Essays on Child Care and Higher Education

Linda Holmlund

Umeå University
Department of Economics
SE-901 87 Umeå
Umeå 2009

Umeå Economic Studies No. 783
From the Department of Economics
Umeå University, Umeå, Sweden
ISBN: 978-91-7264-839-5
ISSN: 0348-1018

Printed in Sweden by Arkitektkopia, Umeå, 2009

Abstract

This thesis consists of a summary and four self-contained papers.

Paper [I] examines whether fathers influence the time their children spend in subsidized child care. Two non-nested models of family child care demand are estimated. The parameter estimates indicate that several characteristics of the father are associated with the time his child spends in child care. J-tests and bootstrapped J-tests also show that a model where the father's characteristics are excluded can be rejected in favour of a model where his characteristics are included.

Paper [II] considers the effects of the Swedish child care fee reform on public expenditures and taxation in the municipalities. A difference-in-difference approach is employed where outcomes are compared with respect to the municipalities' pre-reform fee systems. The results show that pre-reform characteristics determine taxes and child care expenditures in the post-reform period. It is also found that changes in child care quality were not connected to the pre-reform systems characteristics.

Paper [III] provides evidence of the effect of college quality on earnings in Sweden. The results suggest that the link between college quality and earnings is weak. A small positive effect is found for individuals that are likely to work full time. Controlling for region of work affects the estimated effects, indicating a correlation between choice of college quality and choice of labour market region.

In Paper [IV], earnings differences between transfer and non-transfer students are analysed. The results show that earnings, during the first years after leaving the university, are significantly lower for students who change universities compared to students who do not change. The earnings differences decrease significantly over time and over the earnings distribution.

Keywords: Child care demand, subsidized child care, dual care provider model, local public expenditures, income taxation, college quality, earnings, selection on observables, university choice, earnings distribution

Acknowledgements

Finally, the time has come to write the acknowledgements. A moment I have looked forward to for a number of years, but now when I am here, I am not entirely happy. These pages put an end to my nine years at the Department of Economics at Umeå University. This has been a period of hard times and a lot of work, but also a time when I met some of the greatest people I know. I will try my best to make them justice in the following words.

In my early years at the department I worked as a study advisor. If it was not for some people who believed in me back then, I would probably be somewhere else today. So I would like to begin by thanking the undergraduate-crew of Roger Axelsson, Curt Löfgren, Eva Cederblad and Anders Stenberg. Roger; I guess that you have no idea of how responsible you are for my application to the PhD programme, but you were actually the one who opened my eyes (and now, when it is over, I thank you for that). The coffee-room has been very empty without you. Curt; it was very helpful to have a calm and safe person like you by my side at my first real job. Ever since then, you have been a great friend! You are also the only person who understands the true value of our old white Volvo which gives you ten points in my book. Eva; you have been my biggest supporter and my best friend at the department since day one. I will miss you so much! Anders, my co-study advisor; thanks for teaching me how get people out of an office (which in your case; mostly meant getting rid of me…) and also for commenting on some of my papers.

During the writing of this thesis, I had two supervisors who guided me through the process, my main supervisor Magnus Wikström and my vice-supervisor Niklas Hanes. I know that I could not have done this without the two of you and I am grateful for all the time you have spent reading, commenting, re-reading and commenting again. Magnus; your intuition and your skills in both theoretical and empirical economics have been an invaluable source for me. Your door has always been open and you have been

very patient and generous with your time. I have also appreciated your positive attitude and the constant smile you wear on your face. Every time that I stormed into your office questioning my thesis, you had an astonishing ability to make me see things from a brighter side. You also invited me to take part in your evaluation of the maximum fee reform, something that I enjoyed a lot and for which I am very grateful. Niklas; I have terrorized you with questions regarding everything from advanced programming to cake-recipes. Thanks for putting up with my complaints and for supporting and helping me whenever I needed. In the last phase of the process you have also shown an eye for details, and your comments on my last drafts have been much appreciated.

In the middle of the process, when I did not know the topic of my next paper, I went to a seminar with Håkan Regnér, economist at the Swedish Confederation of Professional Associations (Saco). According to Håkan, I questioned his paper in quite a persistent and annoying way. That was the beginning of a very enjoyable collaboration. Håkan; I do not think that I have thanked you enough for your belief in me and for your support, so I hope that the message is clear this time; thanks! I would also like to thank Anna H, Helena P, Lena G and the rest of the staff at Saco for your insights regarding my research and for being great friends. In addition, I am grateful to Thomas Ljunglöf and Galina Pokarzhevskaya for providing valuable help with STATA and SAS. Saco is also thanked for providing me with data. Gunnar Wetterberg, Anna Ekström and Anders Edward deserve thanks for a number of reasons, but especially for letting me use an office once in a while.

There are a lot of people who have contributed in different ways to the completion of this thesis. Marie Hammarstedt has provided excellent administrative support over the years; thanks for keeping track of me and my whereabouts and for answering my questions. Thomas Aronsson, Lena Birkelöf, David Granlund, Olle Westerlund and Christina Wikström served as pre-opponents on earlier drafts of the papers and are all thanked for their comments. I was also fortunate to have Thomas as my office neighbour and he

has always been very positive and supportive. And Olle; you have helped me in many ways during the years and I am grateful for every little thing!

Johanna Freed and Raul Bahamondez at the Swedish National Agency for Education are thanked for providing me with data and information about the Swedish child care system. In addition, I am grateful to the Swedish Social Insurance Agency for providing the data for the first paper. The papers have also benefited from comments and help from Marie Gartell and Björn Öckert. Marie and Lena Lindahl are also thanked for the therapeutic PhD lunches in Stockholm.

When it comes to econometrics, Kurt Brännäs advice has been invaluable. Thank you for taking the time to answer my questions and sharing some words of wisdom. Jörgen Hellström, Jonas Nordström and Ola Simonsen have also spent some time explaining econometrics. Thank you for that!

Since I spent so many years at the department, many people have come and gone. Each and every one of you have contributed in your own way to making my years at the department special and I thank you all. Mentioning you all by name would make an already too long acknowledgement even longer, but I will make room for at least a few of you. First, Kalle Löfgren; there is no one like you! I really appreciate your support over the years and I hope you can forgive me for deserting the yellow Sandvik (and Vännäs AIK!) cover for a boring blue one. Åsa Löfström; you have always shown an interest in my work which I highly appreciate. Thank you for sharing your great knowledge about gender, family and education. Linda Andersson, Sofia Lundberg, Carina Selander, Magdalena Norberg-Schönfeldt and Anna Norin; there were few girls when I came to the department, but I could not have asked for a better group. Torbjörn Lindquist; thanks for all the time you have spent explaining programming and mathematics. Mattias A, Niklas R, Mikael L, Andrea, Lars, Lena, Thomas J, Albina, Jens, Ulf and the rest of the PhD students and previous PhD students; thanks for being such good friends and colleagues and for sharing so many laughs over the years.

Camilla Andersson; thanks for all the administrative help, for your comments on my research and for always being there for me. Johanna Åström; we both moved to Stockholm in the middle of our studies and it has been great to have a friend in the big city. Susanne Alldén; you and Micke have provided a safe haven to turn to whenever there has been a storm at sea. Having a friend who knows what you are going through without being explicitly involved has been great. Camilla, Johanna, Susanne and Micke; I hope you all know how much I value your friendship and support.

I am also grateful to my friends from "the real world". You have contributed to my survival the last years by letting me use your spare rooms, feeding me, offering recreational trips to the mountains, therapeutic phone calls or by simply sharing your positive philosophy of life. Emma and Anders, Gunilla and Per, Anders and Lena, Anna and Jocke, and Linda and Fredrik; you all mean the world to me!

My family deserves special thanks. My mother Monica, my brother Marcus and Ola's parents Per and Katarina; thanks for your unconditional love and your patience with me and my strange working hours. And Mother; thank you for giving me so much time, care and love over the years. Who and where would I be without you? I also thank my parents for providing me with extremely stubborn genes; they have been very helpful during these years.

Saving the best for last, I thank Ola Simonsen. Having you by my side – encouraging, cheering and never letting me give up – is what makes me go on, whether I am skiing, cycling, hiking or writing a dissertation. I could never have done this without your love and support. You rock my world and I love you for that! Thank you.

Stockholm, August 2009

Linda

This thesis consists of a summary and the following four self-contained papers:

[I] Holmlund, L. (2008) Do Fathers Influence the Time Their Children Spend in Subsidized Child Care? *Umeå Economic Studies* No. 746 (revised)

[II] Hanes, N., Holmlund, L., and Wikström, M. (2009) Assessing the Effects of the Child-Care Fee Reform on Public Expenditures and Taxation. *Umeå Economic Studies* No. 780

[III] Holmlund, L. (2009) The Effect of College Quality on Earnings – Evidence from Sweden. *Umeå Economic Studies* No. 781

[IV] Holmlund, L. and Regnér, H. (2009) Earnings Differences Between Transfer and Non-transfer Students. *Umeå Economic Studies* No. 782

1 Introduction

In 2005, Sweden was ranked as number three among the OECD countries when it came to public spending on overall education as a percentage of GDP.[1] Education is unquestionably a prioritized area in Sweden and making both lower and higher education accessible to all citizens has been an important political object. As a consequence of this orientation, the user fees in pre-schools are relatively small, primary and lower secondary education is compulsory and free of charge and there is no tuition fee for students in upper secondary schools and academic institutions. Both higher and lower education are of high availability, with pre-schools with long opening hours and universities and university colleges geographically spread all over the country.

During the last few decades there have been some major changes in the Swedish educational system as well as in society at large. Changes in the structure of the labour market in combination with the expansion of the public child care system have enabled women's participation in the labour market. In addition, globalisation has challenged the educational system with more mobile students and a more intense competition situation for the academic institutions. The quality of education has become increasingly important and discussed both within schools and universities and by policy-makers.

These reflections on the developments that affect the conditions for both higher and lower education are the starting point for the papers in this thesis. The thesis consists of four self-contained papers. Papers [I] and [II] focus on child care. Paper [I] compares two empirical models of family child care demand while Paper [II] studies whether the Swedish municipalities' tax rates and child care expenditures were affected by a child care reform in 2002. Pa-

[1] OECD (2008).

pers [III] and [IV] are contributions in the area of higher education. Paper [III] examines whether the quality of higher education has an effect on students' subsequent earnings and Paper [IV] analyses earnings differences between transfer and non-transfer students.

The rest of the introduction is outlined as follows. Section two includes a brief introduction to Swedish child care and presents theoretical and empirical backgrounds to Papers [I] and [II]. In addition, Papers [I] and [II] are summarized. Section three gives a short description of the expansion of higher education in Sweden and the background to the problems studied in Papers [III] and [IV]. Previous research is presented and theoretical and methodological issues are discussed. The section also includes summaries of Papers [III] and [IV].

2 Child care

The development of publicly provided child care in Sweden dates back to the 1960s when there was a shortage of labour, which facilitated women's participation in the labour market. Since then, the proportion of women that participate in the labour market has increased while the proportion of participating men has decreased. A larger number of working mothers resulted in a growing need for child care and, consequently, the proportion of children in subsidized care increased dramatically during the same period of time (see Figure 1). In 2006, about 85 per cent of all one-to five-year-olds were enrolled in some preschool activity, most of them attending a public facility.[2] Swedish mothers also have among the highest labour force participation in the OECD[3] and Sweden is considered to be one of the most gender equal countries in the world.[4] One

[2] The Swedish National Agency for Education (2007).
[3] OECD (2001).
[4] See e.g., the Gender Empowerment Measure Index in UNDP (2007).

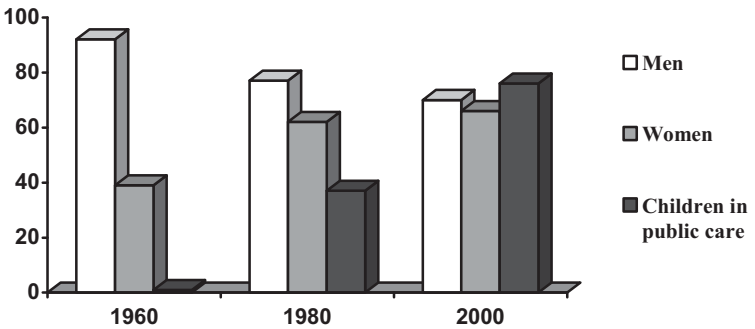

Figure 1: Proportion of men and women that are working and proportion of children aged 1-5 years in subsidized child care. Source: Statistics Sweden and the Swedish National Agency for Education.

example of this is that Swedish fathers and mothers have the same right to paid parental leave and about 17 per cent of the parental days are utilized by fathers.

Child care in Sweden is mainly publicly provided and the availability and quality are comparatively high in an international perspective. The local governments are responsible for the provision of public child care, which is financed partly by central government grants and partly by local tax revenues and user fees. A major child care reform in the beginning of the 2000s (the Maximum fee reform) offered the municipalities to impose a cap on the child care price and the municipalities that opted to participate were granted extra funding to cover the loss in revenue.[5] The main purpose of the reform was to increase the availability of child care, improve the financial circumstances of families with children and facilitate parents' labour force participation. The reform created a more homogenous fee structure in Sweden, with child care fees less related to hours of use.

[5] For more information about the Maximum fee reform see e.g., Holmlund and Wikström (2005) and the Swedish National Agency for Education [Skolverket in Swedish] (2007).

2.1 Child care demand

When modelling family child care demand, the demand is often related to the mother's labour supply (see e.g. Blau and Robins, 1988 and Michalopoulus et al., 1992). In those models, the father's labour force participation is assumed to be predetermined while the mother's labour supply is allowed to vary. The mother is the only potential child care giver in the family and the father's role is simply to provide income to support his family. The mother maximises utility by choosing her labour supply, consumption and the quality of child care. The price of child care is assumed to be proportional to its quality. Child care demand and labour supply are thus functions of the mother's marginal wage, non-labour income and child care quality.

The previous empirical literature on child care costs and demand primarily concerns effects of the price of child care on labour force participation and supply decisions of mothers. Blau (2000) reviews US studies on the effects of the price of child care on employment and finds that employment is decreasing in the price of child care, although the quantitative effects vary among the studies. A more general survey of the child care literature is provided by Blau and Currie (2004) where both the market of child care and child outcomes are covered. For Sweden, Gustafsson and Stafford (1992) study the joint decision to supply labour and demand public child care using data from the 1980s. The estimated elasticity of average price is negative and large in absolute value, indicating that child care demand may be price sensitive. Generally, the determinants of hours of care have received little attention (exceptions include Hotz and Kilburn, 1992; Blau and Hagy, 1998; Joesch, 1998; Joesch and Hiedemann, 2002).

To assume that only the mother determines child care demand may not be appropriate when considering families of today in Sweden and other OECD countries with working mothers and fathers who take an increasing part in their children's care. Therefore, Paper [I] presents an alternative model of family child care demand that includes both parents in the same way and investigates whether the fathers influence the number of hours that their child spends in subsidized care.

2.2 Public provision of child care

Changes in the child care system do not only affect the well-being of families, they also change the conditions for the public sector. If, for example, the reduction in child care fees caused by the Maximum fee reform has behavioural effects for families by altering child care demand and/or labour supply, it may also affect the allocation of the public expenditures on child care. This idea is the starting point for the second paper, which contains a broad evaluation of the effect of the Maximum fee reform on local public expenditures, taxation and child care quality. Paper [II] is related to the literature of public expenditures and provides the first evidence of how child care user fees affect public budgets.

The individual demand for child care as well as the size of the child care expenditures is channelled through the political process. To model demand for public goods, most papers rely on the "median voter model" proposed by Bowen (1943) and Black (1958). This model suggests that the median voter is decisive, and the median voter is often identified as the voter with the median income.[6] There is a large literature that focuses on local public expenditures,

[6] Empirical applications of the median voter model are provided by, e.g., Bradford and Oates (1971a,b), Borcherding and Deacon (1972), Bergstrom and Goodman (1973), and Pommerehne and Frey (1976).

following the seminal papers by Borcherding and Deacon (1972) and Bergstrom and Goodman (1973). The main focus in this literature has been on determining how variables characterizing the median voter's budget constraint affect the demand for local public services. The expenditures are often modelled as a function of local characteristics such as tax base, population size, demographic structure, intergovernmental grants and tax price.

