)	1.00 (0.19)		
Teach, Hum & Arts	1.80 (5.98)***	8.79 (4.03)***	8.72 (4.07)***	1.06 (0.05)	
Business & social sciences	0.55 (11.33)***	1.02 (0.06)	0.95 (0.17)	0.44 (1.12)	0.16 (1.47)
Natural sciences & technology	0.50 (18.84)***	0.28 (4.14)***	0.26 (4.28)***	0.05 (3.70)***	0.08 (2.98)***
Forestry & agriculture	0.82 (2.46)**	0.87 (0.34)	0.78 (0.60)	0.15 (2.28)**	0.04 (2.39)**
Health & social work & services	3.73 (22.41)***	9.90 (6.79)***	9.76 (6.80)***	43.31 (4.43)***	4.17 (1.45)
Non-single	0.97 (1.02)	1.00 (0.02)	0.94 (0.28)	0.76 (0.62)	1.34 (0.50)
Underage children	1.02 (0.70)	1.64 (3.05)***	1.61 (2.99)***	1.17 (0.44)	0.78 (0.61)
House	0.85 (5.52)***	0.61 (2.64)***	0.62 (2.51)**	0.32 (2.35)**	0.29 (2.41)**
MET			0.98 (1.09)	1.04 (0.69)	1.15 (1.57)
No_smoke			0.82 (1.17)	0.80 (0.41)	0.42 (1.08)
No_alcohol			1.29 (0.97)	0.87 (0.27)	0.56 (0.61)
Health			0.99 (0.39)	0.93 (0.69)	0.97 (0.23)
Monoton work			0.46 (2.08)**	0.64 (0.69)	0.51 (0.89)
Influence over working metods			2.05 (1.30)	3.52 (1.78)	
Cohort age + year dummies	√	√	√		
Pseudo R2	0.08	0.26	0.25	0.47	0.38
Log likelihood	-165,774.9	-5,382.70	-5,315.86	-443.91	-259.30
N	304,403	15,290	15,290	2,422	1,216

Notes: Standard errors for LRBD are robust for the within-individual correlation and for the twin data for the within-twin pair correlation. The age, cohort and year dummies are dropped in columns (4) and (5) due to a lack of within-twin pair variation in these variables. One field of education dummy and a dummy for an individual's influence over work methods is dropped from the equation because the coefficients of these variables are poorly identified by the variation in the data. (***) and (**) denote statistical significance at the 1% and 5% levels.

TABLE 3 Standard logit and conditional logit results for women (z-statistics in parenthesis)

	Sample of LRBD treated as individuals (1)	Twins treated as individuals (2)	Twins treated as individuals (3)	Within DZ twins (4)	Within MZ twins (5)
Education years	1.21 (25.77)***	1.22 (5.63)***	1.21 (5.47)***	1.17 (1.82)	1.73 (3.78)***
Age	0.94 (4.79)***	0.93 (1.30)	0.92 (1.36)		
Age squared	1.10 (8.31)***	1.00 (1.71)	1.00 (1.62)		
Teach, Hum & Arts	1.55 (5.96)***	3.73 (3.47)***	3.26 (3.15)***	3.88 (1.50)	0.30 (1.35)
Business & social sciences	0.61 (11.20)***	0.69 (1.82)	0.68 (1.93)	0.50 (1.67)	0.11 (3.04)***
Natural sciences & technology	0.59 (10.93)***	0.34 (4.51)***	0.35 (4.50)***	0.27 (2.36)**	0.21 (1.99)**
Forestry & agriculture	1.09 (0.77)	1.36 (0.67)	1.21 (0.43)	0.59 (0.63)	0.12 (2.23)**
Health & social work & services	2.98 (29.13)***	3.71 (7.18)***	3.65 (7.19)***	2.23 (2.12)**	0.59 (0.85)
Non-single	1.08 (3.10)***	1.10 (0.91)	1.09 (0.78)	0.89 (0.50)	1.56 (1.56)
Underage children	1.23 (9.34)***	1.30 (2.85)***	1.34 (3.17)***	1.58 (2.03)**	1.76 (2.14)**
House	0.94 (2.26)**	1.10 (0.91)	0.96 (0.31)	0.83 (0.78)	0.93 (0.25)
MET			1.02 (0.75)	0.99 (0.26)	1.04 (0.57)
No_smoke			1.29 (2.33)**	1.71 (1.81)	1.14 (0.32)
No_alcohol			1.86 (4.21)***	1.47 (1.14)	0.99 (0.19)
Health			0.96 (2.06)**	0.95 (1.26)	0.88 (2.13)**
Monoton work			0.62 (3.05)***	0.91 (0.32)	0.92 (0.21)
Influence over working methods			3.10 (4.67)***	2.57 (2.44)**	3.32 (1.91)
Cohort age + year dummies	√	√	√		
Pseudo R2	0.10	0.15	0.18	0.20	0.17
Log likelihood	-226,433.23	-12,589.32	-12,157.64	-1,372.12	-851.19
N	365,890	21,468	21,468	4,952	2,958

Notes: Standard errors for LRBD are robust to within-individual correlation and for twin data to within-twin pair correlation. The age, cohort and year dummies are dropped in columns (4) and (5) due to the lack of within-twin pair variation in these variables. (***) and (**) denote statistical significance at the 1% and 5% levels

4.3 Robustness tests

I have studied the robustness of my main results in two ways. The first specification tests whether the results are sensitive to the included control variables. The second test determines whether the results vary with the stage of the economic cycle.

The first robustness test is conducted due to a concern that the model may include variables that are regarded as "bad controls" (e.g., Angrist and Pischke, 2009). These bad controls are themselves outcome variables of the dependent variable of interest. Appropriate controls are fixed at the time that the regressor of interest was determined. Because the variable of interest is education, all of the controls that may be outcomes of such education should not be included in the model. Therefore, marital status, presence of children and the dummy variables for owning a house are excluded, because individuals with more education tend to have fewer children, are more likely to be married and have a higher probability of owning a house. Because many of the survey variables are potentially endogenous, all of the survey controls were also dropped from the model. The results, presented in Table 4, are comparable to my main findings. In particular, the standard logit estimate is 1.24 for males and 1.22 for females. In a specification where family background is controlled for, the estimate increases to 1.42 for males, and the estimate is now statistically significant for females as well. In a specification where both family background and genetic effects are held constant, the estimates become stronger: the point estimate is 1.69 for males and 1.62 for females.

The second robustness test relies on the assumption that during economic upturns, less qualified workers will have greater access to vacant positions than during downturns, as the labour market opportunities outside the public sector vary. For example, Falch, Johansen and Strøm (2009) find, using a panel of Norwegian local governments for 1981-2002, that teacher shortages measured by the share of teachers without approved education are strongly pro-cyclical in Norway.

To consider the possibility of differential education effects in different phases of the research period, the model was rerun by splitting the entire research period into three sub-periods: 1990-1994, 1995-1999 and 2000-2004. The first period represents the difficult years in the Finnish labour markets, including a major recession at the beginning of the 1990s. The second period includes the years of recovery from the recession and an ICT boom led by Nokia, and the last period covers the slight downturn after the boom and the years of stable labour market conditions after the downturn. The results are presented in Table 5. There is no clear evidence that different research periods provide differential education effects on the likelihood of joining public sector employment. Overall, the results presented in Tables 4 and 5 indicate that my findings are robust.

TABLE 4 Standard logit and conditional logit results excluding the "bad controls" (z-statistics in parenthesis)

	Men			Women		
	Twins treated as individuals (1)	Within DZ twins (2)	Within MZ twins (3)	Twins treated as individuals (4)	Within DZ twins (5)	Within MZ twins (6)
Education years	1.24 (5.85)***	1.42 (2.61)***	1.69 (2.93)***	1.22 (5.64)***	1.19 (2.05)**	1.62 (3.35)***
Pseudo R2	0.25	0.44	0.31	0.15	0.16	0.10
Log likelihood	-5434.63	-473.26	-289.25	-12624.81	-1439.04	-927.50
N	15,290	2,422	1,216	21,468	4,952	2,958

Notes: Standard errors are robust for the within-twin pair correlation. (***) and (**) denote statistical significance at the 1% and 5% levels.