There are some empirical applications of public expenditures aimed at specific age groups, for example school-aged children, but there are few studies that consider child care expenditures.[7] In addition, evidence of the effect of child care subsidies on governmental budgets is scarce. One exception is Graafland (2000), who considers the general equilibrium effects of child care subsidies on labour supply and public finance. The results suggest that child care subsidy reforms may be almost self-financed.

There is only a small Swedish literature that considers economic aspects of child care, and in recent years the contributions have mainly focused on the Maximum fee reform.[8] Brink et al. (2007) simulate welfare effects of the Maximum fee reform and an alternative reform consisting of increased child benefits, and they conclude that the Maximum fee reform is not necessarily preferred. Holmlund and Wikström (2005) consider cost differences for preschool and after-school care in the Swedish municipalities before and after the Maximum fee reform. Their results indicate that the municipalities' cost differences for child care were affected by the type of fee structure that was applied prior to the reform. Lastly, in Lundin et al. (2008) the exogenous variation in price reductions caused by the reform has been utilized to study if fe-

[7] For example, Ahlin and Johansson (2001) study the individual demand for local public schooling in Sweden and Borge and Rattsø (1995) examine how the age composition in the municipality affects the spending on local services like care for elderly, schooling and child care.
[8] Earlier contributions on Swedish child care include e.g. Bjurek et al. (1992), Gustafsson and Stafford (1992) and Lundholm and Ohlsson (1998).

male labour supply was increased. Their results suggest that reduced child care prices do not affect female labour supply in Sweden.

2.3 Summary of Papers [I] and [II]

Paper [I]: Do Fathers Influence the Time Their Children Spend in Subsidized Child Care?

Paper [I] analyses whether the fathers matter for the number of hours that their children spend in subsidized child care by comparing two non-nested models of family child care demand. The dual care-taker model allows both parents' labour supplies to vary and includes several personal characteristics of both parents. The single care-taker model follows earlier research and assumes that the father's labour supply is fixed and exogenous to the family's child care demand. The family budget constraint is explicitly modelled by taking into account the incentives in the Swedish fee system when deriving the parents' marginal wages. To compare the models more formally, J-tests and bootstrap J-tests are performed.

The study is based on a sample of 683 children and their parents and includes information about child care utilization and parents' labour market attachment as well as personal characteristics of both parents. Information about municipal characteristics and child care quality are also included.

The parameter estimates show that several of the father's characteristics are associated with the time his child spends in child care. The J-tests and the bootstrap J-tests all show that the single care-taker model can be rejected in favour of the dual care-taker model, while the dual care-taker model cannot be

rejected in favour of the single care-taker model. In all, the results suggest that the father's characteristics influence family child care demand.

Paper [II]: Assessing the Effects of the Child Care Fee Reform on Public Expenditures and Taxation

Paper [II] studies the effects of the Swedish child care fee reform of 2002 on public expenditures and taxation in the municipalities. The purpose of the reform was mainly to increase availability of child care and to lower and equalize child care fees. The reform implied, among other things, a common system of public child care fees. Participation was voluntary but the participating municipalities were compensated for the increased demand and loss of revenue by grants from the central government. All but two municipalities implemented the reform proposal the first year and the last two followed the year after.

Since all municipalities eventually entered the common fee system, it is not possible to compare the outcome for participating municipalities with a control group of non-participants. Instead, we employ a difference-in-difference approach, where outcomes are compared with respect to differences in the municipalities' pre-reform fee systems. All Swedish municipalities are included in the analysis, which covers the time period 1999 to 2005.

The results show that pre-reform characteristics determine taxes and child care expenditures in the post-reform period. Municipalities that applied time rates had larger expenditure increases and also higher tax rate increases in comparison to the other fee subgroups. Our results suggest that the reform changed the child care demand for municipalities that applied time rates relative to the municipalities that applied income dependent fees prior to reform. We also

find that changes in child care quality are not connected to the pre-reform fee systems characteristics.

3 Higher education

During the last few decades, there has been a rapid expansion of the number of students in higher education in Sweden.[9] This expansion is shown in Figure 2, which illustrates the development of the number of registered students, the number of degrees and the number of entrants into higher education for the period 1977-2004. The figure shows that between 1990 and 2003 the number of registered students doubled.

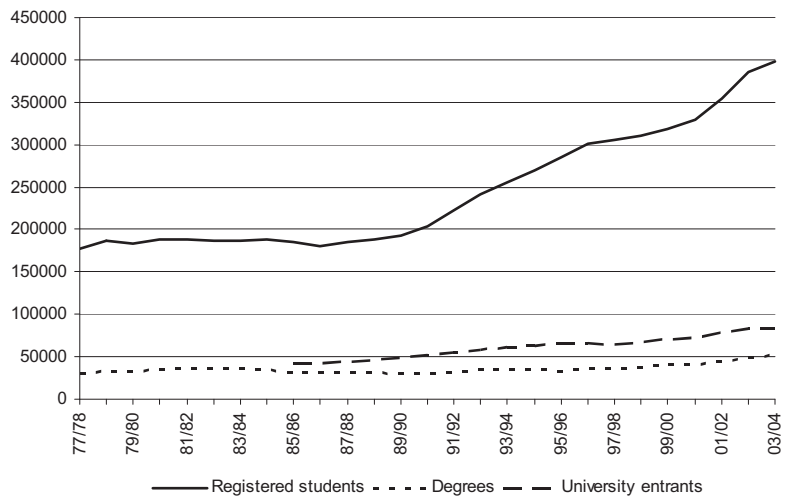

Figure 2: The number of registered students, the number of degrees and the number of university entrants. Source: Statistics Sweden.

The expansion in number of students was preceded by an increase in the number of colleges and universities. Since the 1950s, the number of institutions

[9] See e.g. Öckert and Regnér (2000) and Lindahl and Regnér (2005) for overviews of higher education in Sweden.

that provide higher education has increased from less than 10 to more than 50. Many of the new colleges were established outside the traditional university regions, i.e., in non-urban regions, as part of the decentralization of higher education and as an attempt to attract new groups of students with non-academic backgrounds. The decentralization and the expansion have also raised concerns about the quality of the provided education.[10] The regional colleges have lower shares of faculty with doctoral degrees and a weaker link between education and research. Although Swedish colleges are generally considered to be of high quality, they differ in their outcomes on quality indicators. On average, newer colleges perform worse on those indicators than older colleges. However, little is known about the relation between college characteristics/college quality and students' labour market outcomes in Sweden, i.e., the implications of differences in college characteristics are unknown. In addition, there are few non-US studies on the effect of college quality. As an attempt to fill this gap, the third paper focuses on the effect of college quality on earnings in Sweden.

Figure 2 also illustrates the large difference between the number of students and the number of degrees. This indicates that students do not simply enter college, choose one educational path and eventually graduate and obtain their degrees. Students may revise their educational decision at any point in time, leading to either a change of field or college, or a drop-out. It is fairly easy to transfer between Swedish universities and the development of Internet-based courses facilitates for students to study at more than one university. In addition, a large proportion of students study abroad as part of an exchange programme or as free movers. This mobility of students has been encouraged by the Bologna process, which aims at creating a European higher education area. However, even though students have become increasingly mobile, there are no

[10] See e.g., Öckert and Regnér (2000).

European studies that consider transfer students. Paper [IV] provides the first European evidence of earnings differences between transfer and non-transfer students by focusing on students that transfer between Swedish universities.

3.1 The returns to college education

There are two main theoretical explanations of why we would expect a correlation between different educational attributes (e.g. years of schooling, college quality or field of study) and wages. The human capital interpretation departs from Mincer (1958) and Becker (1962), and argues that education affects the workers' productivity, which is then reflected in higher wages. This approach is challenged by the signalling model proposed by Spence (1973). The signalling model suggests that employers use education (or choices made during the education period) as a signal of the workers' innate ability or productivity. According to this theory, the correlation between educational attainment and wages is not a result of the individuals' human capital accumulation but of the sorting behaviour of employers.

There is a vast literature on the returns to education in terms of years of schooling or level of education, following the work of Becker (1964) and Mincer (1974).[11] However, recently more focus has been placed on the heterogeneity of the college education premium. Results from the US show that wages vary significantly between students who have attended colleges of different qualities (Black and Smith, 2004; Dale and Krueger, 2002; Monks, 2000; Brewer, Eide and Ehrenberg, 1999; Behrman, Rosenzweig and Taubman, 1996; Loury and Garman, 1995), that earnings premiums vary significantly across different fields of study (Arcidiacono, 2004), that wages of workers with higher education depend on the type of academic degree or number of

[11] For an overview of this research, see e.g., Angrist and Kreuger (1999) and Card (1999).

academic degrees and that wages are higher for students who switch between colleges (Del Rossi and Hersch, 2008; Light and Strayer, 2004).

The small Swedish literature on higher education has mainly focused on the choice of academic institution. Recent contributions in this area include Wadensjö (1991), Lindahl and Regnér (2005), Gartell and Regnér (2005), Lundin (2006) and Eliasson (2006a, 2006b). The results from these studies diverge; some find an effect of the choice of college while others find no effect, all interpreting the result in terms of the quality of the seat of learning. Choice of method, outcome years and sample selection may explain the diverging results.

3.2 Methodological issues

The key econometric issue in the literature related to this part of the thesis results from the non-random selection of students into, among others things, academic institutions of different qualities and different fields of study. In general, there is a positive selection of students, where students of higher ability enter academic institutions of higher quality or choose higher levels of education. If not considered, this will result in an overestimation of the causal effect of the educational attribute.

The most frequently adopted approach to reduce the selection bias and identify the true effect of education is to rely on what Heckman and Robb (1985) call "selection on observables". This approach assumes that the correlation between the educational choices and the error term is due to characteristics that are observable to the researcher and which influence the selection process. This implies that the bias resulting from the selection of more able students into better colleges or higher levels of education could be removed by control-

ling for those pre-determined observable characteristics in a linear wage equation.

Paper [III] follows Heckman and Robb, and motivates the choice of method by the availability of exceptionally rich administrative data. The paper is based on a large dataset and contains a broad variety of variables, e.g., family information, parental background, pre-academic schooling, grades, geographical information, academic education and various income measures for a number of outcome years. Due to the nature of the selection problem and the rich information available in the dataset, it is plausible to interpret the result in this paper as a causal effect.

When studying transfer students one might be more interested in the actual outcome for those who have switched universities than the potential outcome for a randomly assigned transfer. Therefore, Paper [IV] focuses on earnings differences between transfer and non-transfer students where the selection of students who transfer is what partly explains the results.

3.3 Summary of Papers [III] and [IV]

Paper [III]: The Effect of College Quality on Earnings – Evidence from Sweden

This paper examines the effect of college quality on earnings using administrative data on Swedish college students who began studying in 1995. Previous studies on the effect of college quality are almost exclusively based on US data and most of them indicate a positive effect. However, it may be misleading to generalize from these results to countries with more centralized university

systems, indicating a need for more non-US studies on the topic. This study contributes to filling this gap, by providing evidence from Sweden: a country that is characterized by publicly provided higher education with no tuition fees as well as by a labour market with low wage dispersion.

Three college characteristics that are assumed to be positively correlated with quality will be considered; proportion of teachers with a PhD, teacher/student ratio and GPA from upper secondary school among contemporary college entrants. The variables are introduced both separately and combined into an index. We follow a selection on observables approach to identify the effect of college quality on earnings, which is implemented by OLS. To consider possible heterogeneity, the effect for men and women is estimated separately and quantile regression is used to examine if the effect of quality differs over the income distribution.

The overall results suggest that the link between college quality and earnings is weak in Sweden. A small positive effect is found for individuals that are likely to work full time as well as for individuals in the upper part of the income distribution, while negative effects are found for individuals located in the middle and lower parts of the income distribution. However, the estimated effects are small and the economic significance negligible. Furthermore, controlling for region of work affects the estimated effects, indicating a correlation between choice of college quality and choice of labour market region.

Paper [IV]: Earnings Differences Between Transfer and Non-transfer Students

The purpose of this paper is to study earnings differences between transfer and non-transfer students in Sweden. A broad definition of transfer between aca-

demic institutions is utilized where all students that have obtained credit points at more than one seat of learning are classified as transfer students. Data on Swedish students reveals that more than 30 per cent of the students have changed universities at least once, and that students change to all types of universities. Data also shows that students who change universities have higher educational attainment than students who do not change.

To our knowledge, there is only one previous study that considers the individual effects of switching universities and includes all possible transfers. Light and Strayer (2004) analyse the impact of college transfer in the US and find that students who change colleges receive about six per cent higher wages than those who do not change.

In contrast to the US study, this paper finds that students who change universities receive lower subsequent earnings in the short run than students who do not change. This concerns students changing to universities of high observed quality as well as students changing to institutions of lower observed quality. The earnings differences decrease significantly over the earnings distribution and over time, indicating that it takes longer for students who change universities to find an appropriate job match. The pattern seems consistent with non-transfer students having higher earnings because of their relatively earlier labour market entry, and transfer students catching up because of their additional human capital investments.

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I

Do Fathers Influence the Time Their Children Spend in Subsidized Child Care?

Linda Holmlund*
Department of Economics, Umeå University
SE-901 87 Umeå, Sweden

Abstract

This paper examines whether the fathers' characteristics affect the number of hours their children spend in subsidized child care. More explicitly, we estimate two non-nested models of child care demand in Sweden. The "dual care provider" model allows for variations in the labor supply of both parents and includes a number of personal characteristics of both the father and the mother. The "single care provider" model follows earlier research and assumes that the father's working hours are fixed and exogenous to the family's child care demand. The parameter estimates indicate that several characteristics of the father are associated with the time his child spends in child care. J-tests and bootstrap J-tests were performed to compare the models. The tests show that the single care provider model can be rejected in favor of the dual care provider model, but the reverse is not true.

Keywords: Child care demand, Subsidized child care, Dual care provider model
JEL Classification: J13

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*I am grateful for comments and suggestions by Kurt Brännäs, Niklas Hanes, Olle Westerlund, Magnus Wikström, participants at a seminar at Umeå University and participants at the European Association of Labour Economists (EALE) conference 2007. I also thank the Swedish Social Insurance Agency and the Swedish National Agency for Education for providing the data used in this study.

1 Introduction

This paper concerns the demand for child care by Swedish parents and analyzes whether the father's characteristics influence the number of hours his children spend in subsidized child care. Focusing on the father is an approach that differs from that taken in the traditional literature, in which child care demand has often been related to the mother's labor supply, see e.g. Blau and Robins (1988) and Michalopoulus et al. (1992). In this literature, the father's participation in the labor force is assumed to be predetermined and it is often assumed that he does not spend any time caring for his child. Consequently, the mother is regarded as the only potential child care provider in the family. The father's role is simply to provide income to support his family. A few papers, for example Joesch and Hiedemann (2002), include the father's preferences and labor supply choices in the theoretical model, but still exclude these from the empirical model. Since the focus has been on the mother and her labor supply, factors determining the number of hours a child spends in child care have received little attention.[1] Instead, most papers have examined how the mother's labor supply is affected by the cost and quality of child care.[2]

To assume that the only factors that influence child care demand are related to the mother may not be appropriate when considering modern families in the OECD countries. During the second half of the 20th century, women began to participate more in the labor market and now many mothers continue to work

[1] Exceptions include e.g. Hotz and Kilburn (1992), Blau and Hagy (1998), Joesch (1998), and Joesch and Hiedemann (2002). However, empirically these studies draw on the traditional model and exclude the father from their models of child care demand. There is one empirical study of child care demand in Sweden by Wikström (2007) that includes both the father and the mother. Nevertheless, since this study does not include any variables related to income, it is difficult to compare the results to those from other studies.

[2] See e.g. Connelly (1992), Ribar (1995), Averett et al. (1997) and Kimmel (1998) for the US, Lokshin (2004) for Russia, and Kornstad and Thoresen (2007) for Norway. There is also an emerging literature that incorporates the effect of rationing, see e.g. Gustafsson and Stafford (1992) for Sweden, Wrohlich (2006) for Germany, and Del Boca and Vuri (2007) for Italy.

after a child is born. Statistics from OECD (2001) show that employment rates of mothers with young children increased rapidly in almost all countries during the 1990s. There are also indications that fathers are increasingly involved in child care and other household tasks.