TABLE 5 Standard logit and conditional logit results for the sub-samples (z-statistics in parenthesis)

	Men			Women		
	Twins treated as individuals (1)	Within DZ twins (2)	Within MZ twins (3)	Twins treated as individuals (4)	Within DZ twins (5)	Within MZ twins (6)
Period 1990-1994						
Education years	1.19 (4.30)***	1.42 (2.25)**	1.88 (3.40)***	1.19 (4.51)***	1.05 (0.53)	1.62 (2.90)***
Pseudo R2	0.26	0.46	0.36	0.18	0.21	0.15
Log likelihood	-2072.94	-171.41	-102.07	-4421.46	-480.92	-328.62
N	5,870	912	462	7,828	1,766	1,116
Period 1995-1999						
Education years	1.28 (5.76)***	1.59 (2.36)**	2.08 (2.38)**	1.24 (5.45)***	1.26 (2.50)**	2.00 (4.29)***
Psedo R2	-1751.22	0.54	0.48	0.19	0.20	0.20
Log likelihood	0.27	-130.71	-73.50	-4008.08	-459.08	-266.22
N	5,060	812	410	7,146	1,660	966
Period 2000-2004						
Education years	1.29 (5.39)***	1.67 (2.68)***	2.16 (2.33)**	1.19 (4.72)***	1.18 (1.70)	1.61 (2.84)***
Pseudo R2	0.30	0.61	0.57	0.18	0.23	0.21
Log likelihood	-1451.03	-93.68	-50.69	-3694.04	-408.29	-240.32
N	4,360	698	344	6,494	1,526	876

Notes: Standard errors are robust for the within-twin pair correlation. (***) and (**) denote statistical significance at the 1% and 5% levels

5 Conclusions

This study used fraternal and identical twin pairs from Finland to examine the impact of education on the likelihood of working in the public sector. The twin sample was compared with a general population sample to check the representativeness of the data. The standard logit results for a sample that treats all twins as individuals were comparable with the general population sample and suggest that higher education increases the likelihood of obtaining a public sector job. The conditional logit results for fraternal twins indicate that the role of education remains positive and statistically significant for males but becomes statistically insignificant for females. This lack of a role of education for females is consistent with the work of Dustmann and van Soest (1998), with the exception that those authors used data on males only. However, when the genetic effect is also controlled for, the impact of education remains statistically significant for males and is also statistically significant for females. This finding suggests that the relationship between higher education and the choice of working in the public sector is not due to the correlation between genetic effects (such as ability, risk aversion and work preferences) and schooling.

The results of this paper support the earlier findings that higher education plays an important role in determining whether an individual chooses public or private sector work. Such a career choice is logical in the sense that the public sector needs qualified employees to accomplish the required tasks. Although there is no specific entry route to central government duties through education, a higher university degree is often required for specialist duties. In the local government sector, many jobs have qualifications specified by law that require a specific educational background. For example, the work of health care professionals is regulated by legislation on the exercise of occupations. The acquisition of higher education thus influences individuals' work decisions, and this impact is a pure structural effect.

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CHAPTER 6
EMPLOYMENT SECTOR AND PAY GAPS: GENETIC AND ENVIRONMENTAL INFLUENCES*

Abstract**

This paper uses data on Finnish twins to examine two questions regarding public sector labour markets. First, what are the genetic and environmental contributions to being a public sector employee, and second, are there wage gaps between public and private sector employees. The results indicate that 34 to 40% of the observed variance in the tendency to be a public sector worker can be attributed to genetic factors, with no influence of the shared environment. Furthermore, at least one-third of the genetic variance is mediated through educational attainment. The results from the wage gap analyses suggest that OLS estimates are downward biased. In fact, while OLS estimates indicate a negative wage gap for both males (seven per cent) and females (four per cent), the within-twin estimates do not indicate any inequalities with respect to pay offered by the two sectors.

Keywords: public sector employment, behavioural genetics, twin studies, wage differentials
JEL classification: J24, J31, J45

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1 Introduction

There are two interesting questions that have been studied in public sector labour markets. First, what types of individuals are attracted to public sector jobs and what attributes make these jobs appealing? Second, are their differences between the pay earned by public and private sector employees?

Theoretical models assume that employees choose the working sector on the basis of utility maximisation, thereby leading to a self-selection of preferable activities by workers (e.g., Roy, 1951). Accordingly, selection by the working sector is often influenced by individual psychological (unobserved) factors. For example, research indicates that some individuals are more attracted to and motivated to work for the public interest, to do good for others and to shape the well-being of the society (e.g., Perry and Wise, 1990). Some authors further suggest that public sector employees value non-monetary benefits more highly than they do financial rewards (e.g., Crewson, 2004; Karl and Sutton, 1998) and that they are more risk-averse than private sector employees (Bellante and Link, 1981; Christofides and Pashardes, 2002; Hartog, Ferrer-i-Carbonell and Jonker, 2002; Pfeifer, 2011). Furthermore, there is some evidence as to how ability is distributed across the labour markets; typically, the public sector attracts a less high-quality labour force (e.g., Corcoran, Evans and Schwab, 2004; Nickell and Quintini, 2002; Pfeifer, 2011). The second group of attributes affecting the sectoral choice relates to individual demographic (observed) factors, such as being older, better educated, married, ethnic minority, a house renter and having been raised in a family in which a parent or other relative has worked for the government (e.g., Bellante and Link, 1981; Kanellopoulos, 1997; Dustmann and van Soest, 1998; Adamchick and Bedi, 2000; Christofides and Pashardes, 2002; Lewis and Frank, 2002). Based on this vast body of literature, it is therefore standard to consider public sector work as an endogenous economical outcome.

The empirical evidence has also been used to study public-private sector wage differentials. As the aggregate wages indicate that employees typically earn more in the public sector than they do in the private sector, many attempts have been made to explain why such pay gaps exist. Kanellopoulos (1997), Christofides and Pashardes (2002) and Akhmedjonov and Izgi (2012) find that the aggregate pay gaps are mainly explained by differences in individual attributes such as better skill characteristics. Bender and Elliot (2002), Chatterji, Mumford and Smith (2011) and Cai and Liu (2011) extend the conventional analysis by emphasising the role of job attributes in the unequal pay offered by the two sectors. These studies find that in addition to human capital characteristics, workplace-specific attributes account for a major part of the observed pay gaps between public and private sector employees. Bargain and Melly (2008)

also find that a control of self-selection is extremely important in the estimation of wage gaps, as often the wage differential is simply due to sorting.[1]

For many developed economies, a significant part of the aggregate wage differentials between sectors remain unexplained, even when controlling for many characteristics. These findings provide a fairly uniform picture. First, the conditional wage differentials are positive, at least for females (e.g., Blanchflower, 1996; Gregory and Borland, 1999; Giordano *et al*., 2011), and second, the wage differentials are smaller in countries where the pay formation is more regulated (e.g., Lucifora and Meurs, 2006). This is also the situation in Finland, where the indicated average return of being a public sector worker is positive for females, ranging from one to seven per cent, and negative for males, at three to five per cent (Korkeamäki, 1999; Uusitalo, 1999; Maczulskij and Pehkonen, 2011). These conditional wage differentials are rather small compared to European economies with less regulated labour markets.[2]

Despite their popularity in the labour economics literature, many aspects about public sector labour markets remain unanswered. In particular, no study has attempted to determine the role of genetic attributes and shared environment on the choice of working in the public sector or on the wage differentials. The goal of this paper is to fill this gap in the literature by using data on twins, as twin siblings have a similar family background and identical twins are also similar in terms of genetics. This paper applies a behavioural genetics framework in the estimation of genetic and shared environment influences on working in the public sector, while the wage differential analysis is conducted using a within-twin pair approach.

The motivation to examine the genetic and shared environmental contributions to being a public sector worker stems from an extensive behavioural genetics literature, which provides convincing empirical evidence with respect to heritable effects on a variety of sociological and economic outcomes. This branch of the literature includes Keller *et al*. (1992), who study the heritability of work values; Plomin and Spinath (2004), who focus on ability; Cesarini *et al*. (2009), who examine the genetic heritability of risk-taking; Miller, Mulvey and Martin (2001), who investigate the genetic heritability of education; Johnson *et al*. (2004), who find that marital status is mainly explained by genetic factors and Tambs *et al*. (1989) and Nicolaou and Shane (2010), who find heritable occupational preferences. Because all of these attributes also contribute to the decision to become a public sector worker, it is reasonable to ask to what extent working in this sector can actually be explained by genetic factors. In addition to genetic effects, public sector employment may also be influenced by shared

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1 See also Maczulskij and Pehkonen (2011), who find evidence that self-selection explains a significant part of the pay gaps in Finland (together with human capital variables and industry-specific valuations on skills).