One country in which these changes have been exemplified is Sweden. Swedish (and Canadian) men participate most in unpaid household work, and Swedish mothers have one of the highest participation rates in the labor market of any country in the world.[3] The Swedish government has launched a number of family reforms that facilitate mothers' participation in the labor market and encourage fathers to take care of their children. For example, both fathers and mothers have legal rights to parental leave and part time work after childbirth, with the opportunity to return to full time work later. Subsidized child care of high quality and wide availability is publicly provided and heavily utilized by Swedish parents. Previous studies have shown that specialization within Swedish households has decreased as women's share of the job market has increased.[4] In addition, the proportion of parental leave days that Swedish fathers take has increased from 8.8 per cent in 1990 to 17.2 per cent in 2003.[5]

If both parents are involved in their child's care, one could assume that the preferences and labor supply choices of both parents' influence the time their child spends in child care. If this is the case, we cannot base a study of child care demand on a model where only factors related to the mother are considered. Therefore, in this paper, we derive a different model, which takes both parents into account in the same way. In this family model, both parents are potential child care providers and both parents' labor supplies are allowed

[3] See OECD (2001) for more information about work and family life in the OECD countries. See also Table A1 in the Appendix for a comparison of mothers' employment rates and fertility rates in different countries.
[4] See e.g. Anxo (2002).
[5] Ministry of Health and Social Affairs [Socialdepartementet in Swedish] (2004).

to vary. Consequently, the corresponding empirical model includes both the father's and the mother's wage rates and other characteristics of both parents.

A model where both parents are considered equally seems to be appropriate for a study of child care demand in Sweden. However, since it has not yet been empirically determined which model best fits the Swedish data, and to serve as a comparison with earlier studies, we also include a model based on earlier research. In this model, the mother is assumed to be the only child care provider and the father's preferences are considered to have no influence on child care demand. To compare the empirical models, J-tests and bootstrap J-tests will be performed. As far as we know, no previous study has examined, empirically, whether variables related to the father are associated with the number of hours that his child spends in child care or whether a single or a dual care provider model is more appropriate. In addition, studies that focus on the number of hours a child spends in child care are rare and this paper adds to that literature.

The paper is organized as follows. Section 2 presents the theoretical framework on the basis of which the variables included in the empirical models were selected. Section 3 describes the data and the variables included while Section 4 introduces the empirical models and describes the tests used to evaluate the models. Section 5 contains the empirical results and Section 6 concludes.

2 Theoretical framework

In this section, we present two theoretical models of family child care demand. The models aim at determining the factors that influence parents' choice of the time their children spend in subsidized care and are used to identify the variables in the empirical models. The first model is a "dual care provider"

model that includes both parents as potential carers. The second model is a "single care provider" model where only the mother is considered to be the potential carer.

2.1 Dual care provider model

In this model both the father and the mother are potential child care providers. Both parents' labor supplies are allowed to vary. All families are considered to be potential users of subsidized child care and, to simplify the model, each family is assumed to have only one child. Utility is assumed to be a function of child care quality (Q), consumption (C), the mother's and father's leisure times (L_M, L_F), the time the mother and father spend with the child (t_M, t_F) and exogenous factors related to the mother, the father, and other exogenous variables (Z_M, Z_F, Z_O). The family utility function can be expressed by:

$$U = U\{Q, C, L_M, L_F, t_M, t_F, Z_M, Z_F, Z_O\}.$$

The family faces time and budget constraints. If we normalize the total amount of time available to each parent to one, the time constraints can be written

$$1 = l_i + t_i + L_i\,,\ i = m, f$$

$$\tilde{t} = t_M + t_F + x$$

where l_M is the mother's hours of employment, l_F is the father's hours of employment, t_M is the mother's time spent caring for the child, t_F is the father's time spent caring for the child, x is the number of hours of subsidized child care, and $\tilde{t}$ is the total number of hours during which the child needs care.

In Sweden, child care fees are proportional to family labor income up to a limit.[6] Let $A = (\alpha_y, \alpha)$ be the parameters of the fee system, where α_y is a fee proportional to income and α is a fixed value corresponding to the maximum fee. The fee system is such that $A = (\alpha_y, 0)$ for families whose family labor income is below the limit and $A = (0, \alpha)$ for families whose family labor income is above the limit. A family budget constraint that takes into consideration the child care fees that must be paid by the parents can be written:

$$C = \tilde{w}_M * l_M + \tilde{w}_F * l_F + \tilde{y}$$

where $\tilde{w}_M$ is the mother's hourly marginal wage rate calculated as $w_M(1-\tau-\alpha_y)$ where τ is the marginal income tax and $\tilde{w}_F$ is the father's hourly marginal wage rate calculated as $w_F(1-\tau-\alpha_y)$. The term $\tilde{y}$ is "other income" reduced by a potential fixed fee, ($\tilde{y} = y - \alpha$).

Optimal hours of child care are obtained by maximizing the utility function, subject to the constraints and solving the first order conditions simultaneously. The demand for child care can be described by the following reduced form

$$x = x(\tilde{w}_M, \tilde{w}_F, \tilde{y}, Z_M, Z_F, Z_O, Q, \tilde{t}).$$

Child care demand is a function of the father's and mother's marginal wage rates, other income reduced by the maximum fee for parents who have a total

[6] In 2002 this limit was 38,000 SEK per month. For preschool care, the fee was three per cent for the first child, two per cent for the second child and one per cent for the third child. No fee was paid for the forth child. This means that the maximum fee for the first child was 1,140 SEK per month. See Holmlund and Wikström (2005) for a more detailed description of the fee system.

income above the maximum fee limit, other paternal and maternal characteristics, other characteristics, child care quality, and the total time that the child needs care.

2.2 Single care provider model

For comparison, we derive a single care provider model, based on earlier research by, e.g., Ribar (1992) and Hotz and Kilburn (1992). In this model, the father is assumed to work a fixed number of hours and he is not considered to be a potential child care provider. The mother is assumed to make decisions about her labor supply and about child care hours. Utility is assumed to be a function of child care quality (Q), consumption (C), the mother's leisure time (L_M), the father's leisure time ($\bar{L}_F$), the mother's time spent with the child (t_M), exogenous characteristics related to the mother (Z_M) and other exogenous characteristics (Z_O). The time constraint for the mother is similar to that in the dual care provider model, while the child's time constraint is different since the father no longer is a care provider. The budget constraint is also slightly different. In the single care provider model, the father's wage rate does not directly affect child care demand since his labor supply is assumed to be fixed and exogenous. His wage rate is excluded from the model, while his annual income from paid employment is included in "other income". The reduced form is analogous to the dual care provider model and can be written

$$x = x(\tilde{w}_M, \tilde{y}, Z_M, Z_O, Q, \tilde{t})$$

where $\tilde{y} = y - \alpha + \bar{l}_F \tilde{w}_F$.

When only the mother is a potential care provider, the child care hours are determined by the mother's marginal wage rate, other income, the mother's

characteristics, other characteristics that affect the parents' preferences, child care quality and the total time that the child needs care. The only variable that is directly related to the father is "other income", in which his annual income from paid work is included.

3 Data

The study is based on the dataset "Tid och Pengar" (Time and Money), compiled by the Swedish Social Insurance Agency in January 2003. One of the parents of each of 1,578 children born in 1999 was interviewed about the family's child care choices and labor supplies as well as about socioeconomic and demographic factors. In addition, register data, containing income-related variables, were added for both parents and covered the years 1993 to 2002. In this study, we use the variables from 2002. "Tid och Pengar" is combined with information about different municipalities' child care fee systems and variables related to child care quality. Different structural variables are also added. These data are provided by the Swedish National Agency for Education and refer to the year 2003. Since the children under consideration were born in 1999, the child care demand is measured for children who were four years old in 2003.

The sample used in this study consists of two parent households where both parents work full time or part time.[7] Parents with extremely low or high (less than 50 SEK or more than 500 SEK) gross hourly wages are excluded as well as parents who reported a large number of working hours (more than 50 hours per week). Finally, some households are excluded due to missing values. The

[7] Child care for children with parents who are unemployed or on parental leave is rationed in Sweden. They cannot freely choose the number of hours of public child care, but are guaranteed 15 hours per week by law. We do not discuss rationing in this paper and these families are therefore excluded. Students are excluded due to measurement errors produced by missing values in the annual income from employment and working hours.

final sample consists of 683 households.[8] Descriptive statistics for the sample are presented in Table 1.

3.1 Variable description

3.1.1 Dependent variable

The dependent variable is the number of hours per week that the child spends in subsidized care. This variable is constructed on the basis of the questions "How is your child care arranged today?" and "How many hours per week does your child spend in child care?" and corresponds to the number of hours in preschool or family day care. Children who were cared for outside preschool or family day care are assigned zero hours of subsidized care.[9]

Unfortunately, the survey provides no indication of whether or not the preschools and family day care facilities were subsidized. Preschool and family day care could include both public and private facilities. However, in this study we treat all children who attended a preschool or family day care as users of subsidized care. We chose to do this for two reasons. First, the vast majority of children in preschool or family day care attend public facilities. Statistics show that, in 2002, 81 per cent of all 1-5 year olds were enrolled in some preschool activity, i.e. public or private preschool or family day care. As many as 84 per cent of those children attended public preschools or family day care run by the municipalities, while 16 per cent attended a facility (preschool or family day care) that operated under non-municipal auspices.[10]

[8] Table A2 in the Appendix gives the details of how the sample was obtained.
[9] Table A3 in the Appendix gives the proportions of children in different types of child care.
[10] These statistics are from the Swedish National Agency for Education [Skolverket in Swedish] (2004). See the Swedish National Agency for Education (2004) for more information about the child care system in Sweden.

Table 1: Descriptive statistics

	Mean	Std dev	Min	Max
Hours in subsidized care	29.5	10.4	0	55
Mother's gross wage rate	118	47.5	51.2	500
Mother's marginal wage rate	76.2	25.6	33.1	340
Father's gross wage rate	147	57.3	51.0	468
Father's marginal wage rate	81.3	21.8	33.7	222
Other income, dual care provider model	56.4	37.2	4.0	182
Other income, single care provider model	223	69.0	79.0	617
Number of siblings, 0-6 years	0.45	0.55	0	2
Number of siblings, 7-12 years	0.56	0.70	0	3
Mother's age	33.9	4.4	21	49
Father's age	36.2	5.3	24	55
Proportion of mothers born abroad	0.03		0	1
Proportion of fathers born abroad	0.02		0	1
Urbanization	83.5	12.9	31	100
Tax base, per capita	132	20.8	101	251
Municipality's child care expenditures, per child	82.8	8.2	58.0	125
Children/staff ratio	5.4	0.45	3.7	6.7
Children per preschool group	17.2	1.5	13.5	22.7

Note: all monetary values are expressed in SEK. Other income, tax base and child care expenditures are expressed in thousands of SEK.

Second, if a family chooses a non-municipal preschool or family day care that is approved by the municipality, they usually pay the same fee as they would have done if they had chosen a public preschool in the same municipality. Most private preschools are included in the publicly subsidized system. Therefore, we believe that it is reasonable to treat all children who attend preschool or family day care as users of subsidized child care.

3.1.2 Independent variables

The independent variables include characteristics of the parents and the family as well as variables related to the municipality. The family characteristics include parents' ages, parents' origin, number of siblings and different measures of income. Two dummy variables indicating whether the mother or the father was born in Sweden are included to control for parents origin. The sibling variables refer to the number of siblings in two different age categories: 0-6 and 7-12. Three different income measures are utilized: mother's marginal wage rate, father's marginal wage rate and other income.

Gross earnings per hour, w_i, are derived by dividing annual income from employment by annual working hours.[11] Marginal wage rates are then calculated as $w_i(1-\tau-\alpha_y)$ for i = mother or father, where τ is the marginal tax rate and α_y is the sum of the proportional child care fees for all

[11] Working hours are derived from answers to the question "how many hours do you/your partner work in an ordinary week, including overtime?" To obtain annual working hours the weekly figure was multiplied by 52. We also tried an approach using 47 weeks per year, but that did not affect the results.

children in the household that are between 0 and 6 years old.[12] For mothers and fathers in households who must pay the maximum fee, $\alpha_y = 0$.[13]

Other income comprises the parents' virtual income components and actual income from sources other than employment, consisting, here, of child allowance, housing allowance and social assistance. The virtual income components correspond to the intercept incomes that are obtained by linearizing each parent's budget constraint around the tax segment where the recorded hours of work were located, i.e., the intercept obtained when the individual's budget segment is extended to zero hours of work. If the parents must pay the maximum fee, the total fee for all children in the household is deducted from other income. In the single care provider model, where the father's labor supply is assumed to be exogenous, the father's annual net income from paid employment is included in other income while his virtual income component is excluded.

Since the municipalities are responsible for child care provision and there may be differences in quality and availability between municipalities, a number of variables that are measured at the level of the municipality are included. Urbanization measures the proportion of the municipality's inhabitants that live in a so-called population centre.[14] A highly populated city usually has a large proportion of its inhabitants living in a population centre. For example,

[12] We do not have information about child care hours for siblings. However, it is reasonable to believe that siblings spend the same number of hours in preschool. The fees for siblings that are older than six years, i.e., siblings that may attend after-school care, are not considered.

[13] In 2002, Sweden had an individually based piecewise linear income tax system with two thresholds. For taxable incomes below the first threshold, only a municipal tax had to be paid. The municipal tax varied between 27.5 per cent and 33.4 per cent, depending on which municipality they lived in. For incomes between the first and second thresholds, an additional state tax of 20 per cent had to be paid. For incomes above the second threshold, the state tax was 25 per cent. Since we have information about the parents' annual incomes from paid employment, where they lived and the municipal tax rates, we are able to account for this non-linearity when calculating marginal wage rates.

[14] A population centre is defined as a settlement with at least 200 inhabitants and a maximum distance of 200 meters between the houses.

several municipalities in the Stockholm area have the value 100, which is the highest possible value. A large tax base indicates that the municipality receives a high revenue from the inhabitants' income taxes, thus, tax base per capita is included to control for the municipality's resources. To control for the effect of child care quality, we include some variables that are considered to be related to the quality of child care: the municipality's expenditures per child for child care, the number of children per preschool employee and the number of children in each preschool group. These variables correspond to the average values per municipality.

4 Empirical model

To determine whether the father's characteristics influence child care demand, we estimate two reduced form models based on our theoretical framework. The dual care provider model can be expressed in the following reduced form

$$x_j = \alpha^D + \beta^D \tilde{w}_{Mj} + \gamma^D \tilde{w}_{Fj} + \rho^D \tilde{y}_j^D + \theta^D Z_{Mj} + \phi^D Z_{Fj} + \varphi^D Z_{Oj} + \vartheta^D Q_j + \varepsilon_j^D \qquad (1)$$

where the subscript j refers to the household; $\tilde{w}_M$ and $\tilde{w}_F$ are the mother's and father's hourly net wage rates, respectively; $\tilde{y}^D$ is other income, including the mother's and father's virtual income components and other actual income; Z_M is a vector of the characteristics of the mother, Z_F is a vector of the characteristics of the father, and Z_O is a vector of other explanatory variables that are common to both parents, e.g., other family characteristics and variables related to the municipality; Q includes variables related to child care quality; ε^D is an error term and $\beta^D, \gamma^D, \rho^D, \theta^D, \phi^D, \varphi^D$ and ϑ^D are coefficients.

The single care provider model can be specified in a similar way:

$$x_j = \alpha^S + \beta^S \tilde{w}_{Mj} + \rho^S \tilde{y}_j^S + \theta^S Z_{Mj} + \varphi^S Z_{Oj} + \vartheta^S Q_j + \varepsilon_j^S \quad (2)$$

This specification excludes the characteristics of the father from equation (1) and includes a definition of other income where the father's annual income is included while his virtual income component is excluded. In this model, the father's alternative cost for leisure is irrelevant since his labor supply is fixed. However, his annual income may affect the mother's labor supply and is, therefore, included in the variable other income.

The inclusion of income variables in the two models poses a potential endogeneity problem. Mother's marginal wage rate, father's marginal wage rate and other income may be endogenous to family child care demand and an ordinary least squares estimation may result in biased estimates.[15] To correct for endogeneity, the models are estimated using two stage least squares (2SLS). In the first step, mother's marginal wage rate, father's marginal wage rate and the two different variables for other income are estimated using OLS. For identification we use dummy variables related to different education levels, which are assumed to be correlated with the income measures but uncorrelated with child care hours.[16] In addition, the models include control variables corresponding to equations (1) and (2). The coefficients obtained from these estimations are used to calculate predicted values. In the second step, the predicted values from the first step are included and the models from equations (1) and (2) are estimated using OLS.[17]

[15] Hausman tests were performed to check whether the income variables were endogenous. The tests indicated that the income variables were endogenous in both models.
[16] F-tests and t-tests were performed to assess the relevance of the instruments. The tests indicate that the instruments significantly affect the income variables, both individually and in combination.
[17] The results from the first step are available from the author on request.