2 See Giordano *et al*. (2011) for their recent wage gap analysis for ten selected Euro area countries. For example, they report high wage gaps for Portugal and Spain, where the gaps vary between 21 and 30% in favour of public sector employees. For the sake of comparison, the union density rates in these countries are approximately 20% in Portugal and 16% in Spain, compared to 70% in Finland (see recent OECD country comparison).

environments, which may include role-modelling and the transmission of labour market information from parents to children.

With regard to the analysis of the public-private sector wage differential, there is an apparent need to generally understand the wage-setting mechanism. Previous empirical studies on wage determination in the public and private sectors have typically focused on human capital and demographic and job-specific variables, which have been found to significantly affect wages, though approximately one-half of the variance in wages remains unexplained (e.g., Adamchick and Bedi, 2000; Christofides and Pashardes, 2002; Giordano *et al*., 2011). The other variables that are important in labour market success include unobserved ability[3] and the effects of family background that may go beyond the benefits of family income, instructive parenting style or advanced schooling (e.g., Griliches and Mason, 1972; Corcoran, Jencks and Olneck, 1976). Furthermore, several studies document the fact that non-economic attributes such as attractiveness (e.g., Hamermesh and Biddle, 1994), height (e.g., Judge and Cable, 2004), social skills (e.g. Persico, Postlewaite and Silverman, 2004) and personality (e.g., Almlund *et al*., 2011) are rewarded in the labour market. A particular challenge in the empirical literature is that these non-economic attributes and the object of primary interest, unobserved ability, can be measured only using poor proxies. The twin data accounts for the difference in this respect, as using a within-twin pair method for identical twins constitutes strong controls for unobserved ability and all other unobserved factors that are closely related to genetics. Furthermore, the effects of the entire family background are controlled for, as the experiences related to the shared environment are the same for twins raised in the same family.

The results of this article suggest that genetic factors account for a large part of the observed variance in working in the public sector (34 to 40%), while the effect of shared environments is statistically insignificant. Furthermore, at least one-third of the genetic variance is mediated through educational attainment. The results from the wage gap analyses indicate that neglecting the controls of genetics and shared environment effects in estimating public-private sector wage gaps could yield downward-biased estimates. In fact, while ordinary least squares results indicate a statistically significant, negative wage gap for both males (seven per cent) and females (four per cent), there is no unequal pay offered by the two sectors when the controls of unobserved ability and other variables related to genetics and family background are held constant.

The paper is organised as follows. Section 2 presents the twin sample, which is matched with the Finnish Longitudinal Employer-Employee Data (FLEED). Section 3 presents the empirical analysis of the effects of shared environment and genetic factors on working in the public sector. Section 4 reports

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3 Many studies find that the fraction of wage variance explained by some measured ability (e.g., cognitive ability measured by test scores) is modest because it often operates through educational attainment (e.g., Griliches and Mason, 1972; Uusitalo, 1999, from Finland; Cavley, Heckman and Vytlacil, 2001).

similar findings based on wage differential analysis. Finally, section 5 concludes the paper.

2 Data and descriptive statistics

The twin sample is based on the older Finnish Twin Cohort Study by the Department of Public Health at the University of Helsinki, which has been matched to the Finnish Longitudinal Employer-Employee Data (FLEED) from Statistics Finland.

The Twin Cohort Study was established in 1974 and was initially conducted using the Central Population Registry of Finland (see Kaprio *et al*., 1979). The original study involved the use of a postal health survey that was conducted in 1975, 1981 and 1990 on same-gender twin pairs who were born before 1958. The third questionnaire was sent to pairs who were born between the years 1930 and 1957 and who were thus between the ages of 33 and 60 in 1990. A total of 16,179 twin pairs were contacted, and the response rate for the 1990 survey was 77%, giving us 12,502 twin pairs in total. The twin pairs are either fraternal (dizygotic, DZ), or identical (monozygotic, MZ). The zygosity of the twin pairs was determined on the basis of their answers to the questions on similarity in appearance in childhood. However, the classification was redone for a subsample using 11 blood markers. The classification results agreed completely, with the probability of misclassification of a blood marker concordant pair being 1.7% (Kaprio et al., 1979).

Using a personal identifier, the Twin Cohort Study is matched with the FLEED. The FLEED data cover nearly all Finns between the ages of 16 and 70 for the period from 1988 to 2004. The data are constructed from a number of different administrative registers for individuals, firms and establishments that are collected or maintained by Statistics Finland. In sum, the matched data contain information on 12,502 twin pairs for the period 1990 to 2004.

The analyses are focused on twin pairs where *both* are employed at year *t* in either the public or the private sector. After excluding entrepreneurs, students, retired persons, unemployed persons and those who have zero earnings (wage salaries) from the sample, the original number of twin pairs decreases to 8,267 twin pairs. Restricting the analyses to individuals who have valid information on important background variables further reduces the sample size to 7,513 twin pairs. The majority of this decrease is due to incomplete information on job tenure and socio-economic status. Finally, those yearly observations that have no information on one's twin sibling (e.g., the twin sibling is unemployed) are excluded from that particular year, resulting in a remainder of 3,805 twin pairs in the final sample. Of these twin pairs, 1,289 are identical and 1,780 are males. In total, the sample includes 21,116 male and 23,802 female yearly observations for the period 1990 to 2004. The data are unbalanced because not every pair is observed every year, i.e., there are gaps in the data.

The descriptive statistics in Table 1 provide an overview of the sample by working sector. Columns (1) and (3) present the variable means for the sample of all twins for males and females, respectively, and columns (2) and (4) present the similar means within identical twin pairs in which one twin sibling works in the public sector and the other twin works in the private sector.

The table shows that the average annual earnings (deflated in 2004 euros) are six per cent higher in the public sector for males, whereas the average pay gap for females is one per cent in favour of private sector employees but statistically insignificant. While the individuals in the sample are 44 years old on average, the public sector employees are slightly younger.[4] Consistent with the existing literature, the public sector employees are more educated and also have higher socio-economic status than private sector employees (e.g., Kanellopoulos, 1997; Adamchik and Bedi, 2000; Christofides and Pashardes, 2002). Private sector employees are, in turn, more experienced, and they also report considerably longer job tenure (approximately 4 years for public versus 11 years for private), which reflects the typical use of temporary contracts in public sector jobs. The classification by education field shows that public sector workers are more likely to have an educational background in teaching, health, social work and services, whereas private sector workers are more likely to have been educated in general and technology fields. Finally, a higher share of public sector employees has children compared to their counterparts in the private sector (see also Adamchik and Bedi, 2000; Christofides and Pashardes, 2002), whereas public sector male employees are also more likely married or cohabiting (see Kanellopoulos, 1997, among others) and are less likely to own a house compared to private sector male employees. Kanellopoulos (1997), however, reports the opposite finding with respect to house ownership.

The statistics from columns (2) and (4) provide three interesting observations. First, when the differences between employees in the public and private sectors are examined *within* identical twin pairs, the average public-private sector wage differentials are statistically insignificant for both genders. Second, the differences regarding many individual characteristics between the employees in the public and private sectors become insignificant for both genders. For example, there is no longer a clear discrepancy between employees in the public and private sectors with respect to their marital status and family size, which are often regarded as two of the explanatory factors with respect to being a public sector worker. Third, the differences that exist mainly relate to human capital characteristics of an individual, namely, educational background and work experience. In particular, among otherwise genetically equivalent employees, those employees who are more educated (and thus less experienced) and have

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[4] Earlier literature has shown that public sector employees are older than private sector employees because younger individuals typically have greater access to private sector jobs than to public sector ones, partly because they have not accumulated the experience and connections required to secure a job in the public sector (e.g., Dustmann and van Soest, 1998; Christofides and Pashardes, 2002). The statistics drawn from my sample are thus reasonable, given the lack of young individuals in the dataset.

educational backgrounds in services or health and social work rather than in technology, business and social sciences are more likely to be found in the public sector. These findings, based on a simple statistical approach, suggest that differences in vocational preferences seem to determine, to a great extent, who chooses a public sector job and who does not.