4.1 Specification tests

Since other income is defined differently in the two models, the models are non-nested. This means that the models are separate and that one model is not a special case of the other. This imposes a problem when deciding which model specification best fits the data. We could not simply impose restrictions on one model to obtain the other and examine the significance of the loss of fit that arises. Instead, we have to use procedures for testing non-nested regression models. Almost all the literature on non-nested hypothesis testing in the context of regression models relies on the work of Cox (1961; 1962). However, even though the Cox test is generally applicable, it is not always easy to implement. One alternative is the J-test, which is used in this paper.

4.1.1 The J-test

The J-test was proposed by Davidson and MacKinnon (1981) and has several appealing features. The J-test is intuitive, convenient to implement and easily generalized to allow for several non-nested alternative regression models. In addition, the test may be more powerful than comparable tests.[18] When conducting a J-test, a maintained hypothesis (model 1) is defined; this is then confronted by a competing hypothesis (model 2). The success of the competing hypothesis is determined by whether or not it has any explanatory power, given the explanation provided by the maintained hypothesis. If so, the maintained hypothesis is rejected. In practice, this is done by adding a supplementary variable, comprising the fitted values from the competing model fitted to the same data, to the maintained model and evaluating its significance. Then the hypotheses are reversed, i.e., the competing hypothesis becomes the maintained, and the procedure is repeated.

[18] See e.g. Fan and Li (1995) and Godfrey (1998).

In our setting, the J statistics are the *t* statistics for $\lambda = 0$ in the regressions

$$x_j = S_j\eta + \lambda_2(D_j\hat{\varsigma}) + \varepsilon_j \quad (3)$$

$$x_j = D_j\varsigma + \lambda_1(S_j\hat{\eta}) + \varepsilon_j \quad (4)$$

where *S* includes all vectors of variables included in the single care provider model, *D* contains all vectors of variables included in the dual care provider model and η and ς are coefficients.

4.1.2 The Bootstrap J-test

Fan and Li (1995) and Davidson and MacKinnon (2002) draw attention to some drawbacks of the J-test. One difficulty is that the J-test suffers from a size distortion when the regressors in the null model are near to being orthogonal to those in the alternative model. In addition, the test is not exact in finite samples and its finite-sample distribution can be very far from the normal distribution that it follows asymptotically. It is also well known that the J-test tends to over reject the null. This implies that we need better approximations of the finite sample distribution of the J-test statistic. One way to obtain these is to perform bootstrapped J-tests, where a bootstrap sample is used to calculate a J-test statistic, J^*, in exactly the same way as the ordinary J-test statistic ($\hat{J}$).[19] The procedure is repeated a certain number of times, B, and the empirical reference distribution for the J-test statistic under the maintained hypothesis is thus obtained. The bootstrap test is conducted by

[19] $\hat{J}$ corresponds to the *t* statistic of λ in the section above, in which the ordinary J-test is described.

calculating a bootstrap P value and rejecting the null hypothesis whenever this P value is less than the level of the test.

The bootstrap P value can be calculated by the formula

$$\hat{p}^*(\hat{J}) = \frac{1}{B}\sum_{j=1}^{B} I(J_j^* \geq \hat{J})$$

where I is an indicator function that equals 1 if its argument is true and 0 otherwise. This implies that the test is one-tailed.[20]

5 Empirical findings

5.1 Parameter estimates

Table 2 presents the results for the two models, estimated by 2SLS.[21] Let us begin by examining the parameter estimates for the dual care provider model. In this model, the characteristics of both parents are included, as well as other control variables. The estimates for the parents' marginal wage rates both have negative signs. This implies that the higher a parent's wage rate, the fewer hours her/his child spends in child care. However, none of the parents' wage parameters are statistically significant. This is not surprising, since the sample consists of families where both parents are working. Since informal care is rare in Sweden, almost all families with two working parents need subsidized child care during parental working hours and this need is not determined by the level of the wages. Swedish child care fees are also very low and affordable for most families.

[20] The bootstrap procedure is described more in detail in Davidson and MacKinnon (2002) and Fan and Li (1995).

[21] The models were also estimated using OLS as a comparison. The results from the OLS estimations are presented in Table A4 in the Appendix.

Table 2: Parameter estimates from 2SLS

	Dual care provider model		Single care provider model	
Covariate	Estimate	S.E	Estimate	S.E
Family level				
Mother's marginal wage rate	-0.02	0.09	0.17**	0.07
Father's marginal wage rate	-0.23	0.28		
Other income	0.22*	0.12	-0.009	0.009
Number of siblings, 0-6 years	-3.48***	0.81	-3.50***	0.82
Number of siblings, 7-12 years	-1.10*	0.58	-1.22**	0.62
Mother's age	0.23	0.15	0.07	0.10
Father's age	-0.38*	0.21		
Mother born abroad	4.44*	2.51	0.75	2.64
Father born abroad	-11.15***	3.80		
Municipality level				
Urbanization	0.10**	0.05	0.08**	0.04
Tax base, per capita	0.06	0.05	0.03	0.03
Municipality's child care expenditures, per child	-0.02	0.07	-0.05	0.06
Children/staff ratio	1.56	1.33	-0.30	1.03
Children per preschool group	-0.11	0.26	-0.16	0.25
Intercept	24.30*	14.18	16.38	10.40
Number of observations	683		683	
Adj. R^2	0.11		0.08	

Note: all monetary values are expressed in SEK. Other income, tax base and child care expenditures are expressed in thousands of SEK. Standard errors are heteroscedastic consistent. ***, **, and * denote significance at the one per cent level, five per cent level, and ten per cent level, respectively.

In addition, when both parents are involved in their child's care, the child care hours are determined by both parents' working hours and there is no simple correlation between one parent's working hours and the time the child spends in child care. Other income is positively related to the child care hours and is statistically significant. This is somewhat surprising since we expect leisure and time spent with children to be normal goods.

The effect of siblings is significant and similar to what has been found by other researchers, e.g. Joesch and Hiedemann (2002). The presence of more siblings results in fewer hours being spent in child care and younger siblings have a greater effect than older siblings. For every sibling under the age of six, the child spends approximately 3.5 hours less in child care each week, while having a sibling aged 7-12 decreases the time spent in child care by approximately one hour. One possible explanation is that one of the parents may be more likely to work part time if there are younger children in the family. If the parent is at home with one child, he or she can care for more children without it taking much more time. This implies that there may be increasing returns to scale in family child care.

If we continue to examine the variables that are related to the parents, we find a negative correlation between the father's age and child care hours. The mother's age is not significantly determined. Since previous studies by e.g. Brayfield and Hofferth (1995), Johansen et al. (1996), and Joesch (1998) have provided evidence of the importance of race and ethnicity for child care decisions, we included two dummy variables that indicated whether the mother or the father was born outside Sweden. The results show that if the father is born outside Sweden, the time spent in subsidized child care decreases by approximately 11 hours per week. Having a mother born outside Sweden increases the time spent in child care by approximately 4.5 hours. The importance of origin may depend on values and beliefs about appropriate ways

to care for children and effects of maternal employment on children. However, since only a limited number of parents in our sample were born outside Sweden and the standard errors are high, these results should be interpreted with caution.

Several variables relating to the municipal level were included to control for supply effects and quality of care. Among these variables, only urbanization seems to be associated with child care demand. If the family lives in a municipality where many of the inhabitants live in a population centre, the time spent in child care increases. This effect is probably due to the availability of child care. If you live in a highly populated area, it is more likely that you have a preschool nearby and this may affect the demand. The tax base has no effect on child care use. Finally, none of the quality related variables appear to affect child care demand. One reason for this could be that, due to Swedish national standards for quality in child care, the variation in the quality between municipalities is small. This lack of variation could make it difficult to capture any effects. Another possible explanation is that the variables are measured on a municipality level and all within-municipality variation is ignored. The lack of significance could also indicate that parents actually do not care about quality, or that the variables are not relevant proxies for quality.

Now, let us briefly comment on the results for the single care provider model. In this model, only the mother is a potential care provider. In contrast to the dual care provider model, the mother's marginal wage rate has a positive and significant effect on child care hours. The father's wage rate was not included. Instead, his annual income from labor was assumed to have a similar effect as other non-labor incomes and is added to the "other income" variable. The effect of other income is negative in this model, while it was positive in the dual care provider model. However, other income is significantly determined in the single care provider model. The effect of siblings mirror that in the dual

care provider model, both with respect to significance and magnitude. Mother's age is still insignificant while the dummy variable indicating whether the mother was born abroad changes from significant to insignificant. The variables relating to the municipal level all yield similar results to those in the dual care provider model. The only variable that is associated with child care demand is urbanization. Tax base and the quality related parameter estimates are not significant.

These parameter estimates provide some evidence to support inclusion of the father in the model of child care demand. When considering the point estimates of the dual care provider model, both the father's age and whether he was born abroad affect child care hours. His wage rate was not a significant parameter but neither was the mother's. In addition, the adjusted R-square value was higher for the model where both parents were considered. However, to compare the models more formally, we must use a test that accounts for the fact that the models are non-nested.

5.2 Results of the J-tests

To test formally which model specification is more relevant, J-tests are performed (as described in Section 4.1). The results are presented in Table 3.

Let us begin by examining the J-test of the single care provider model. The null hypothesis is that the fitted values from the dual care provider model do not significantly contribute to the single care provider model. The test returns a *t* statistic for the fitted values of 4.46, which enables us to reject the null hypothesis at the five per cent significance level. Thus, we reject the single care provider model in favor of the dual care provider model.

Table 3: Results of the J-tests and Bootstrap J-tests

		Maintained hypothesis			
		Single care provider model		Dual care provider model	
Test	Covariate	*t* ratio	P value	*t* ratio	P value
J-test	Fitted values from competing hypothesis	4.46	0.00	-0.81	0.42
Bootstrap J-test	Fitted values from competing hypothesis	-0.02[a]	0.00	0.34[a]	0.88

Note: the models correspond to the 2SLS mentioned in Section 5.1. [a] The *t* ratios for the bootstrap J-tests correspond to the mean *t* ratio.

In order to test the dual care provider model, the null hypothesis is reversed. The dual care provider model is then defined as the maintained model and the null hypothesis is that the fitted values from the single care provider model do not significantly contribute to the dual care provider model. The *t* statistic for the fitted values is -0.81. This implies that we can not reject the null hypothesis at the five per cent significance level. The single care provider model does not contribute significantly to the dual care provider model.

However, since the J-test is not exact in finite samples, the results from the tests must be interpreted with some caution. In order to obtain more conclusive results, we follow Davidson and MacKinnon (2002) and bootstrap the J-tests. The bootstrap produces an empirical reference distribution for the J-statistic under the maintained hypothesis. The bootstrap J-tests are conducted as described in Section 4.1. For each model, we create 49,999 bootstrap samples

and calculate corresponding J-statistics and P values. The results are presented in Table 3.

First, the single care provider model is defined as the maintained hypothesis. The bootstrap P value is 0.00, i.e., there are no bootstrap *t* ratios that exceed the observed value of 4.46 from the ordinary J-test. This implies that we can still reject the single care provider model in favor of the dual care provider model. Second, we let the dual care provider model be the maintained hypothesis and repeat the procedure. We obtain a bootstrap P value equal to 0.88. This means that 88 per cent of the bootstrap *t* ratios exceed the observed value of -0.81 obtained from the ordinary J-test. This implies that rejection at the five per cent level is not possible and that the dual care provider model can not be rejected in favor of the single care provider model. The results from the bootstrap J-tests support the results of the ordinary J-tests. The single care provider model is still rejected in favor of the dual care provider model while the dual care provider model can not be rejected in favor of the single care provider model. The dual care provider model appears to be a better specification of child care demand in Sweden. Together with the results from the 2SLS, we conclude that the father's characteristics are important for child care demand in Sweden and that both parents' characteristics should be included in the empirical model.

6 Conclusions

This paper provides empirical evidence to help determine whether the father's characteristics should be included in the estimations of family child care demand. We examined two models of child care demand, one that includes characteristics of both parents equally and one following earlier research where the contribution of the father was his annual income (included in the

variable other income). The parameter estimates indicated that the fathers' characteristics do influence the number of hours that their children spend in subsidized child care. In addition, the J-tests and the bootstrap J-tests provided similar results; i.e., that a model specification that includes variables related to the father in the same way as the mother is to be preferred. The results support the hypothesis that both parents' characteristics are important when examining the child care demand of Swedish families. Nearly all previous studies about child care demand have ignored the fact that the father's characteristics could be relevant. Most studies assume that since the father is more likely to work full time, the child care hours are determined by the mother and her characteristics and preferences. However, our results show that even though Swedish fathers often work more hours than Swedish mothers, they still influence family child care demand. One possible explanation is that fathers who are involved and interested in their child's care and well-being affect child care demand through their preferences, even though they have long working hours. Another explanation is that many parents divide the responsibility for delivering and collecting children from preschool and some utilize flexible working hours to decrease the time that the child spends in subsidized care.

This study is based on Swedish data and we cannot comment on whether the dual care provider model is appropriate for other OECD countries. However, since the employment rates of women have increased in almost all OECD countries, one may suspect that the dual care provider model could be appropriate for other countries as well. Using a single care provider model, without taking the father's preferences and leisure- and labor supply choices into account could lead to bias and other problems associated with omitted variables. Therefore, more research in this area is needed. For example, it would be interesting to examine whether variables relating to fathers matter for child care demand in other Nordic countries, which have similar family

policies and social security systems. For Sweden, now that we have determined that the dual care provider model fits the data best, a natural next step is to develop a richer model of child care demand that allows for interaction effects, and estimate parental labor supplies and child care demand simultaneously.

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Appendix

Table A1: Employment and fertility rates

	Employment rates of mothers with children under 6 years of age[a]	Total fertility rate[b]
Belgium	69.5	1.61
Finland	58.8	1.76
France	56.2	1.89
Germany	51.1	1.34
Greece	48.6	1.27
Italy	45.7	1.29
Netherlands	60.7	1.75
Norway	72.8	1.80
Spain	41.8	1.29
Sweden	77.8	1.71
UK	55.8	1.71
US	61.5	2.07

[a] Data refer to 1999, except for Sweden and Finland where data refer to 2000 and 1998 respectively. Source: OECD Employment Outlook 2001. [b] Data refer to the period 2000-2005. Source: Eurostat.

Table A2: Estimation sample

Interviewed families	1,578
Exclusions:	
Parents not living together	166
Missing family status	1
Mother does not work	540
Missing mother's employment	19
Father does not work	139
Missing father's employment	149
Remaining families	867
Mother's wage missing or < 50 SEK	63
Father's wage missing or < 50 SEK	79
Mother's working hours >51	5
Father's working hours >51	57
Remaining families	697
Other variables missing	14
Remaining families	683

Table A3: Mode of care

	Percentage of families	
Mode of care	Sample 1	Sample 2
Preschool or family day care	89.9	95.1
Private care provider in own home	0.4	0.4
Relative	0.8	1.0
Parents work and take care of child	0.5	0.6
One parent is on parental leave	5.0	0.9
One parent works from home	1.5	0.3
One parent is unemployed or on sick leave	0.9	0.1
Other	0.8	0.9
Don't know/won't answer	0.2	0.7
Total	100	100
Number of observations	1,567	683

Note: Data refer to the dataset "Tid och Pengar". Sample 1 consists of all families where the selected child was born in 1999 and includes working and non working, single and cohabiting parents. Sample 2 corresponds to the sample used in the analysis in this paper, see Section 3.

Table A4: OLS estimates for hours in subsidized child care

	Dual care provider model		Single care provider model	
Covariate	Estimate	S.E	Estimate	S.E
Family level				
Mother's marginal wage rate	-0.03*	0.02	-0.03*	0.02
Father's marginal wage rate	-0.03	0.02		
Other income	0.03***	0.01	0.01**	0.01
Number of siblings, 0-6 years	-3.45***	0.80	-3.30***	0.82
Number of siblings, 7-12 years	-1.35**	0.61	-1.31**	0.63
Mother's age	0.33***	0.12	0.23***	0.09
Father's age	-0.16	0.11		
Mother born abroad	3.07	2.20	0.27	2.69
Father born abroad	-11.07***	3.20		
Municipality level				
Urbanization	0.08**	0.04	0.08**	0.04
Tax base, per capita	0.06**	0.02	0.05**	0.02
Municipality's child care expenditure, per child	-0.04	0.06	-0.04	0.06
Children/staff ratio	0.46	0.99	0.35	0.99
Children per preschool group	-0.10	0.26	-0.14	0.25
Intercept	16.52	10.48	13.79	10.27
Number of observations	683		683	
Adj. R^2	0.11		0.09	

Note: all monetary values are expressed in SEK. Other income, tax base and child care expenditures are expressed in thousands of SEK. Standard errors are heteroscedastic consistent. ***, **, and * denote significance at the one per cent level, five per cent level, and ten per cent level, respectively.