TABLE 1 Summary statistics by sector: all twins and within identical twin pairs

	Males						Females					
	All twins (1)			Within identical twin pairs (2)			All twins (3)			Within identical twin pairs (4)		
	Public	Private	Diff. *t*-stat[a]	Public	Private	Diff.*t*-stat[b]	Public	Private	Diff. *t*-stat[a]	Public	Private	Diff. *t*-stat[b]
log(annual earnings)	10.32	10.26	2.97***	10.27	10.28	0.10	9.90	9.91	0.40	9.83	9.89	1.63
Age, years	44.2	44.8	8.58***	43.3	43.3		44.0	45.0	21.81***	44.8	44.8	
Education years	14.2	11.8	42.34***	13.7	12.8	4.68***	12.4	11.1	35.51***	11.8	11.5	3.22***
Work experience, years	17.9	23.1	56.39***	18.5	21.3	10.68***	19.1	24.1	77.39***	20.5	23.3	14.15***
Tenure, years	4.4	12.3	82.56***	3.9	11.3	30.03***	4.3	11.9	119.4***	5.2	10.4	29.55***
Socio-economic status, dummy												
Upper-level employee	0.45	0.18	13.42***	0.36	0.4	1.86*	0.17	0.08	7.96***	0.14	0.09	1.51
Lower-level employee	0.32	0.22	4.96***	0.34	03	0.57	0.61	0.51	6.43***	0.61	0.57	0.93
Manual worker	0.23	0.60	16.77***	0.30	0.6	2.37**	0.22	0.41	13.34***	0.25	0.34	2.25***
Education field, dummy												
General or unknown	0.21	0.42	9.53***	0.25	0.35	1.61	0.28	0.52	16.14***	0.39	0.45	1.40
Education	0.04	0.00	4.62***	0.03	0.00	0.93	0.03	0.00	4.42***	0.02	0.00	0.88
Humanistic and arts	0.06	0.00	6.40***	0.06	0.00	1.64	0.03	0.01	2.46**	0.02	0.04	0.94
Business and social sciences	0.17	0.08	5.56***	0.12	0.15	0.40	0.18	0.21	1.89*	0.19	0.29	2.42**
Natural sciences	0.04	0.02	1.71*	0.03	0.00	1.02	0.1	0.01	0.37	0.02	0.02	0.18
Technology	0.17	0.43	11.87***	0.24	0.39	2.38**	0.03	0.11	7.16***	0.05	0.05	0.85
Forestry and agriculture	0.03	0.02	0.19	0.02	0.03	0.24	0.01	0.01	0.50	0.01	0.01	0.26
Health and social work	0.11	0.01	10.05***	0.10	0.03	1.42	0.32	0.03	24.89***	0.21	0.03	5.41***

TABLE 1 (Continues) Summary statistics by sector: all twins and within identical twin pairs

	Men						Women					
	All twins (1)			Within identical twin pairs (2)			All twins (3)			Within identical twin pairs (4)		
	Public	Private	Diff. *t*-stat[a]	Public	Private	Diff. *t*-stat[a]	Public	Private	Diff. *t*-stat[a]	Public	Private	Diff. *t*-stat[a]
Services	0.17	0.02	11.59***	0.16	0.04	2.26**	0.11	0.10	0.12	0.12	0.11	0.45
Non-single, dummy	0.84	0.79	2.81***	0.84	0.77	1.12	0.71	0.70	0.73	0.73	0.66	1.80*
Underage children, dummy	0.65	0.55	5.05***	0.70	0.60	1.58	0.58	0.49	6.54***	0.51	0.46	1.46
Own house, dummy	0.77	0.83	3.14***	0.796	0.81	0.71	0.81	0.80	0.95	0.82	0.80	0.55
Observations	3,387	17,729		608	608		10,540	13,262		1,399	1,399	

a standard errors are robust to within individual correlation, b standard errors are robust to within-twin pair correlation. ***, ** and * denote statistical significances at least at the 1%, 5% and 10% levels.

3 Employment sector: genetic and environmental influences

3.1 DF-model

This section studies to what extent working in the public sector varies due to genetic and environmental factors. One approach to address this question is the use of the DF-model (DeFries and Fulker, 1985). The DF-model yields estimates for shared environmental variance (denoted by c^2) and heritability (denoted by h^2) from the following equation, which is estimated using ordinary least squares (OLS):

$$Public_{1ft} = \beta_0 + \beta_1 Public_{2ft} + \beta_2 R_f + \beta_3 R_f * Public_{2ft} + \varepsilon_{1ft} \quad (1)$$

The dependent variable of the analysis is the share of years in the public sector between 1990 and 2004.[5] Therefore, $Public_{1ft}$ represents the share of years in the public sector for the first twin in a twin pair (family *f*) at year *t*, and $Public_{2ft}$ is the corresponding score variable for the second member of a twin pair. The variable for genetic relatedness of the twin pair is R_f, which takes a value of one for identical twins and a value of 0.5 for fraternal twins. β_1 in this model provides a direct estimate of shared environmental influences, c^2, and β_3 provides an estimate of genetic influences, h^2. The double-entry method employed by Cherny *et al*. (1992) is used, which involves entering each twin's score twice, once as the proband score and once as the co-twin score (see also Miller *et al*., 2001). Obviously, the double-entry method produces biased standard errors and must be corrected. Therefore, the approach proposed by Kohler and Rodgers (2001) is followed and asymptotic standard errors are calculated with double-entry twin data.

The DF-model relies on the following four assumptions (e.g., Behrman and Taubman, 1976). The first assumption is that genes and the environment have additive effects. The second is that the additive environmental influence is the same for identical and fraternal twins. The third is that assortative mating does not occur, and the fourth is that there is no correlation or interaction between genetic factors and shared environment.

DeFries and Fulker (1985) note that their regression model can be extended to include other control variables that are associated with the outcome variable. This approach is used in several econometric analyses in behavioural genetics (see also Miller *et al*., 2001; Nicolaou *et al*., 2008). Although they do not formally prove it, Cropanzano and James (1990) also argue that the model requires

[5] See, for example, Kohler and Rodgers (1999) for their assurance on the use of continuous dependent variables in DF regression models. Using the share of years in the public sector as the dependent variable would also, at least partly, account for the differences in number of annual observations across individuals.

an inclusion of potential confounders for researchers to be able to make strong statements about the effects of genetics and shared environments on the outcome variable. The additional controls considered for inclusion in this analysis are education, education field, age, socio-economic status (SES) and dummy variables for being non-single, for having underage children and for owning one's house.[6] These variables are associated with the likelihood of being a public sector employee (e.g., Kanellopoulos, 1997; Adamchik and Bedi, 2000; Christofides and Pashardes, 2002). In addition to equation (1), the following equation is estimated by OLS:

$$Public_{1ft} = \beta_0 + \beta_1 Public_{2ft} + \beta_2 R_f + \beta_3 R_f * Public_{2ft} + \beta_4 Education_{ift} + \beta_5 Educ\_field_{1ft} + \beta_6 Age_{1ft} + \beta_7 SES_{1ft} + \beta_8 Non - single_{1ft} + \beta_9 Children_{1ft} + \beta_{10} House_{1ft} + \varepsilon_{1ft} \quad (2)$$

A comparison of the estimates of c^2 and h^2 between the models presented in equations (1) and (2) provides information on the extent to which measurable individual-level characteristics capture the shared environmental and genetic factors that influence an individual's decision to work in the public sector.

The correlation of the outcome variable within identical twins may be more than twice the corresponding figure for fraternal twins, i.e., $r_{MZ} > 2r_{DZ}$. This finding suggests that the data may be significantly influenced by additive genetic effects and that the model can yield estimates that fall within the categories $h^2 > 1$ and/or $c^2 < 0$ (e.g., Waller, 1994). If we assume that genetic effects need not be additive, the basic DF-model can be re-formulated as follows:

$$Public_{1ft} = \beta_0 + \beta_2 R_f + \beta_3 R_f * Public_{2ft} + \beta_4 D_f * Public_{2ft} + \varepsilon_{1ft} \quad (3)$$

Here, the variable D_f takes a value of one for identical twins and a value of 0.25 for fraternal twins (Waller, 1994). The parameter for narrow-sense heritability is β_3, and the estimated dominance effect is β_4. Broad-sense heritability is the sum of these two parameters, $\beta_3 + \beta_4$, and corresponds to the heritability estimate h^2. This specification thus omits the term for shared environment, i.e., it is assumed that $c^2 = 0$. The specification presented in equation (1) is typically referred to as the ACE specification, where A stands for additive genetics, C for a common

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6 Despite its popularity, the inclusion of additional variables into the model might become problematic, as some of these controls are likely to be endogenous, such as education. However, such an endogeneity problem is at least partly solved because the DF-model includes explicit controls for shared environment and genetics factors that are important in explaining the variation in educational attainment of an individual (see Miller *et al.*, 2001). Naturally, measuring education by a valid instrument variable Z would, of course, be the most effective solution for addressing this potential problem; unfortunately, the data are too limited for this regard.

environment and E for error. The specification presented in equation (3) is the ADE specification, where D denotes the dominant genetic relatedness.

In sum, if the observed variance in working in the public sector depends only on the shared environment, the approach yields estimates that are consistent with $c^2 > 0$ and $h^2 = 0$. This would indicate that the propensity to work in the public sector may increase according to family background characteristics, such as job market information from the parents. On the other hand, if genetic factors influence the choice to work in the public sector, the results will be consistent with $c^2 = 0$ and $h^2 > 0$. Such results would indicate that working in the public sector is influenced by the genetic factors that are transmitted biologically from parents to children. It is also possible that the variance in working in the public sector is explained both by genetic factors and by shared environments. In essence, the approach yields estimates such that $c^2 > 0$ and $h^2 > 0$.

3.2 Interpreting the estimates for heritability: some criticism

The behavioural genetics model has been subject to criticism over the years, mainly because heritability estimates may reflect genetically induced environmental effects (e.g., Martin, 1978; Stenberg, 2012 for a review note). In essence, the presence of a gene-environment correlation[7], in which the probability of an individual being exposed to a specific environment differs based on genetics, may lead to a misinterpretation of the *true* impact of heritability estimates. The assumption that environments are influenced by genetics, together with the possibility of gene-environment interactions, reciprocal causation and multiplier effects, suggests that estimates of h^2 may be partly generated by environmental factors and may therefore often be overestimated by authors.[8]

The relevance of policy analysis based on variance decomposition has also been disputed. For example, Manski (2011) argues that because the estimates for genetic heritability (h^2) and shared environment (c^2) are only symbolic representations of hypothesised latent forces, variance decomposition does not yield estimates of political relevance or provide evidence of the relative importance of either genetic or environmental factors (see also Goldberger, 1979). A molecular genetics approach presents a more advanced view of the research on heritability and the information that it provides that may assist in policy analysis. In the molecular genetics approach, the effect of a genotype is estimated directly, rather than inferred, by contrasting the resemblance of different types of relatives (e.g., Beauchamp *et al*., 2011). For example, Beauchamp *et al*.'s (2011) study is one of the studies in the research field at the intersection of genetics and economics (see Benjamin *et al*., 2012 for a review). Beauchamp *et al*.

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7 See Plomin, DeFries and Loehlin (1977), who distinguish between three gene-environment correlation mechanisms through which genes may influence environments and indirectly generate various outcomes. These mechanisms are passive genetic influence, evocative genetic influence and active genetic influence.

8 In interpreting heritability estimates, it is important to appreciate the possibility that similarity in characteristics could also indicate joint decision-making rather than similarity in preferences.

(2011) obtain promising results on the effects of specific alleles on the tested outcome variable (educational attainment), but they fail to replicate the results during the second stage of the study, which involves the use of data from another survey. Nevertheless, they make a cautious argument that large sample sizes must be used to identify significant genetic influences on economic variables. They also note that heritability estimates generally indicate that, for most traits, a sizeable fraction of the within-family resemblance can be traced to shared DNA.

3.3 Results

Tables 2 and 3 present the results of the DF regression analyses separately for males and females. For males, the estimate for shared environment was negative, which indicates that dominance effects may be present. Therefore, the ADE specification is preferred to the ACE specification for males, and, consequently, the estimate for shared environment (c^2) is assumed to be zero.

The estimates from the standard DF-model presented in equation (1) are reported in column (1). The estimate for heritability is large and highly significant for both genders. The results for males suggest that the joint estimate (broad-sense heritability), which refers to the sum of $\beta_3 + \beta_4$, is 0.40. The indicated measure of heritability for females is 0.34. The estimate for shared environment is, in turn, considerably lower at 0.06 for females and statistically insignificant. Under the assumptions of the DF-model, the results indicate that public sector work is heritable at a rate of 34 to 40% and that the effect of shared environments is statistically zero. In other words, a significant part of the variance in public sector work is linked to genetic factors. How do these results change when information on observed individual-level factors is included in the model? The results are reported in columns (2) to (6), as every additional variable is added one-by-one in the model. The results indicate that additional controls decrease the direct impact of heritability from 40 to 20% for males and from 34 to 23% for females. Educational outcomes – and mainly education field - play a notable part in this respect, whereas the other confounding variables do not affect the heritability estimates.[9] In other words, the variables for educational outcomes capture approximately one-third of the major influence of genetic factors on working in the public sector for females, and one-half for males.[10] The findings that education field has the greatest impact on heritability estimates is reasonable because one's field of education substantially determines

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9 In fact, the within-twin pair differences in characteristics between the employees in the public and private sectors seem to tell this story; see Table 1.

10 See also Nicolaou *et al.* (2008), who study the heritability of self-employment. They reran their analysis and adjusted the model for potential controls associated with self-employment, including income, education, marital status, age, ethnic group and immigrant status. They find that the extended model reduces the heritability estimates for self-employment by seven percentage points, from 0.48 to 0.41. Consistent with my results, Nicolaou *et al.* (2008) find that the decrease in heritability estimate is mainly due to the inclusion of the education variable in the model.

one's employment sector via both educational and occupational interests, which are also heritable (Miller *et al*., 2001; Nicolaou and Shane, 2010).

TABLE 2 OLS estimates of DF-model for males: dependent variable is share of years in the public sector between 1990 and 2004

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Heritability, h^2	.40 (.06)***	.35 (.06)***	.20 (.05)***	.20 (.05)***	.20 (.05)***	.20 (.05)***
Education years		√	√	√	√	√
Education field			√	√	√	√
Age				√	√	√
Socioeconomic status					√	√
Demographic factors						√
R^2	.07	.14	.34	.33	.34	.33
Number of obs.	21,116	21,116	21,116	21,116	21,116	21,116

Notes: *** denotes statistical significance at least at the 1% level. Asymptotic standard errors are in parenthesis. The estimate of c2 is negative in each specification; therefore, ADE specification is preferred.

TABLE 3 OLS estimates of DF-model for females: dependent variable is share of years in the public sector between 1990 and 2004

	(1)	(2)	(3)	(4)	(5)	(6)
Common environment, c^2	.06 (.08)	.01 (.08)	.02 (.07)	.01 (.07)	.01 (.07)	.01 (.07)
Heritability, h^2	.34 (.11)***	.34 (.11)***	.23 (.10)**	.23 (.10)**	.23 (.10)**	.23 (.09)**
Education		√	√	√	√	√
Education field			√	√	√	√
Age				√	√	√
Socioeconomic status					√	√
Demographic factors						√
R^2	.09	.13	.27	.28	.28	.29
Number of obs.	23,802	23,802	23,802	23,802	23,802	23,802

Notes: *** and ** denote statistical significance at least at the 1% and 5% levels. Asymptotic standard errors are in parenthesis

4 Pay gaps: genetic and environmental influences

4.1 Econometric models

Public-private sector wage differentials are analysed using a basic Mincerian wage equation that is augmented with a public sector dummy in the following manner:

$$\log(w_{1ft}) = \beta Pub_{ift} + \gamma' X_{ift} + A_{if} + \varepsilon_{1ft} \quad (4)$$

where *i*, *f* and *t* are indices for the individual, the family and time, respectively. Therefore, w_{ift} is the annual wage earned by individual *i* (*i* = 1,2) in a family *f* (*f* = 1,…,*F*) during year *t* (*t* = 1990,…,2004). Pub_{ift} is a dummy variable that indicates whether an individual is a public or private sector worker (one for public; zero otherwise). X_{ift} is a vector of individual characteristics that includes potential work experience and its squared term (multiplied by 100), work experience in one's current job (i.e., tenure), years of education, education field (nine categories), socio-economic status (three categories), the presence of underage children, marital status (single or non-single), house ownership, year dummies and cohort age. Broadly defined, A_{if} is the ability and includes, for example, intelligence, personality, social skills, access to schooling and an instructive parenting style. Finally, ε_{ift} is the iid error.