II

Assessing the Effects of the Child-Care Fee Reform on Public Expenditures and Taxation

Niklas Hanes, Linda Holmlund and Magnus Wikström*
Department of Economics, Umeå University
SE-901 87 Umeå, Sweden

Abstract

This paper studies the effects of the Swedish child-care fee reform on public expenditures and taxation in the municipalities. The reform implied a common system of child-care fees among all the municipalities and was introduced in 2002. In order to study its effects, we employ a difference-in-difference approach, where outcomes are compared with respect to differences in the municipalities' pre-reform fee systems. It was found that pre-reform characteristics determine taxes and expenditures in the post-reform period. We then discuss the likely causes of these differences and find that the reform did change the child-care demand in municipalities that had applied time rates relative to those who applied income dependent fees prior to reform. Changes in child-care quality were not connected to the pre-reform fee systems characteristics.

Keywords: Child-care subsidies, Local public expenditures, Income taxation
JEL Classification: H71, H72, J13

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* We are grateful to David Granlund for valuable comments and to the Swedish National Agency for Education, the Swedish Council for Working Life and Social Research, the Bank of Sweden Tercentenary Foundation, and the National Tax Board for research grants.

1 Introduction

One of the recent contributions to Swedish child-care policy is the introduction of maximum user fees in publicly provided pre-school child-care and school age child-care that took place in 2002. This reform was motivated by a number of reasons. In the 1990s, the child-care fees had increased dramatically, and the variation between the municipalities had also increased. The use of charges that related to household income became more extensive and the use of time rates (e.g. hourly rates) increased as well. The critique against the use of such fees was based on an economic as well as an educational viewpoint. Income dependent fees were generally seen as disadvantageous because of the vast marginal effects created, especially for low-income families. Time rates were mainly seen as disadvantageous from the perspective of child-care as an educational activity, and of poor households having little opportunity to use child-care full time. One part of the reform proposal was to introduce a common fee system for all municipalities. The fees were at the same time suggested to be reduced for most family types. Participation in the reform was voluntary and the municipalities that agreed to implement the new system were to be compensated for the loss in fee revenue following the reform. The reform proposal was implemented in all but two municipalities in 2002, and the other two municipalities implemented the changes the year after.

One of the more interesting aspects of the reform of public child-care financing is the consequences it may have for the allocation of the public expenditures on child-care and the level of taxes in the municipalities. Changing the system of financing will generally affect the incentives for families as well as for the municipalities that are responsible for the provision of child-care services. Municipalities determine important aspects of the quality of the child-care provided, and may thus change the child-care quality, as their funding is restricted. There is very little information on the effects that child-care subsi-

dies have on government budgets. One exception is a simulation-based study by Graafland (2000), who discusses the general equilibrium effects of child-care subsidies on labour supply and public finance. Graafland finds that an increase in child-care subsidies increases labour supply and employment, and the effects on the Government's budget are estimated to be small, implying that child-care subsidy reforms may be almost self-financed.

A key parameter in determining whether subsidies have beneficial effects on the economy is the labour supply responses to the price of child-care. Blau (2000) reviews U.S. studies on the effects of the price of child-care on employment and finds that employment is decreasing in the price of child-care, although the quantitative effects vary among the studies. Previous evidence on the Swedish reform suggests that the effects on labour supply are small. Lundin, Mörk and Öckert (2008) use price variation from the fee reform to estimate the effects of child-care costs on parents' labour supply. They find that labour supply responses were very small. Similarly, a paper by Brink, Nordblom and Wahlberg (2007) also finds small labour supply effects. In addition, they compare a child-care fee reform with a general increase in the public child support system from a welfare point of view and cannot exclude that an increase in child support increases welfare relative to a change in the fee system. Also consistent with small behavioural effects on the family level is a study by Wikström (2007). He analyses the child-care demand before and after the reform, and finds that the average changes in hours of care were small in most municipalities.

This paper serves the purpose of studying the effects of the Swedish maximum fee reform on municipal child-care expenditures and income tax rates. To our knowledge, it is the first paper that empirically analyses how child-care user fee regulations affect public budgets. The analysis is based on the Swedish municipalities over the time period 1999 to 2005. Since the previous Swedish

studies find small effects at the family level, one may hypothesise that the effects on the municipal expenditures and taxation are small as well. However, the previous studies mainly focus on how the reform changed the disposable income of families with small children. This is a reasonable starting point, since the fee systems used prior to reform were in many cases extremely complex and the difficulties associated with estimating labour supply responses under complex budget sets are well known (see e.g. Pudney, 1989). Nevertheless, the fee reform gave rise to income as well as substitution effects that varied among the municipalities because of differences in the pre-reform fee systems. To capture this heterogeneity at the municipal level, we use a difference-in-difference approach, where an assessment is made by comparing municipalities with different characteristics of their fee systems prior to reform. In particular, we distinguish between municipalities that used time rates and income dependent fees respectively. We then analyse if the effects found are the result of relative demand changes or changes in child-care quality by studying changes in the proportion of small children in child-care, the number of hours of care, and teacher-child ratios over the same time period. Finally, the reader should note that since all municipalities eventually adopted the common fee system, and since the reform package included other components besides the changes in the fee systems, we are not able to compare the outcome for the participating municipalities with a control group of non-participants. Hence, our focus on relative differences among groups of municipalities with differing characteristics of their pre-reform fee systems is a natural way to address the effects of the fee reform.

The main result is that the changes in public child-care expenditures and income tax rates between the pre- and post-reform period were significantly different among municipalities with different pre-reform fee systems. Municipalities that applied time rates had larger expenditure increases and also higher tax-rate increases in comparison to municipalities that used income dependent

fees. We also find that changes in child-care quality between fee subgroups were negligible, while the relative child-care demand changed. These results are consistent with the explanation that the use of time rates restricts demand in terms of the numbers of hours of care relative to the use of income dependent fees.

The rest of the paper is organized as follows. Section 2 describes the Swedish child-care system and the 2002 reform. Section 3 presents our research strategy and an empirical model. In Section 4, the data and empirical results are presented, while Section 5 concludes.

2 Background

2.1 Pre-school child-care in Sweden

In Sweden, the municipalities are obligated to provide child-care for children aged one to twelve years. The central government decides on the curriculum that specifies the overall goals and orientation for pre-schools, and the municipalities are responsible for implementing the national goals. The child-care is financed partly by central government grants and partly by local tax revenues and user fees. The municipality can permit a private pre-school to perform the pre-school activities if the program offered meets the standards for safety and quality and if the fees charged are not unreasonably high. In most municipalities, private pre-schools are subsidised in the same way as the public pre-schools.

Child-care can be divided into two broad categories: pre-school child-care, which is directed towards children of age one to five, and school-age child-care aimed at children six to twelve years of age. Pre-schools care for children while their parents are working or studying. Pre-school activities are organized

in essentially three different ways. The most common form of child-care consists of pre-school centres that provide integrated child-care and early education. A second form is family day care. It involves childminders, employed by the municipality, who provide child-care in their own homes while the parents work or study. In 2006 about 85 per cent of all children one to five years of age attended pre-school centres or family day care.[1] The open pre-school, finally, is a supplement where children of parents who are at home during the day can participate. It is an educational group activity, developed by childminders, stay-at-home-parents and pre-school staff.

2.2 Child-care reform

During the 1990s child-care fees became an increasingly important source of funding for the Swedish municipalities. The fee revenue as a percentage of total cost in pre-school centres went from approximately ten per cent in the beginning of the 1990s to 17 per cent in 1999. The changes in the municipal fee systems during the 1990s concerned fees related to household income (income dependent fees) and to time spent in child-care (time rates). The most marked increase was in time rates. In 1993, 60 per cent of the municipalities had at most two time rates in pre-school care, while in 1999 the corresponding figure was 13 per cent. By the end of the 1990s, most municipalities applied some form of income dependent fee. The most common method was to use a proportional income rate combined with an upper limit income level. The proportional rates varied between the municipalities and between families with different characteristics, and the median marginal rate was about 10 per cent out of family income. Some municipalities charged families according to income intervals with zero marginal rates.[2]

[1] The Swedish National Agency for Education [Skolverket in Swedish] (2007a).
[2] Descriptions of fee systems are given by the Swedish National Agency for Education (1999, 2003).

The reform 'Maximum fees and general pre-school' was mainly introduced to increase accessibility to pre-schools and school-age child-care. In 1999, the national government initiated an investigation into the publicly provided child-care. In May 2000, the Government launched a proposal for reform which consisted of three different parts: (i) the right to participate in public child-care for children of parents that are either unemployed or on parental leave with a sibling, (ii), a uniform system of child-care fees and (iii) a general free of charge pre-school for four- and five-year-olds for a stipulated number of hours per year. The reform was decided on by the Swedish Parliament in November 2000, and the first part to be implemented concerned children of the unemployed (July 1, 2001) and of people on parental leave (January 1, 2002).[3]

The second part of the reform concerned the maximum fee system discussed in this paper. This system was implemented on January 1, 2002. One purpose of the maximum fee was to improve the financial circumstances as well as horizontal equity among families with children. Prior to the reform, the fees for pre-schools varied to a large extent among the municipalities. A family with two children, average incomes and children who spent 33 hours per week in pre-school paid between 0 and 4,160 SEK per month in 1999.[4] Another aim was to reduce marginal effects and to encourage participation in the work-force. Finally, since pre-school is considered an integrated child-care and early education activity, the reform was also seen as a way to facilitate educational planning.

The new fee system specified the fee as a function of household income with an upper limit. In pre-school care, the household income related part was set at three per cent for the first child, two per cent for the second child, one per cent

[3] General descriptions of the maximum fee reform package are given by the Swedish National Agency for Education (2003, 2004, 2007a, 2007b).
[4] The Swedish National Agency for Education (1999).

for the third child and zero for the following children. The maximum household income level was set at 38,000 SEK per month, meaning that the maximum fee was set at 1,140 SEK per month for the first child. The third part of the reform was introduced on January 1, 2003, and concerned general pre-school for four- and five-year-olds for at least 525 hours per year. This general pre-school is free of charge.

The right to pre-school for children whose parents are unemployed or on parental leave and the general pre-school for four- and five-year-olds are regulated in law and thus compulsory for the municipality. The maximum fee is voluntary. The maximum fee reform was made as an offer to municipalities to agree to a common fee system. Since it would mean that municipalities would lose revenue from fee collection, the national government devised a compensation scheme to cover the losses. A central government grant, the maximum fee grant, was made available for the municipalities that joined the system. This grant was calculated on the basis of the number of small children in the municipality and a standardized cost; the cost differs between the municipalities based on a calculated cost of providing services.[5] The grant was of a lump-sum nature and not conditioned by use, meaning that municipalities could choose how to spend the grant. In addition, another intergovernmental grant was introduced to assure that the quality of child-care was kept intact. This latter grant, the grant for quality securing measures (or quality grant for short), was conditioned by the municipalities spending the money on improving the quality of child-care either in the form of hiring more personnel or by improving the competence of existing personnel. The grant was calculated on the same basis as the maximum fee grant. However, some municipalities were unable to use the entire grant as intended, and therefore returned part of the money.[6]

[5] The Swedish National Agency for Education (2007).
[6] Ibid.

All but two municipalities joined the maximum fee system the first year it was introduced. The other two municipalities joined the system in 2003. The introduction of the maximum fee had a considerable impact on the fee structure in the Swedish municipalities. The out-of-pocket payment of families decreased sharply. Between 2001 and 2003, the average fee per family decreased by 1,300 SEK. Thus, the financing of municipal child-care changed dramatically in 2002. Table 1 displays the average fee collected as a percentage of the total expenditure on public child-care for municipalities with different pre-reform system characteristics for the years 1999 and 2002.

In the table we have distinguished between those municipalities that applied fees dependent on household income and those charging fees based on the time spent at the child-care centre. By the end of the 1990s, most municipalities used some form of time dependent fee. These were constructed by using either hourly rates or time intervals. The number of time intervals used varied; 144 out of 289 municipalities used more than three intervals in their fee schedules. The use of income dependent fees was also common. One construction usually applied was a proportional rate with an upper limit. The amount of revenue brought in by fees varied relatively little among municipalities with different pre-reform characteristics. Approximately 16 per cent of the cost of child-care was covered by fees. The exception was those few municipalities that did not use time rates, where a smaller proportion of the cost was covered by fees. Note also the drop in fee coverage in 2002, the first year with the new system. Even though municipalities faced the same system in 2002, there were some variations in fee coverage depending on differences in cost and the composition of families in terms of income levels.

Table 1: Fees collected as a percentage of total expenditure 1999 and 2002, municipality averages

Description	Year		Number of municipalities
	1999	2002	
Time rates in 1999			
Hourly rate	17.2	10.6	55
Interval rate	16.0	9.1	226
No time rate	12.9	9.3	8
Income dependent fee 1999			
Proportional rate	16.1	9.3	182
Interval rate	15.9	9.5	69
No income dependent fee	17.0	10.1	38

Source: Calculations based on the Swedish National Agency for Education (1999).

3 Research strategy

3.1 The determinants of public child-care expenditures, quality and local tax rates

A major concern with the child-care reform was the fear that the municipalities would be unable to maintain quality at the pre-reform levels or that the municipalities would increase taxes in order to finance the decreasing revenue from child-care fees. In order to study the effects of the fee reform, this section first briefly discusses a model for the primary purpose of explaining what factors determine public expenditures on child-care, child-care quality and tax

rates at the municipal level. Then we discuss how to identify the effects of the fee reform in an empirical analysis.

To motivate our analysis, we sketch a simple public expenditure model augmented with individual decisions regarding labour supply and child-care demand.[7] Municipalities are assumed to be run by decision makers, maximizing welfare of families taking into consideration how individuals respond to policy when making their decisions. Child-care fees are here assumed to be exogenous to the municipal decision-maker, since a primary purpose is to study the effects of parametric changes in the fee system. Families solve a labour supply decision, in which utility depends upon consumption and leisure as well as the quality of public child-care. Labour supply and the demand for child-care will depend on the hourly wage net of income taxes, the quality of child-care, and the parameters of the child-care fee system.

Municipalities provide child-care quality and other goods. They use receipts from income taxes, child-care user fees and intergovernmental grants to finance the expenditures. A social planner maximizes welfare of the residents by choosing child-care quality and an income tax rate. For our purposes, the upshot of such a model is reduced form expressions for the tax rate and quality, which we can denote $q = q\left(n, \Gamma, y, z\right)$ and $\tau = \tau\left(n, \Gamma, y, z\right)$, where q and τ denote quality and tax rate, respectively, n is the (relative) size of the group of families with small children, Γ parameters of the fee system, y economic factors (wages, intergovernmental grants etc.) and z other factors that affect the cost of providing the public child-care services.

[7] There is a large literature on public expenditures. See Bergstrom and Goodman (1973) for an early example of how to model public expenditures, and Andersson, Aronsson and Wikström (2004) for a theoretical model and empirical application of tax rate determination under variable labour supply. The model used here is described in detail in Holmlund and Wikström (2005).

To obtain an expression of the expenditures on child-care, let the unit cost of child-care be a strictly increasing function of child-care demand x and quality q; $k(x,q,z)$. Parameters of the fee system enter the cost of child-care through child-care demand and/or the quality of child-care. Finally, one should note that the qualitative effect of various exogenous factors on child-care quality, taxation, and expenditure per child cannot be established without making specific assumptions.

3.2 Identifying heterogeneous effects of the fee reform

Previous evidence suggests that the change in demand following from the fee reform differed depending upon the pre-reform fee systems the municipalities had applied. In particular, municipalities that applied time rates had a lower average number of hours of care prior to reform, and the increase in hours in 2002 was bigger than in municipalities that did not apply time rates prior to the reform (Wikström, 2007). The maximum fee reform implied that households paid an amount proportional to income (up to a maximum level of income), and the fee variations with respect to the number of hours of care were severely restricted by the fee cap. In terms of a demand model for the family, this means that the hourly price of child-care decreased for those municipalities that applied time rates prior to reform, while the hourly price in municipalities that applied income dependent fees did not change. This suggests that time rates, in comparison to other fee systems, may serve to limit the demand for child-care in terms of the number of hours of care. On the other hand, the decision to participate in pre-school might have been differently affected by the reform. Families in municipalities with income dependent fees faced high out-of-pocket costs associated with participation prior to reform, while the cost of participation for families facing time rates was relatively lower, since they could choose part-time attendance. Thus, conditioning on the pre-reform fee

systems may capture differences in parental demand effects due to the reform. Obviously, municipalities that experienced large demand increases following from the reform may have responded by decreasing the quality of child-care in order to limit the negative effect on the municipality's budget. This means that demand increases do not necessarily translate into increases in expenditure per child and taxation, and that differences in pre-reform systems may instead distinguish municipalities with respect to quality changes.

To further motivate the analysis in this paper, we note that the introduction of a common maximum fee system was made in all but two of the municipalities in the year 2002. This means that, unless we are able to observe some differences between municipalities, it will be difficult to separate changes in the fee system from other changes that may have affected the municipalities at the same time. We exploit the idea that different pre-reform fee systems capture relative demand effects (or quality effects) by controlling for what type of system was in use in 1999. By choosing characteristics of the fee systems three years prior to reform, we limit the risk that the identifying variables are endogenous to the reform outcomes since the first steps towards the reform were taken in the late spring of 1999. We distinguish different fee systems in two directions by the use of dummy variables; (i) municipalities that used time rates, either hourly rates or rates in time intervals, and (ii) municipalities that used income dependent fees, either in the form of fees directly proportional to household income or fees differing between income intervals. Thus, in all there are four dummy variables that capture the pre-reform fee systems. The distribution of municipalities over the pre-reform fee systems is given in Table 2.

Table 2: Municipal child-care fee systems in 1999

	Time rates 1999			
Income dependent fee 1999	No	Hourly rate	Interval rate	Sum
No	2	8	28	38
Proportional rate	4	35	143	182
Interval rate	2	12	55	69
Sum	8	55	226	289

Source: Calculations based on the Swedish National Agency for Education (1999).

In the way we have distinguished the pre-reform fee systems, all possible fee combinations were used. The number of municipalities in the different cells of the table is unevenly sized. According to the table, the most common fee system was using a fee proportional to household income in combination with a time interval fee. Note also that there were only two municipalities that applied uniform child-care fees in 1999.

We use data for the municipalities over the years 1999 to 2005. Let subindex i denote municipality and t year. The empirical models that we estimate are the following

$$k_{it} = f_i + d_t + Z_{it} + Y_{it} + \sum_{j=1}^{4} \alpha_j \Gamma_j + \varepsilon_{it}$$

$$\tau_{it} = f_i + d_t + Z_{it} + Y_{it} + \sum_{j=1}^{4} \alpha_j \Gamma_j + \varepsilon_{it}$$

where k_{it} and τ_{it} denote per child expenditure and income tax rate , f_i is a municipality specific effect, d_t a period specific effect, Z_{it} variables and parameters associated with the municipality's cost conditions, Y_{it} variables and parameters associated with economic information, and ε_{it} is a normally distributed error term with mean zero. Finally, the sum $\sum_j \alpha_j \Gamma_j$ consists of dummy variables Γ_j, j=1,4, taking the value one for observations in the post-reform period if the fee system is of type j in the pre-reform period, and associated parameters α_j, j=1,4. The way we have specified the equations above implies that the estimated effects of the pre-reform fee systems are interpreted as difference-in-difference estimates of the fee changes that occurred in 2002.

4 Empirical analysis

4.1 Data

The empirical analysis is based on data on the 290 Swedish municipalities. As mentioned above, data for a period before and after the reform date is used. We combine data from Statistics Sweden and the Swedish National Agency for Education over the period 1999 to 2005. Characteristics of the municipalities are obtained from Statistics Sweden and include age distributions, population, and population distances (the average distance in kilometres between individuals in a municipality). Economic characteristics include local tax rates, per capita tax bases (average income), and intergovernmental grants. The grant variables are the grant for the implementation of the maximum fee system, the grant for quality securing measurements in pre-school, and the general intergovernmental grant. All monetary variables have been deflated by the consumer price index and are measured in 2005 money value.

Child-care data was obtained from the Swedish National Agency for Education. In this paper, we use information on public child-care. Child-care data is available for public as well as private pre-schools, but there is no information on expenditure for private pre-schools. Moreover, private pre-schools have not necessarily applied the same fee systems as the public pre-schools. Variables used are the teacher-child ratio (which measures personnel intensity in municipal pre-schools as the number of teachers per 100 children), the per-child public expenditure, the percentage of pre-school children with a different native language than Swedish, the percentage of children of age one to five that participate in pre-school, and the average number of hours of care in pre-school.

To capture differences in fee setting among the municipalities prior to the reform, we use information from a questionnaire by the Swedish National Agency for Education conducted in 1999.[8] Dummy variables have been constructed to describe the different systems as discussed in Section 3.2. An advantage of using information from 1999 is that the reform content was unknown at the time, meaning that we can treat the pre-reform dummies as exogenous. Two of the municipalities introduced the maximum fee reform in the year 2003. For those municipalities, the post-reform period covers the years 2003 to 2005. Out of the 2030 observations contained in the original data, some have been excluded due to missing information. Description of the variables used and descriptive statistics are presented in Tables A1 and A2 in the Appendix.

[8] See Section 3.2 for our definitions of the fee dummy variables, and the Swedish National Agency for Education (1999) for the original investigation of child-care fees.

4.2 Results

In order to obtain suitable empirical specifications, we start by estimating general models for the two outcome variables, the public expenditure per child and local income tax rate, in which differences between subgroups of pre-reform fee systems are allowed to vary over the years following the reform. The idea is that municipalities do not necessarily adapt immediately to the new system. To control for slow adjustment, each subgroup specific dummy is interacted with period specific dummies for the years 2002 to 2005. Then, we test the null hypothesis that between-subgroup differences are constant over the post-reform period versus the alternative that differences vary over the post-reform years. For the local income tax rate, we reject the null hypothesis. Here we find that a plausible empirical specification is that the first year effect (2002) is different from that of the later years. For the public expenditure we cannot reject the null hypothesis, meaning that we can treat the reform effects as constant over the post-reform period.[9] The final estimation results are presented in Tables 3 and 4 below.

Child-care expenditures

In Table 3, the results regarding the determinants of the expenditure per child are presented. In column 1, we condition on period specific effects, the subgroup dummies, and the background variables. As a comparison, column 2 presents the estimation results where we have excluded the background information.

[9] Municipalities may have responded to reform prior to the reform date. To address this issue, we have also estimated models in which the reform effects are allowed to be non-zero for the year 2001. We cannot reject the null hypothesis of zero reform effects during the year 2001.

Table 3: Determinants of the per child municipal expenditure

	I		II	
Variable	Coefficient	Std. error	Coefficient	Std. error
Intercept 2000	-0.572	0.882	1.73***	0.652
Intercept 2001	0.222	1.20	4.12***	0.626
Intercept 2002	-3.42	2.88	2.20*	1.82
Intercept 2003	-4.38	3.14	2.74	1.84
Intercept 2004	-6.78*	3.57	2.69	1.83
Intercept 2005	-14.01***	4.95	5.20***	1.84
Pre-reform fee subgroups				
Hourly rate	5.35***	1.84	6.47***	1.70
Time interval rate	3.75**	1.75	4.72***	1.63
Proportional income fee	-0.720	1.06	-1.17	1.06
Income interval fee	-0.350	1.17	-0.94	1.20
Other variables				
Population proportion 1-3 years old	-5.53***	1.84		
Population proportion 4-5 years old	-3.75**	1.75		
Population proportion 6-15 years old	-0.593	0.528		
Population proportion 16-19 years old	1.06*	0.603		
Population proportion over 65 years old	-0.096	0.332		
Proportion of children speaking a foreign language	-0.035	0.049		
Log of population	7.53	14.8		
Population distance	-0.004	0.014		
Average income	0.344***	0.123		
General grant	0.101	0.312		
Maximum fee grant	-11.43**	4.84		
Quality grant	79.28***	18.81		
Number of observations	1,978		1,985	
Adj. R^2	0.632		0.623	

Note: Estimation period 1999-2005. Municipality specific effects are included. Standard errors are heteroskedastic-consistent. *** denotes statistical significance on the one percent level, ** significance on the five per cent level, and * significance on the ten per cent level

The estimates presented in column 1 of Table 3 suggest that there was no large uniform shift in spending at the time of the introduction of the maximum fee reform in 2002. The period specific estimate drops between the years 2001 and 2002, but the change is not significantly determined. Municipalities that applied time rates prior to the reform had significantly larger expenditure in the post-reform period. The effect is somewhat bigger for those municipalities that applied hourly rates; according to column 1 it is approximately 5,000 SEK per child or 5 per cent of the average expenditure. Note also that adding explanatory variables has no major effect on the subgroup dummy estimates.

Let us briefly comment upon the estimates of the background variables. We find that the demographic characteristics of the municipality determine the expenditure on child-care. A larger share of children aged one to five decreased the expenditure per child, while other age group sizes do not appear to have had any effect on the expenditure on child-care. This result indicates slow adjustment to demographic changes in the younger age groups, and is consistent with previous research on the effects of demography on public expenditures[10]. The expenditure on child-care is increasing in average income of the municipality, while there is no clear pattern regarding the different intergovernmental grants. The general grant appears to have had no effect on spending per child. However, the parameter associated with the grant for quality securing measurements is very large and positive, while the maximum fee grant had a negative effect. One potential problem is that the quality grant is not given as a lump sum. Since the grant was conditioned on personnel expansion in the public child-care sector, and since some municipalities returned money that they were unable to use, the grant may be endogenous. Therefore,

[10] See e.g. Borge and Rattsø (1995).

one should not interpret the estimate associated with the quality grant as a casual effect.[11]

Income tax rates

One important aspect of the fee reform is if it had any major impact on taxation in the municipalities. In Table 4, the results for the determinants of local income tax rates are presented. As mentioned above, we cannot reject the hypothesis that the fee reform had different effects over time. Therefore in Table 4 we distinguish between a first-year effect (2002) and effects of the later years (2003-2005).

We first note that local income tax rates are determined by the demographic group sizes. It is primarily those age groups towards which the main part of the local public services is directed, i.e. school age children and the elderly, which affect the tax rates. According to the estimates, tax rates are positively associated with average income in the municipalities. This result is contrary to prior expectations, since a positive relation indicates that the income elasticity of demand for public services is larger than what is usually found in the literature.[12] However, municipalities that increased the taxes the most during this period are those with high income. We interpret this as an indication that the

[11] Another potential problem with estimating the influence of the two child-care grants separately is that they are highly correlated. This stems from the fact that the grants allocated are (in part) determined by the same underlying factors. We have run additional regressions where one of the two variables is excluded. This decreases (in absolute value) the estimate of the other parameter. In particular, the parameter associated with the maximum fee grant becomes small and insignificant, while the effect of the quality grant is still large. The other parameter estimates are only marginally affected by the exclusion of the grant variables.

[12] In terms of a demand model for public expenditures, a positive relation between the tax rate and income is consistent with an income elasticity larger than one. However, the income elasticity of demand is usually estimated to be less than one.

Table 4: Determinants of municipal income tax rates

	I		II	
Variable	Coefficient	Std. error	Coefficient	Std. error
Intercept 2000	-0.071***	0.027	0.035*	0.021
Intercept 2001	-0.127***	0.037	0.061***	0.020
Intercept 2002	-0.087	0.098	0.262***	0.083
Intercept 2003	-0.014	0.098	0.448***	0.078
Intercept 2004	-0.055	0.113	0.559***	0.078
Intercept 2005	-0.375**	0.164	0.595***	0.078
Pre-reform fee subgroups				
2002 effects				
Hourly rate	-0.101	0.073	-0.090	0.078
Time interval rate	-0.066	0.068	-0.078	0.074
Proportional income fee	-0.064*	0.038	-0.104**	0.042
Income interval fee	-0.104**	0.043	-0.114**	0.046
2003-2005 effects				
Hourly rate	0.068	0.064	0.086	0.074
Time interval rate	-0.016	0.060	-0.029	0.069
Proportional income	-0.186***	0.035	-0.240***	0.043
Income interval fee	-0.214***	0.039	-0.243***	0.047

To be continued

Table 4 continued

	I		II	
Variable	Coefficient	Std. error	Coefficient	Std. error
Other variables				
Population proportion 1-3 years old	0.040	0.044		
Population proportion 4-5 years old	-0.035	0.049		
Population proportion 6-15 years old	0.031*	0.017		
Population proportion 16-19 years old	-0.027	0.019		
Population proportion over 65 years old	0.030***	0.011		
Proportion of children speaking a foreign language	$-1.94 \cdot 10^{-4}$	0.002		
Log of population	-0.144	0.483		
Population distance	-0.236	0.331		
Average income	0.025***	0.004		
General grant	-0.017**	0.007		
Maximum fee grant	-0.327**	0.147		
Quality grant	2.43***	0.747		
Number of observations	2,019		2,026	
Adj. R^2	0.973		0.969	

Note: Estimation period 1999-2005. Municipality specific effects are included. Standard errors are heteroskedastic-consistent. *** denotes statistical significance on the one percent level, ** significance on the five per cent level, and * significance on the ten per cent level.

low tax municipalities adjusted their tax rates during the estimation period.[13] Note also that the effect of the general intergovernmental grants is negative, showing that grants serve to equalize tax rates between poor and rich communities. The average local income tax rate increased for each of the years contained in our data. However, the yearly increase is small, about 0.03 to 0.12 percentage points. Looking at the estimates in Table 4, column 1, we note that period specific effects appear to increase around the reform date, although the difference is not significantly determined. A more interesting development is found between the subgroups. Looking at the first year effects, municipalities that applied time rates in 1999 did not have significantly different tax rates compared to the reference group in 2002. However, municipalities that applied income dependent fees had significantly lower tax rates in 2002, indicating that these municipalities did not increase taxes as much between 2001 and 2002 as the rest of the municipalities did. This difference is further strengthened over the years 2003 to 2005. Municipalities that applied income dependent fees in 1999 had on average 0.2 percentage points lower tax rates during the years 2003 to 2005. These results are consistent with our earlier results; municipalities that applied time rates prior to the reform increased their expenditure per child as well as tax rates in comparison to those municipalities that applied income dependent fee systems.

The two intergovernmental grants associated with the fee reform have opposite sign effects. The maximum fee grant decreases tax rates, which is plausible considering that the grant was a lump sum. This indicates that the maximum fee grant served to finance the revenue drop caused by the fee reform, and that municipalities would have increased their taxes had the grant not been given. On the other hand, we find that the quality-securing grant increased

[13] Estimating a model for tax changes as a function of past tax rates yields the result that taxes increase less in those municipalities that had high initial tax rates, i.e. tax rates are (partially) equalized over time.

taxes. Given the large effect of the quality grant on expenditures, we are not really surprised to find a positive association. However, as mentioned above, this grant was not of a lump sum nature. One should therefore be careful in interpreting the quantitative effect.

Quality versus demand effects

There are basically two explanations of the estimated differences between subgroups. One explanation is that the demand increase was larger in the municipalities that applied time rates compared to the rest of the municipalities. If time rates restrict demand by decreasing the number of hours in child-care, as previous evidence suggests, then switching to a system with income dependent fees will likely increase the demand in terms of hours of care. However, we cannot at this stage rule out the explanation that municipalities in different subgroups responded differently by changing the quality of child-care. This would be the case, for example, if municipalities using time rates increased the child-care quality relative to the other municipalities. In order to determine which of these two explanations is most suitable, it is necessary to study the reform effects with respect to quality and demand.

The municipality data offers some possibility for analysis here. Quality is measured by using the teacher-child ratio defined as the number of personnel per one hundred children. Although this measure does not capture all aspects of quality, it is readily available at the municipal level. Demand is measured by two variables, aimed at capturing two different dimensions of child-care demand. First, to capture the decision on hours, the determinants of the average number of hours per week among pre-school children are estimated. As mentioned above, we expect that the average number of hours increased in municipalities that used time rates prior to reform relative to the other municipalities. Second, to capture the participation decision, the percentage of small

children in the municipality that attend a public pre-school is studied. Our hypothesis is that participation increased more in municipalities that used income dependent fees than in municipalities that used time rates for the reason outlined in Section 3.2. We regress these three variables on the same determinants as before. The estimation results are presented in Table 5.