The wage equation is first estimated using ordinary least squares (OLS). This provides an estimate of β that is denoted by β_{OLS}. This parameter measures in percentage terms how much less or more public sector workers earn than workers in the private sector earn. For β_{OLS} to be a consistent estimator for β, both A_{if} and ε_{ift} should be uncorrelated with Pub_{ift} and X_{ift}. Because A_{if} is generally unobserved (or poorly measured), equation (4) omits this term and may yield a biased estimate of the public-private sector wage differential. For example, a negative correlation between ability and public sector work will lead β_{OLS} to underestimate the true value of β.

The assumption is that A_{if} can be expressed as: $A_{if} = c_f + h_{if}$ where c_f denotes the effects of a shared environment and h_{if} is a term for genetics. c_f is assumed to be similar for twins raised in the same family *f*. However, h_{if} is assumed to be similar only for identical twins because they share 100% of their genes. Consider next the wage equations for twins 1 and 2 raised in family *f*.

$$\begin{aligned} \log(w_{1ft}) &= \beta Pub_{1ft} + \gamma' X_{1ft} + c_f + h_{1f} + \varepsilon_{1ft} \\ \log(w_{2ft}) &= \beta Pub_{2ft} + \gamma' X_{2ft} + c_f + h_{2f} + \varepsilon_{2ft} \end{aligned} \quad (5)$$

A within-twin pair (WTP) estimator is of the form:

$$\log(w_{2ft}) - \log(w_{1ft}) = \beta(Pub_{2ft} - Pub_{1ft}) + \gamma'(X_{2ft} - X_{ift}) + (h_{2f} - h_{if}) + (\varepsilon_{2ft} - \varepsilon_{1ft}) \quad (6)$$

where the shared environment effect c_f has been differenced out. Furthermore, if the twins are identical, then $h_{2f} - h_{1f} = 0$, and thus, the genetic effect can also be differenced out.[11] The concept underlying the within-twin pair method is that a return to public sector employment can be estimated by controlling for the part of the unobserved heterogeneity that is due to shared environment and genetics. Equation (6) provides an estimate for β that is denoted by β_{WTP}. The assumption is that β_{WTP} is a consistent estimate of β and is less biased than β_{OLS}. It is important to note that the within-twin pair method also conditions out the endogeneity problem of the employment sector that is caused by the shared environment and genetics and the between-twins differences in vector $X_{ift.}$

The genetic and environmental factors do not explain all of the differences in occupational choices within identical twins, however, and naturally leads to the question as to why identical twins make different choices? There are several possibilities. First, the siblings may simply have different career interests (see also Ashenfelter and Rouse, 1998). Second, the siblings may live in different regions. In essence, the twin who lives in a region with higher unemployment probably searches for jobs more intensely in the public sector where the demand conditions and prospects for wage increases are higher compared to the private sector (e.g., Pagani, 2003; Dell'Aringa, 2007). Third, the other twin may have certain health conditions (such as injury) that restrict him or her from engaging in the same job as his or her co-twin. For example, police officers and fire fighters (both typical public sector occupations) must be in good physical health and have severe risk of injuries and limitations. Fourth, the siblings may have different educational qualifications. In this case, the twin who has attained more education compared with his or her co-twin is more likely to be employed in the public sector, where many jobs require a specific educational background.[12] Fifth, the differences in occupational choices could be influenced by the job market information from a spouse or a peer group.

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11 The double-entry method is not used in this approach, and the number of available observations drops by one-half in within twin-pair estimation.

12 The differences in education may occur if the other sibling drops out before completing his or her education. Factors relating to dropping out may include, for example, having children at a young age, personal shocks in life or the influence of a peer group. See also Ashenfelter and Rouse (1998) for their excellent discussion about twin differences in educational levels. For example, they find that most of the differences in educational attainment between female twins are explained by the fact that the other twin got married or, on the contrary, got divorced and needed to get a job.

4.2 OLS and within-twin pair estimates

Table 4 presents the OLS and within-twin estimates separately for males and females. The standard errors are robust to within-twin pair correlation. To determine the representativeness of the twin sample, we compare the OLS results with the data from Statistics Finland for the same period (1990 to 2004) and the same age distribution as the twin data. These check-up data are longitudinal register-based data (LRBD) for a seven per cent random sample of the Finnish population in 2001.

The OLS results show that the sample of twins is representative of the sample of the general population in Finland. The findings indicate that, on average, male workers in the public sector earn seven per cent less than private sector workers. The wage differential for females is smaller, at negative four per cent. The result for males is comparable with other Finnish evidence that reports that the wage gap ranges from negative three to five per cent. The result for females is not consistent with the earlier evidence that finds a small positive wage premium for public sector female employees (Korkeamäki, 1999; Maczulskij and Pehkonen, 2011). The typical positive wage gap for females is probably a function of the method used by Korkeamäki (1999) and Maczulskij and Pehkonen (2011), in which the working sector is treated as endogenous and selectivity is controlled for in the wage equations.

The OLS results are compared with the within-twin pair results. For the sake of comparison, the estimates are reported for both fraternal and identical twins; see columns (3) and (4). The results for males indicate that it is important to control for shared environment and genetic variables and that when these factors are controlled for, the estimate of the return to public sector work is both statistically and economically zero (as compared to the baseline OLS estimate of negative seven per cent, which does not control for these factors). Interestingly, the model for fraternal twins that controls only for the experiences related to family environment produces a wage gap of negative six per cent, which is similar to the OLS result. This finding indicates that the difference in the estimated wage gaps is explained by genetic factors, such as intelligence, attractiveness, social skills and risk-taking behaviour. The results for females suggest that once the shared environment and unobserved variables related to genetics are controlled for, the estimated public-private sector wage gap becomes statistically insignificant. However, the point estimate is -0.053, which indicates that the pay gap may be at least economically significant at approximately 5%. As the result is unclear for females, I studied the robustness of my results using a specification that focuses on full-year employees because these employees represent the prime working population who has relatively stable job careers. This specification yields results that are comparable to the main findings of this study (results are available from the author). In fact, the within-twin pair estimate for females is now -0.018, indicating that the economical significance in pay gap is only modest.

TABLE 4 OLS and WTP estimates for males and females: dependent variable is log(annual earnings)

	Males				Females			
	OLS LRBD data (1)	OLS twin data (2)	WTP DZ twins (3)	WTP MZ twins (4)	OLS LRBD data (1)	OLS twin data (2)	WTP DZ twins (3)	WTP MZ twins (4)
Public sector	-.082 (.005)***	-.072 (.021)***	-.061(.034)*	.009 (.046)	-.025 (.004)***	-.037 (.013)***	-.019 (.022)	-.053 (.033)
Education years	.081 (.001)***	.060 (.005)***	.053 (.009)***	.051 (.019)***	.071 (.001)***	.065 (.006)***	.056 (.010)***	.015 (.014)
Work experience	.021 (.001)***	.014 (.002)***	.010 (.005)**	.014 (.010)	.017 (.001)***	.014 (.002)***	.010 (.003)***	.011 (.004)**
Work experience^2	-.036 (.002)***	-.030 (.006)***	-.019 (.014)	-.037 (.030)	-.036 (.001)***	-.030 (.005)***	-.023 (.010)**	-.033 (.013)**
Tenure	.012 (.000)***	.010 (.001)***	.008 (.001)***	.008 (.002)***	.011 (.000)***	.009 (.001)***	.009 (.001)***	.010 (.001)***
Children	.024 (.004)***	.027 (.013)**	.035 (.017)*	.046 (.028)	-.047(.003)***	-.060 (.011)***	-.082 (.023)***	-.077 (.024)***
Non-single	.078 (.005)***	.061 (.015)***	.057 (.021)**	.014 (.035)	-.040 .003)***	-.065 (.011)***	-.072 (.019)***	-.053 (.027)**
Own house	.065 (.005)***	.043 (.016)***	.043 (.019)**	.015 (.029)	.036 (.004)***	.031 (.011)***	.034 (.021)	.015 (.031)
Other controls	yes	yes	yes	yes	yes	yes	yes	yes
R^2	.31	.36	.17	.09	.24	.23	.12	.08
Number of obs.	304,403	21,116	6,893	3,665	365,890	23,802	7,507	4,394

Notes:***, ** and * denote statistical significance at least at the 1%, 5% and 10% significance levels. Standard errors are in parenthesis and are robust to individual correlation (LRBD data) and within-twin pair correlation (twin data). Other controls include socio-economic status, education field, age cohort and year dummies.