The teacher-child ratios are slowly decreasing over the post-reform period, but appear too heterogeneous for the period specific effects to be estimated with precision. We also note that there was no change in intercept between 2001 and 2002. The subgroup dummies vary in sign with large standard errors, indicating that there is no clear-cut response in child-care quality to the change in relative demand. Taken together, we interpret the results as evidence that the municipalities did not respond to the fee reform by decreasing the quality of public child-care.[14]

The second column of the table presents the regression results for the percentage of children in public pre-school. We first note that the proportion increases over time, and that the difference between 1999 and 2005 is as large as 29 per cent. The single largest yearly increase coincides with the reform date. However, this should not necessarily be ascribed to the fee changes. It is likely that a big part of the increase is due to the possibility for children of parents on parental leave and unemployed people to participate in pre-school that was introduced around the same time. There is no consistent pattern regarding the subgroup differences. The estimates associated with time rates are negative, but not significantly different from the reference group. We conclude that the

[14] One can note that the quality grant in this case too has a large effect (not shown in the table); the parameter estimate is large and significant. An increase in the grant with one standard deviation increased the teacher-child ratio by approximately 0.3 standard deviations on average.

Table 5: The effects on quality and demand for child-care

Variable	Teacher-child ratio	Participation in pre-school	Hours of care
Intercept 2000	-0.250	2.10***	-0.176*
	(0.166)	(0.611)	(0.107)
Intercept 2001	-0.136	3.28***	-0.331**
	(0.223)	(0.786)	(0.146)
Intercept 2002	-0.312	16.0***	-1.15***
	(0.737)	(2.69)	(0.340)
Intercept 2003	-0.652	19.9***	-1.37***
	(0.760)	(2.77)	(0.374)
Intercept 2004	-1.19	22.3***	-1.67***
	(0.799)	(2.94)	(0.431)
Intercept 2005	-1.57	28.7***	-2.78***
	(0.978)	(3.85)	(0.563)
Pre-reform fee subgroups			
Hourly rate	0.021	-2.27	1.10***
	(0.487)	(1.81)	(0.235)
Time interval rate	-0.473	-1.07	0.368*
	(0.478)	(1.76)	(0.224)
Proportional income	-0.010	1.22	-0.012
	(0.212)	(0.769)	(0.106)
Income interval fee	0.152	-0.618	0.275**
	(0.226)	(0.804)	(0.116)
Number of observations	2018	2019	1978
Adj. R^2	0.496	0.898	0.875

Note: The estimation period is 1999-2005. Heteroskedastic-consistent standard errors are given within parenthesis. The background variables included are the same as in Tables 3 and 4, column 2. Municipality specific effects are also included. *** denotes statistical significance on the one percent level, ** significance on the five per cent level, and * significance on the ten per cent level.

hypothesis that the demand increases, in terms of the number of pre-school participants, are associated with the pre-reform fee systems can be rejected.

The final column of Table 5 presents the estimates of weekly hours in pre-school. The general trend concerning hours of care in pre-school is negative, which we mainly attribute to the possibility of the unemployed and those on parental leave to have their children in pre-school part time. In addition, the general pre-school for children of age four to five may also have had a negative effect on hours. In comparison to the other subgroups, the number of hours increased in the hourly rate subgroup for the post-reform years. As the general trend is negative, it means that the average number of hours did not decrease between 2001 and 2002 in the hourly rate subgroup. We also note that the subgroup dummy is positive for the time interval group and also for the income interval group, but these effects are much smaller in size.

Finally, in order to further strengthen our interpretation of the results, we establish that there is indeed a link between expenditures, the demand for care and quality. A "cost function" is estimated directly by regressing the expenditure per child on the teacher-child ratio, participation, and hours of attendance. The results show that the child-care expenditure is positively associated with quality and hours of care, and negatively associated with participation. Thus, the (relative) increase in the number of hours in the time rate group translated into higher per child expenditure relative to the other fee groups.[15]

[15] The estimated equation is ln(Expenditure)=0.012*Quality + 0.004*Hours - 0.002*Participation. All parameters are significantly determined at the five per cent level. The regression also includes municipality specific effects, period specific effects, population and population distance. The results are available from the author upon request.

5 Conclusions

In this paper, we have added to the empirical knowledge of the Swedish child-care fee reform, and more generally to the determinants of public child-care expenditures. The analysis builds on the fact that municipalities applied different fee systems prior to reform, which makes it possible to construct fee subgroups and make comparisons over time between the subgroups. Two different outcome variables are first analysed; the public expenditure per child and the local income tax rate. Our main findings are as follows: Municipalities that applied time rates prior to reform had bigger increases in per child expenditures and income tax rates compared to the municipalities that applied income dependent fees. The differences are sizeable; the difference with respect to tax rates is about the same size as the average change in tax rates in all municipalities between the pre- and post-reform period. For the child-care expenditures, the differences are about five per cent of the cost per child.

The differences may have been caused by a stronger demand increase in the group of municipalities that applied time rates, forcing these municipalities to increase expenditure as a reaction to the demand increase, but it may also have been caused by changes in child-care quality. The additional regressions that we ran suggested that the differences are caused by relative demand shifts among the fee subgroups. In particular, the average number of hours of care in pre-school decreased less in the municipalities that applied hourly rates prior to reform. In comparison to previous Swedish studies on child-care reform and labour supply, Lundin, Mörk and Öckert (2007), and Brink, Nordblom and Wahlberg (2007), our results show larger real effects on behaviour, not only by the municipalities changing taxes and expenditures, but also on individual behaviour in terms of child-care demand. This implies that it is important to consider general equilibrium effects in terms of taxes and expenditures within

the local public sector. It also implies that it may be important to consider child-care demand separately from labour supply behaviour.

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Appendix

Table A1: Variable definitions

Variable name	Description	Data source
Municipal expenditure per child	The expenditure per registered child in public pre-school in 1,000 SEK calculated in 2005 money value	SCB
Municipal income tax rate	The municipal income tax rate measured in percentage points	SCB
Teacher-child ratio	The number of personnel in public pre-school as a percentage of the number of registered children in public pre-school	NAE
Participation in public pre-school	The number of registered children in public pre-school as a percentage of the population of age one to five	NAE
Hours of care	The average number of hours of care per week among the children registered in public pre-school.	NAE
Population proportion 1-3 years old	The percentage of the population of age one to three years	SCB
Population proportion 4-5 years old	The percentage of the population of age four to five years.	SCB
Population proportion 6-15 years old	The percentage of the population of age six to 15 years	SCB
Population proportion 16-19 years old	The percentage of the population of age 16 to 19 years	SCB
Population proportion over 65 years old	The percentage of the population over the age of 65	SCB
Proportion of children speaking a foreign language	The percentage of all registered children of age one to five in public pre-school that have a native language other than Swedish	NAE
Log of population	The natural logarithm of the municipality's population	SCB

To be continued

Table A1 continued

Variable name	Description	Data source
Population distance	The average distance between inhabitants in the municipality measured in kilometres	SCB
Average income	The municipality's income tax base in 1,000 SEK per inhabitant calculated in 2005 money value	SCB
General grants	1999-2004; the municipality's income from general intergovernmental grants per capita in 1,000 SEK calculated in 2005 money value, 2005; the sum of municipal equalization per capita in 1,000 SEK	SCB
Maximum fee grant	The maximum fee grant per capita in 1,000 SEK calculated in 2005 money value	NAE
Quality grant	The sum of the grant for quality securing measures and personnel grant per capita in 1,000 SEK calculated in 2005 money value	NAE
Hourly rate	A dummy variable that takes the value one in the post-reform period if the municipality applied a fee system with an hourly rate in the pre-reform period	NAE
Time interval rate	A dummy variable that takes the value one in the post-reform period if the municipality applied a fee system with time intervals in the pre-reform period	NAE
Proportional income fee	A dummy variable that takes the value one in the post-reform period if the municipality charged users in proportion to household income in the pre-reform period	NAE
Income interval fee	A dummy variable that takes the value one in the post-reform period if fees were paid according to household income within different intervals	NAE

Note: The data sources are SCB=Statistics Sweden, and NAE=The Swedish National Agency for Education (Skolverket).

Table A2: Descriptive statistics

	Time period			
	1999-2001		2002-2005	
Variable	Mean (std.dev)	Number of observations	Mean (std.dev)	Number of observations
Municipal expenditure per child	92.11 (10.81)	830	97.34 (10.25)	1,155
Municipal income tax rate	21.13 (1.38)	867	21.36 (1.29)	1,159
Teacher-child ratio	18.81 (2.26)	867	18.75 (1.88)	1,158
Participation in public pre-school	54.70 (13.55)	867	64.86 (17.24)	1,159
Hours of care	29.34 (2.38)	830	28.34 (2.16)	1,155
Population proportion 1-3 years old	2.94 (0.43)	867	3.02 (0.51)	1,159
Population proportion 4-5 years old	2.25 (0.34)	867	2.01 (0.30)	1,159
Population proportion 6-15 years old	13.93 (1.32)	867	13.26 (1.34)	1,159
Population proportion 16-19 years old	4.82 (0.49)	867	5.23 (0.54)	1,159
Population proportion over 65 years old	19.82 (3.74)	867	20.16 (3.58)	1,159
Proportion of children speaking a foreign language	6.57 (7.56)	866	7.98 (9.09)	1,159
Log of population	9.82 (0.89)	867	9.82 (0.91)	1,160
Population distance	0.279 (0.272)	867	0.283 (0.280)	1,159

To be continued

Table A2 continued

	Time period			
	1999-2001		2002-2005	
Variable	Mean (std.dev)	Number of observations	Mean (std.dev)	Number of observations
Average income	110.7 (14.49)	867	126.7 (17.72)	1,159
General grants	6.86 (4.29)	867	7.51 (5.31)	1,159
Maximum fee grant	0	867	0.337 (0.087)	1,153
Quality grant	0	867	0.076 (0.046)	1,153

Note: Monetary variables are measured in 1,000 SEK at 2005 prices.

III

The Effect of College Quality on Earnings
Evidence from Sweden

Linda Holmlund
Department of Economics, Umeå University
SE-901 87 Umeå, Sweden

Abstract

This paper examines the effect of college quality on earnings using administrative data on Swedish college students. To consider possible heterogeneity, the effects for men and women are estimated separately and quantile regression is used to determine whether the effect of college quality differs over the income distribution. The overall results suggest that the link between college quality and earnings is weak in Sweden. A small positive effect is found for individuals that are likely to work full time as well as for individuals in the upper part of the income distribution, while negative effects are found for individuals located in the middle and lower parts of the income distribution. Furthermore, controlling for region of work affects the estimated effects, indicating a correlation between choice of college quality and choice of labor market region.

Keywords: College quality, Earnings, Selection on observables
JEL classification: I21, J31

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* I am grateful to Thomas Aronsson, Lena Birkelöf, Marie Gartell, Niklas Hanes, Håkan Regnér, Anders Stenberg, Magnus Wikström, and seminar participants at Stockholm University and the 2008 European Society for Population Economics (ESPE) conference in London for valuable comments and suggestions.

1 Introduction

Several studies have estimated the effect of college quality on earnings and most of them indicate a positive relation. These studies are almost exclusively based on US data. One could expect that the effect of college quality differs depending on the structure of the university system and the conditions on the labor market. This suggests that the US results may not generalize to countries with more centralized university systems.[1] In this paper, we analyze the effect of college quality on students' subsequent earnings in Sweden. The results will contribute to the college quality literature by providing evidence from a country with two distinct characteristics: (*i*) publicly-provided higher education with no tuition fees and (*ii*) a labor market with low wage dispersion.

The US literature on college quality and earnings includes for example Black et al. (2005), Black and Smith (2004, 2006), Monks (2000), Dale and Krueger (2002), and Long (2008). Quality is generally measured by a college's selectivity or by college characteristics that are considered to be correlated with college quality. A common problem confronted in this literature is causality, due to the selection of students into colleges of different qualities. The most common method to address the selection problem is to rely on a selection on observables approach, which is implemented by OLS or by matching. The main result from these studies is that college quality has a positive effect on subsequent earnings. Choice of method does not appear to be of decisive importance for the results.[2] OLS seems to provide the most positive significant results, while matching methods provide estimates of the same size, but with larger standard errors. Evidence for a non-US country is provided by

[1] This is discussed by e.g. Black et al. (2005).
[2] See e.g. Black and Smith (2004) and Long (2008) for a comparison of methods.

Chevalier and Conlon (2003) and Hussain et al. (2009). They use data from the UK and find a positive effect of college quality on wages.

There is a limited Swedish literature related to the effects of college quality, but it focuses on college choice instead of directly conditioning on college quality. In some of these studies, colleges[3] are grouped by age, where older universities are assumed to supply education of higher quality than colleges that were established later. Another approach is to condition on the individual colleges. Recent Swedish contributions in this area include Lindahl and Regnér (2005), Gartell and Regnér (2005), Lundin (2006), and Eliasson (2006a, 2006b).

Lindahl and Regnér (2005) use data on whole siblings to estimate the effect of college choice on subsequent earnings. They find that college graduates from old universities have higher subsequent earnings than college graduates from younger universities. Gartell and Regnér (2005) study the effect on earnings of attending different colleges and find significant effects that can be explained in part by where the individual chose to work after graduation. Lundin (2006) studies a sample of students who graduate from college with a degree in economics or business. He uses a non-parametric regression approach and finds that students who graduate from an old college tend to earn higher initial wages on average than students who graduate from younger colleges. Eliasson (2006a) includes measures of ability and uses OLS to examine the effect on earnings of graduating from five different college groups. In contrast to previous Swedish research, no systematic differences in estimated earnings between the college groups are found. In Eliasson (2006b), propensity score matching is used instead of OLS to estimate the causal effect on earnings of

[3] The terms college and university will be used interchangeably in this paper.

graduating from old universities rather than young universities. No effect of college choice on earnings is found with this method either.

The diverging results in the Swedish studies may be explained by several different factors. The individuals in Lindahl and Regnér are born between 1951 and 1964 while Eliasson uses a sample born between 1969 and 1974 (who graduated during the 1990s). Gartell and Regnér base their study on students who graduated in 1989/90 or 1993/94. This implies that there are large differences in the graduation years between the studies. The students in Gartell and Regnér's study entered the labor market in the first half of the 1990s, a period when Sweden experienced high unemployment. Eliasson's study is based on students who graduated no later than 1998/99. This means that Eliasson includes both students who graduated during a period of high unemployment and students who entered the more favorable labor market in the end of the 1990s. The comparative advantage of studying at an old or selective university could be more important during periods of high unemployment when the employers have a wider selection of applicants to choose from. In periods of low unemployment, employers may not have the same opportunity to sort applicants based on their choice of university. This implies that the different results could be explained by the fact that the effect of college choice differs over the business cycle.

Another possible explanation for the diverging results is that Lindahl and Regnér and Gartell and Regnér may overestimate the effect of college choice due to lack of information about ability. Eliasson includes controls for ability and finds no effect of college choice. In addition, Eliasson aggregates the colleges into two or five groups, based on when they were established. There may be heterogeneous effects within each group, which is hidden by the aggregation. Lastly, Lundin only includes students with a degree in economics

or business. This sample is more homogenous than the other samples, making it difficult to compare the results.

The diverging results from the Swedish studies on the effect of college choice and the lack of European studies on the effect of college quality motivate this study. Even though the results from these previous Swedish studies are often interpreted in terms of college quality, this is the first Swedish study that explicitly studies the effect of college quality itself rather than the effect of studying at different colleges or categories of colleges.[4] Thus, this paper contributes to the existing literature in three ways. First, besides being the first to provide Swedish evidence on the effect of college characteristics on earnings, we contribute to the nearly non-existent European literature on the topic. Since the effect of college quality may differ depending on the university system and/or the labor market structure, evidence from a non-US country is particularly valuable. Second, the data allow us to exclude students who switch universities. Compared to earlier studies, this implies a reduction in the measurement error in college quality. Third, the large number of observations also enables us to consider the heterogeneity among students. Except for some attempts to study men and women separately, the possibility of heterogeneous effects has not been explored in previous studies.