5 Conclusions

This paper is significant within the research field intended to understand why people with different family-of-origin attributes choose to work in the public sector. In addition, it is important to study how these attributes affect the wage differentials between the public and private sector employees, as such information would have interesting implications for political science in general.

The results indicate that working in the public sector is influenced by genetic factors (34% for females and 40% for males), whereas the role of shared environments remains negligible. The findings that genetic factors affect public sector participation is not surprising given the number of occupation-related behaviours that have already been found to be heritable (e.g., Tambs *et al*., 1989; Nicolaou and Shane, 2010). However, according to various critics, overestimates of genetic heritability are common. All such estimates include (although to an unknown extent) different mechanisms that may hamper the interpretation of the *true* impact of heritability. Do these estimates mostly reflect the direct effects of genetic composition on personality traits, intelligence or risk-taking behaviour? Or do these estimates indicate joint decision-making rather than similarity in career preferences? Or are they more due to indirect gene-environmental correlation effects? For example, genes may lead individuals to select environments more favourable to a certain vocational activity, which, in turn, will determine to a significant extent the sector in which the individual will be employed. Thus, one mechanism that may affect the relationship between genes and environment is educational (or vocational) attainment. Some studies argue that parents' genes may affect their behaviour and thereby influence the environment of the child (e.g., Plomin *et al*., 1977). It is therefore possible that highly educated parents who value healthy life-styles raise their children in intelligent and health-conscious environments. As a consequence, such an environment may affect the child's choice of occupation. For instance, the child may choose a career in the health industry, which is typically situated in the public sector.

The results provide some indication as to how genes may influence occupational choice. The findings indicate that the inclusion of education and education field within the model decreases the estimate for heritability to 20% for males and 23% for females. These findings indicate that at least one-third of the impact of genetics factors is influential because of its effect on educational outcomes.

The wage differential analysis provides a number of informative findings. In particular, the OLS results indicate a negative wage differential for both males (seven per cent) and females (four per cent), thought we do not find any clear inequalities with respect to pay offered by the two sectors when unobserved ability, other variables related to genetics and differences in experiences related to family background and family resources are differenced out from the analysis. We can thus conclude that neglecting the control of genetics and shared environment effects in estimating the impact of public sector work on

employees' earnings will yield downward-biased estimates. Interestingly, it seems that the bias with regard to the wage gap for males is entirely caused by genetic factors. This finding could reflect the fact that the private sector attracts relatively more able male employees than the public sector (e.g., Nickell and Quintini, 2005; Pfeifer, 2011); that males who have higher risk preferences tend to select private sector employment over public sector employment (e.g., Hartog *et al*., 2002); or that males who have better economically rewarded attributes (such as attractiveness and social skills) tend to self-select into a private sector occupation. This selectivity pattern could make it challenging for the public sector to retain high-quality male labour.

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SUMMARY IN FINNISH (YHTEENVETO)

Taloudellisia tutkimuksia palkkaeroista ja julkisen sektorin työmarkkinoista

Väitöskirja koostuu viidestä empiirisestä tutkimuksesta, jotka käsittelevät palkkaeroja ja julkisen sektorin työmarkkinoita Suomessa. Tutkimuksia edeltää johdantoluku, joka esittelee lyhyesti Suomen julkisen sektorin työmarkkinat ja käsittelee aikaisempaa tutkimuskirjallisuutta työttömyyden ja palkkojen välisestä yhteydestä, julkisella sektorilla työskentelyyn vaikuttavista tekijöistä sekä julkisen ja yksityisen sektorin välisistä palkkaeroista. Lopuksi johdantoluku esittelee väitöskirjan tutkimuskysymykset ja kokoaa analyysien keskeiset tulokset.

Luvussa 2 tarkastellaan työntekijän ja työnantajan välisiä sopimuksia palkan asetannassa eri koulutustasojen välillä. Spot-markkina – teoria olettaa, että työntekijän palkka määräytyy nykyhetkisen työmarkkinatilanteen mukaan. Implisiittinen sopimusteoria puolestaan olettaa, että palkka määräytyy työsuhteen aikana aikaisemmin vallinneen markkinatilanteen perusteella. Tutkimuksen viitekehyksenä toimii Beaudryn ja DiNardon palkkamallitesti vuodelta 1991, jonka tarkkuutta pyritään parantamaan kahdella eri tavalla. Ensiksi, mallissa kontrolloidaan sekä ajassa muuttumaton yksilökohtainen heterogeenisuus että yrityskohtainen heterogeenisuus. Toiseksi, työntekijän ja työnantajan välisiä sopimuksia tarkastellaan yli ajan, sillä Suomi koki institutionaalisia, taloudellisia ja teknologisia muutoksia tutkimusperiodin aikana.

Tutkimuksessa käytetään yhdistetyn työntekijä-työnantaja -aineiston (FLEED) liikkuvuusotosta, joka on 33 prosentin satunnaisotos 16 vuotta täyttäneistä suomalaisista vuosina 1990–2004. Tästä aineistosta on muodostettu uusi, 25 prosentin satunnaisotos yksityisen sektorin työntekijöistä. Tulosten mukaan sopimukset palkan-asetannassa vaihtelevat koulutustasojen välillä. Korkeasti koulutettujen palkat näyttäisivät määräytyvän pääosin nykyhetkisen työmarkkinatilanteen perusteella. Matalapalkka-aloilla on nähtävissä samankaltainen ilmiö, jossa nykyinen työmarkkinatilanne selittää suuremman osan palkan vaihtelusta kuin työsuhteen aikana aikaisemmin vallinnut markkinatilanne. Tilanne on erilainen toisen asteen koulutuksen saaneilla työntekijöillä, jotka eivät näytä sitoutuvan neuvoteltuihin palkkasopimuksiin yksipuolisesti. Tämä indikoi korkeita kustannuksia työnantajaa vaihdettaessa. Tulokset myös osoittavat, että eri sopimusteoriat ovat vallitsevia pääosin 1990-luvun puolivälistä alkaen.

Nykyinen työmarkkinatilanne vaikuttaa eri tavalla matala-, keski- ja korkeapalkka-alojen ansioihin. Heterogeenisuuttaa esiintyy myös eri työnantajien välillä. Luku 3 laajentaa tietämystä alueellisen työttömyysasteen ja palkkojen välisestä yhteydestä tarkastelemalla julkisen ja yksityisen sektorin palkkojen joustavuutta. Yksityisen sektorin palkkojen on havaittu vaihtelevan myötäsyklisesti, kun taas julkisen sektorin palkat eivät juuri reagoi talouden suhdanteisiin. Siten julkisen ja yksityisen sektorin välinen palkkaero vaihtelee hypoteesin mukaan vastasyklisesti. Toisin sanoen, noususuhdanteen aikana julkisen sektorin palkat laskevat suhteessa yksityisen sektorin palkkoihin, kun taas laskusuhdan-

teen aikana julkisen sektorin palkkapreemio yksityiseen sektoriin nähden kasvaa. Tutkimus toteutetaan mikroaineistolla, joka käsittää vuodet 1990–2004. Aineisto on Tilastokeskuksen 7 prosentin satunnaisotos Suomen väestöstä vuonna 2001. Tulosten mukaan julkisen ja yksityisen sektorin välinen palkkaero noudattaa vastasyklistä vaihtelua. Kymmenen prosentin kasvu alueellisessa työttömyysasteessa näyttäisi olevan kytköksissä keskimäärin yhden prosentin kasvuun julkisen ja yksityisen sektorin välisessä palkkaerossa. Alueellisen työmarkkinatilanteen ja palkkaeron välinen yhteys on suurempi matalapalkka-aloilla kuin keski- ja korkeapalkka-aloilla, sekä kunta- kuin valtio sektorilla. Tulokset osoittavat myös, että palkkaerossa tapahtuva vastasyklinen vaihtelu on tilastollisesti merkitsevää lähinnä laskusuhdanteen aikana.

Luku 4 laajentaa tietämystä julkisen ja yksityisen sektorin välisistä palkkaeroista Suomessa. Tutkimuksessa hyödynnetään samaa mikroaineistoa kuin edellisessä luvussa, mutta nyt tarkastelun kohteena on Suomen laman jälkeinen periodi vuodesta 1995 lähtien. Analyysissa käytetään kvantiiliregressiomenetelmää, joka sallii palkkaeron vaihtelun palkkajakauman eri kohdissa. Luku kontribuoi aikaisempaan tutkimuskirjallisuuteen kahdella tavalla. Ensiksi, mallissa pyritään kontrolloimaan endogeeninen valinta työskennellä julkisella sektorilla. Toiseksi, mallissa sallitaan inhimillisen pääoman tuoton vaihtelu eri toimialojen välillä. Tulokset osoittavat, että miehet ansaitsevat paremmin julkisella sektorilla palkkajakauman alapäässä. Tämä palkkaetu häviää ja muuttuu negatiiviseksi palkkajakauman ylöspäässä. Toisin sanoen, matalapalkka-aloilla kannattaa työskennellä julkisella sektorilla, kun taas korkeapalkka-aloilla yksityisen sektorin työntekijä ansaitsee enemmän. Tämä tulos tarjoaa selityksen Borjasin (2003) havaitsemalle ilmiölle, jossa työntekijöiden liikkuvuus julkiselta sektorilta yksityiselle sektorille kasvaa korkeammille palkkaluokille siirryttäessä. Tulokset ovat erilaisia naisille, jotka näyttäisivät ansaitsevan kaikilla palkkatasoilla enemmän julkisella kuin yksityisellä sektorilla. Naisten palkkaetu julkisella sektorilla on suurempi palkkajakauman yläpäässä.

Aikaisempi tutkimuskirjallisuus osoittaa yksikäsitteisesti, että korkeasti koulutetut henkilöt valikoituvat suuremmalla todennäköisyydellä julkiselle kuin yksityiselle sektorille. Tyypilliset julkisen sektorin ammattitehtävät vaativat korkeaa koulutusta. Tämä viittaa siihen, että henkilöt tekevät koulutus- ja työnantajasektoripäätöksensä samanaikaisesti. Koulutuksen ja julkisen sektorin työn välinen positiivinen yhteys voidaankin tulkita heijastelevan havaitsematonta heterogeenisuutta. Luvussa 5 tutkitaan tätä mahdollisuutta. Tavoitteena on analysoida, johtuuko positiivinen yhteys koulutuksen ja julkisen sektorin työn välillä koulutuksen ja havaitsemattomien tekijöiden välisestä korrelaatiosta. Näihin havaitsemattomiin tekijöihin kuuluvat muun muassa perhetaustaiset tekijät, kyvykkyys sekä muut genetiikkaan liittyvät tekijät, kuten preferenssit ja riskinottohalukkuus. Tutkimusasetelma toteutetaan käyttämällä aineistoa suomalaisista kaksosista. Koska identtisillä kaksosilla on sama perhetausta ja geeniperimä, mallissa voidaan kontrolloida näistä johtuvaa havaitsematonta heterogeenisuutta.

Tutkimuksessa käytetty suomalainen kaksoskohortti on yhdistetty FLEED aineistoon. Kaksoskohortti on Helsingin yliopiston Kansanterveystieteen osaston terveyskysely, joka toteutettiin vuosina 1975, 1981 ja 1990. Kysely lähetettiin kaikille Suomessa asuville, samaa sukupuolta oleville kaksosille, jotka ovat syntyneet ennen vuotta 1958. Kaksoskohortti käsittää tietoa 12,502 kaksosparista, jotka on myöhemmin yhdistetty FLEED aineistoon. Tulosten mukaan koulutusvuodet lisäävät todennäköisyyttä työskennellä julkisella sektorilla. Tämä yhteys säilyy positiivisena senkin jälkeen, kun mallissa kontrolloidaan perhetaustaisista ja geneettisistä tekijöistä johtuvaa havaitsematonta heterogeenisuutta. Koulutusvuosien määrän lisäksi tutkintoalalla on suuri merkitys. Ne henkilöt, joilla on tutkinto luonnontieteistä tai teknologiasta, työskentelevät suuremmalla todennäköisyydellä yksityisellä sektorilla.

Käyttäytymisgenetiikassa ja sen menetelmiä hyödyntävässä ekonometrisessa taloustieteellisessä tutkimuksessa on havaittu, että koulutuksen hankinta ja uravalinnat ovat geneettisesti periytyviä tulemia. Tämän vuoksi on mielekästä olettaa, että julkisella sektorilla työskentely on ammatillinen valinta, jonka variaatiota voidaan ainakin osittain selittää geneettisillä tekijöillä. Palkkaeroanalyysi voi puolestaan tuottaa harhaisia tuloksia, jos mallissa ei pystytä kontrolloimaan palkan-asetantaan vaikuttavaa havaitsematonta kyvykkyyttä. Kyvykkyyden lähteet voidaan jakaa yhteisen ympäristön vaikutuksiin ja genetiikkaan. Yhteisen ympäristön vaikutuksia ovat muun muassa kasvatus, perheen varallisuus ja koulutusmahdollisuudet. Geneettisiin tekijöihin lukeutuu pääosin älykkyys, mutta myös ulkonäkö, pituus, sosiaalinen käyttäytyminen ja persoonallisuus.

Luvussa 6 raportoitu tutkimus pyrkii vastaamaan kahteen kysymykseen. Ensiksi, kuinka paljon yhteinen ympäristö ja geneettinen perimä selittävät julkisella sektorilla työskentelyn varianssista? Toiseksi, esiintyykö julkisen ja yksityisen sektorin työntekijöiden välillä palkkaeroja kun mallissa kontrolloidaan henkilön havaitsematon kyvykkyys? Tulokset osoittavat, että julkisella sektorilla työskentely on geneettisesti periytyvää. Noin 30–40 prosenttia julkisen sektorin työn varianssista voidaan selittää geneettisillä tekijöillä, ja noin kolmasosa tästä vaikutuksesta välittyy koulutusvalintojen kautta. Myös palkkaeroanalyysi tuottaa mielenkiintoisia tuloksia. Perusmalli, jossa havaitsematonta kyvykkyyttä ei kontrolloida, tuottaa alaspäin harhaisia estimaatin arvoja. Näiden tulosten perusteella työntekijät ansaitsevat vähemmän julkisella sektorilla. Negatiivinen palkkaero kuitenkin häviää, kun mallissa kontrolloidaan työntekijän havaitsematon kyvykkyys.

Väitöskirjan tutkimustulokset voidaan jakaa kolmeen pääteemaan. Ensiksi, alueellisen työmarkkinatilanteen heterogeeninen vaikutus johtaa palkkapolarisaatioon eri työntekijäryhmien välillä, jos palkat joustavat matala- ja korkeapalkka-aloilla, mutta eivät keskipalkka-aloilla. Toisaalta työttömyyden erilainen palkkavaikutus julkisella ja yksityisellä sektorilla voi johtaa epätasapainoon työpaikkojen allokoinnissa. Tämä johtuu siitä, että laskusuhdanteen aikana julkisen sektorin työpaikat houkuttelevat paremmalla suhteellisella palkalla ja korkeammalla työturvalla. Toiseksi, julkisen sektorin työtä voidaan pitää urava-

lintana, johon suhdanteiden lisäksi vaikuttavat henkilön koulutuspäätökset sekä selittämättömät geneettiset ominaisuudet. Näihin ominaisuuksiin lukeutuvat oletettavasti alhaisempi riskihalukkuus ja henkilökohtaiset preferenssit. Kolmanneksi, julkisen ja yksityisen sektorin välillä ei ole merkittäviä palkkaeroja, ainakaan keskimäärin. On kuitenkin huomattava, että palkkaeroja esiintyy palkkajakauman eri kohdissa.