The full sample includes 17,554 students who began studying in 1997 and who received positive earnings in 2005. Our main focus is to estimate the effect of college quality for individuals who are likely to work full time in the outcome year, i.e., we are interested in the effect on productivity rather than on labor supply. To make the estimates more comparable to those obtained when using hourly wages, we follow previous Swedish studies and impose an earnings restriction, which results in a sample of 11,344 individuals. Three college

[4] Lindahl and Regnér (2005) include rate of teachers with a PhD, but their variable is measured with substantial error and they still control for college type.

characteristics that are assumed to be positively correlated with quality will be considered; proportion of teachers with a PhD, teacher/student ratio and grade point average (GPA) from upper secondary school among contemporary college beginners. The variables are introduced both separately and combined into an index. We follow a selection on observables approach to identify the effect of college quality on earnings which is implemented by OLS. The method is motivated by the rich dataset at hand which enables us to control for several variables such as individual characteristics, parental background and college and education history. Ability is measured by GPA from upper secondary school.

We estimate the effect of the individual college characteristics and the college quality index for a sample that consists of both men and women as well as for men and women separately. In addition, we analyze several subsamples as part of a sensitivity analysis. To further consider the heterogeneity of the effect we also estimate quantile regressions on individuals with positive earnings to examine if the effect of college quality differs over the income distribution. The quantile regressions enable us to discuss the impact on labor supply and the implications of the earnings restriction.

The results show that there is a positive effect of college quality on earnings for individuals that are likely to work full time and for individuals in the upper part of the income distribution. Negative effects are found for individuals located in the first half of the income distribution. However, the magnitude of the effects is small, indicating that the link between college quality and earnings is weak in Sweden.

The paper is organized as follows: Section 2 describes institutional background and college quality in Sweden. Section 3 presents the data and Section 4

describes the empirical strategy. The results are presented in Section 5 and concluding remarks are provided in Section 6.

2 Institutional background and college quality

In 2007, there were 322,000 registered students at 50 different state-run or private institutions of higher education in Sweden.[5] Even though the number of educational seats has increased substantially during the last 15 years the demand is still higher than the supply in many fields of study. This implies that the applicants have to be ranked. The ranking procedure is transparent and almost exclusively based on observable factors. The applicants are for the most part ranked by grade point average (GPA) from upper secondary school and scores on the Swedish Scholastic Aptitude Test (SweSAT).[6] It is possible for the colleges to apply other admission criteria, but only for a small proportion of the educational seats.

Financial support for all students is provided by the government and intended to cover living expenses and study material. The study allowance for full time studies amounts to SEK 7,492 per month in 2008 (USD 954)[7], of which one-third is a study grant and two-thirds are study loans.[8] The allowance is independent of parents' or spouse's financial resources but may be reduced for students who earn extra income. There are no tuition fees at Swedish colleges and the provision of higher education is almost entirely public.[9] The public

[5] The statistics are from the Swedish National Agency for Higher Education, referred to as Högskoleverket. See the Swedish National Agency for Higher Education (2008b) for more details on the statistics. For an overview of college education in Sweden, see Öckert and Regnér (2000).
[6] In 1997, applicants with at least five years of work experience had the possibility to add 0.5 points to their SweSAT score and apply in a special category. This possibility disappeared in 2008.
[7] Based on exchange rates in December 2008 (1 USD = 7.86 SEK).
[8] In 1997, when our sample of students began their studies, the corresponding amount was SEK 7,078 per month.
[9] Among the larger providers of higher education in Sweden, the Stockholm School of Economics, Chalmers University of Technology and the University College of Jönköping are run by private sector governing bodies, i.e., they are self-governing and independent.

funding that the institutions of higher education receive for undergraduate education is based on the number of full time equivalent students registered and study achievements (number of study credits obtained by the students). The funding system accounts for the varying per-student cost across disciplines. This implies that, for a given study course, all colleges have the same resources per student.

The central government provides goals and guidelines (mostly financial) while the individual colleges decide on, among other things, the orientation of study programs. The colleges are also responsible for assuring and improving the quality of education. The Swedish National Agency for Higher Education (Högskoleverket) supervises the quality of higher education in Sweden, e.g. by evaluating study programs, appraising the entitlement to award degrees, and auditing the quality assurance procedures at the higher education institutions.[10] The program and degree evaluations consider individual programs, not the whole college. The evaluations are based on a number of criteria, e.g. teaching resources, educational setting, infrastructure, organization and quality assurance of the programs. Some of these criteria are also available in key statistics, while others are more qualitative.

The National Agency for Higher Education adopts a broad perspective when measuring quality, relying on both qualitative and quantitative approaches. The economic literature on college quality has relied on aspects that are easy to quantify and that are likely to capture the latent college quality. Common measures are faculty salaries, net tuition, freshmen retention rate, average SAT scores, teacher/student ratio and rejection rate. Some papers combine information from several quality proxies by factor analysis to produce a quality index.[11] Other studies treat quality as synonymous with selectivity/prestige and

[10] The Swedish National Agency for Higher Education (2008a).
[11] See, e.g., Black et al. (2005), Black and Smith (2006) and Long (2008).

condition on category dummies (selective, less selective). This approach assumes that a more selective college has a higher quality than a less selective college.[12]

According to the results from the National Agency's audits, the quality of higher education in Sweden is largely satisfactory. However, there are large variations between colleges and between different fields of study. For example, in 1997 the proportion year-equivalents performed by teachers with a PhD (measured at college level) ranged from 16 percent to 84 percent. The number of teachers per student varied between 0.02 and 0.21. In addition, since students with higher ability, on average, sort into colleges with higher quality there are also large differences in average GPA.[13]

3 Data and descriptives

The study is based on a dataset of all college students who began studying in spring 1997 or autumn 1997. The dataset is derived from administrative records kept by Statistics Sweden and contains detailed individual data related to college education. The student is followed for up to 12 semesters and the data includes, among other things, registrations per semester, obtained credits per semester, where the student studied each semester, field and level of degree(s) and when the degree(s) are obtained.[14] The dataset also includes information about background characteristics, parental characteristics and school grades.

[12] See e.g. Chevalier and Conlon (2003).
[13] The numbers are own calculations based on the Swedish National Agency for Higher Education (1998). See Table A1 in the Appendix for information about the distribution of quality-related variables over the colleges that are included in our study.
[14] 12 semesters correspond to the maximum number of semesters that a Swedish student can obtain a study allowance.

To control for college quality we include variables that relate to input (proportion of teachers with a PhD, teacher/student ratio) as well as a variable that relates to peer group or selectivity (grade point average from upper secondary school of contemporary college beginners).[15] All measures refer to 1997, i.e. the year that the students began their studies. In accordance with previous studies on college quality, the quality variables are measured on the college level.[16] Using measures on the college level also enables us to compare the results to previous Swedish studies on college choice. Proportion of teachers with a PhD is constructed by dividing number of year-equivalents performed by teachers with a PhD by the number of year-equivalents performed by all teachers. Teacher/student ratio refers to the number of year-equivalents performed by teachers and the number of full time equivalent students.[17]

A new criteria referenced grading system was implemented in compulsory school in 1995 and in upper secondary school in 1994. The criteria referenced grades are on a scale of pass, pass with distinction and pass with special distinction. The old grading system was a norm referenced grading system, with grades between one and five, where five was the highest grade. All students in the dataset have norm referenced grades from compulsory school, while there are some students that have criteria referenced grades from upper secondary school. To make the different grading systems more comparable we use a percentile-rank approach for upper secondary school grades, i.e., we rank the individuals separately in each grading system. This implies that each

[15] The choice of quality variables is guided by previous studies by e.g. Black and Smith (2005) and documents from the Swedish National Agency for Higher Education. A further motivation for the choice of quality variables and a description of how the quality variables enter the equations are found in Section 4.

[16] Table A1 in the Appendix summarizes the colleges included and their respective values for the quality variables.

[17] Proportion of teachers with a PhD and teacher/student ratio are obtained from the Swedish National Agency for Higher Education, see the Swedish National Agency for Higher Education (1998).

student receives a rank between 0 and 100, depending on their ranking relative to the other students. The quality variable GPA of contemporary college beginners refers to the 50th percentile of percentile-ranked grades among college beginners at each college.[18]

The outcome variable, earnings, is measured in 2005 and corresponds to annual earnings from labor (log).[19] We will follow a selection on observables strategy for identification and the empirical strategy will be further explained in Section 4. However, this strategy requires that we observe all variables affecting both the treatment (quality) and the outcome (log earnings). The choice of control variables are based on economic theory and previous research and include basic information about the student (age, sex and children), parental background (age, level of education and origin), college education (field, number of credits and degree) and GPA in upper secondary school.

Earlier studies of the effect of college quality have based the college classification on the first or the last college that the student attended.[20] This necessarily implies a measurement error for all students that switch colleges during their study period (a fairly large group[21]). To eliminate this source of measurement error in college quality, we exclude students who have switched colleges. This means that we can be certain that all students in the sample are matched to the correct quality measure, i.e., we do not introduce measurement error due to incorrect matching of students and college quality. The dataset

[18] Grade point average of contemporary students is derived from the dataset from Statistics Sweden.
[19] The use of a cross-section approach instead of a panel approach is determined by the data at hand. However, Black and Smith (2005) show that their cross estimates of the effect of college quality on log wages are stable over time and that the advantage of using panel data is negligible.
[20] Long (2008) uses the first college that the student attended, Black and Smith (2005) use the last college.
[21] Holmlund and Regnér (2009) find that about one-third of Swedish college entrants study at more than one college.

includes 30,281 students who began studying in 1997 and who only studied at one college. Previous studies on higher education have focused on students who have obtained a degree. However, a large fraction of Swedish students leave college without a degree. In our data, as much as 36 percent did not obtain a degree before 2005. These students do not necessarily drop out, some fulfill the requirements for a degree but have not formally applied for the degree certificate. Therefore, we include both students who have a degree as well as students who have no degree, and include controls for degree attainment and number of credit points.

We assign to each student a college classification based on the college that he or she attended. Students from 26 different colleges are included and the inclusion of colleges is based on college size and earlier Swedish studies on college choice.[22] Some students are excluded due to missing values, predominantly in the variables referring to grades.[23] In addition, some are excluded due to missing variables in parental background. We only consider individuals with positive earnings in 2005, i.e., individuals with zero earnings are excluded.[24] The remaining sample consists of 17,554 individuals.

To be able to estimate the effect of college quality on productivity, a measure of hourly wages is preferred. Unfortunately, since our information about earnings is based on tax records, we only have information about annual earnings. Annual earnings consist of both hourly wages and working hours, implying that the outcome is a combination of both productivity and labor supply choices. One way to reduce the effect of unemployment and labor supply choices is to impose an earnings restriction. Previous Swedish studies

[22] See Table A1 in the Appendix for a list of included colleges. 706 observations are deleted due to their college classification. Students from Stockholm School of Economics are not part of the initial data set due to their use of a different reporting system than the other major colleges.
[23] Grades from upper secondary school are only available for students who left upper secondary school in 1990 or later. This reduces the sample by 10,048 observations.
[24] Requiring positive earnings reduces the sample by 1,319 observations.

on the effect of college choice apply an earnings restriction corresponding to SEK 100,000 per year (see e.g. Eliasson, 2006a, 2006b; Gartell and Regnér, 2005; Lindahl and Regnér, 2005). They rely on Antelius and Björklund (2000) who argue that this level of restriction produces estimates similar to those obtained when using hourly wages. However, Antelius and Björklund estimated the effect of education on earnings for the outcome year 1990. A simple adjustment to 2005 prices and wage level would require an increase in the earnings restriction by around 40 percent. In addition, other aspects from this earlier study are likely to differ from this study (e.g. the income distribution or the composition of the sample).

In order to estimate the effect of college quality for those who have a full time job we choose a higher earnings restriction of SEK 200,000. This restriction corresponds to a monthly salary of SEK 16,666 which is a relatively low salary in a Swedish perspective. By imposing a higher earnings restriction the sample will consist primarily of individuals who actually have a job and who are working full time. Thus, the estimates are more likely to capture the effects on hourly wages, i.e., they will reflect productivity rather than labor supplies. This earnings restricted sample consists of 11,344 individuals.

The choice of earnings restriction is not trivial and it may affect the result. To assess the importance of the chosen level, the models are also estimated with a lower earnings restriction of SEK 150,000. This restriction is closer to the Antelius and Björklund restriction, but adjusted to 2005 years wage level. The results from this sample are only briefly discussed. However, the implications of the earnings restriction will also be further investigated in the quantile regressions in Section 5.3.

Table 1 reports descriptive statistics for the earnings restricted sample. Mean annual earnings from labor are approximately SEK 302,000. About 43 per cent

Table 1: Descriptives

Sample: Earnings restriction	>200,000			
	Mean	Std	Min	Max
Annual earnings in 2005 (100 SEK)	3,016	794	2,001	27,782
Women, %	42.7			
Age in 2005	29.1	2.1	26	57
Children, ages 0-3, 2005	0.20	0.47	0	3
Children, ages 4-6, 2005	0.04	0.22	0	3
Children, ages 7-10, 2005	0.02	0.15	0	3
Children, ages 11-15, 2005	0.01	0.12	0	3
GPA upper secondary, percentile rank	49.0	29.2	0.02	99.9
No degree in 2005, %	36.2			
Number of credits	135	62.7	0.5	414
Field of study, %				
Education	2.2			
Humanities	7.6			
Social science	24.5			
Natural science	17.6			
Technology	30.0			
Agriculture	0.38			
Health care	10.1			
Service and transports	3.9			
Unknown/other	3.8			
Parents' characteristics				
Mother from Sweden, %	93.3			
Father from Sweden, %	93.1			
Mother's age 2005	56.9			
Father's age 2005	59.4			
Mother education, missing , %	3.0			
Mother compulsory, %	22.3			
Mother upper secondary, %	35.6			
Mother college education, %	38.8			
Mother graduate work, %	0.32			
Father education, missing, %	5.8			
Father compulsory school, %	26.0			
Father upper secondary school, %	32.8			
Father college education, %	33.6			
Father graduate work, %	1.8			
College characteristics				
Proportion of teachers with a PhD	0.48	0.20	0.16	0.84
Teacher/student ratio	0.06	0.02	0.02	0.21
Percentile ranked GPA among contemporary students at the same college (p50) (/100)	0.49	0.12	0.31	0.72
Quality index	2.18	1.50	0	7.78
Number of observations	11,344			

are women and 36 percent have not obtained a college degree. Technology, social sciences and natural sciences are the most popular fields of study. Information about parental background shows that approximately 7 percent have a mother or a father that were not born in Sweden. The descriptives also show that 39 percent have a mother with college education or higher and 35 percent have a father with college education or higher.

The descriptives for the non restricted sample (where positive earnings are required for inclusion) are found in Table A2 in the Appendix. The mean values are similar with some exceptions. Since no earnings restriction is imposed, this sample has lower mean annual earnings and a larger proportion of women. A substantially smaller proportion is studying technology, while a slightly larger proportion studies humanities and health care. Finally, the distribution of the quality variables is similar in the two samples.

4 Empirical strategy

We assume that students choose colleges of different qualities based on a belief that the chosen college will raise their discounted lifetime utility more than any other college. The individual's college choice is restricted by the college's available slots, i.e. the individual is also selected by the college. This implies that students are not randomly sorted into colleges of different qualities and that estimating the effect of college quality must deal with selection bias. Non-random selection bias will arise if students choose the quality of a college (or if "quality chooses them") based on the characteristics that also determine expected outcomes. Positive selection is expected where better students sort into colleges of higher quality.

If students sort into colleges non-randomly, selection bias may arise because of the dependence between Q_i and ε_i so that $E(\varepsilon_i | Q_i, X_i) \neq 0$. The selection on observables strategy deals with this problem by assuming that the dependence between Q_i and ε_i is due to observed variables, Z_i. The observable selection variables influence what college quality that the student select and by controlling for them, the selection bias is removed. An earnings equation based on this approach can thus be written

$$\ln Y_i = \alpha + X_i \beta + Q_i \gamma + Z_i \varphi + \varepsilon_i$$

This approach relies on the rather strict assumption that everything that affects both the choice of college quality and the outcome is included in X_i and Z_i. However, when a rich dataset is available, the assumption is less problematic. In our case, the dataset includes a large number of variables that are likely to affect both choice of college quality and earnings, e.g. parental characteristics and grades. In addition, the Swedish college admission procedure is mainly based on observable characteristics of the students. The institutional setting and the rich data set at hand make it plausible to adopt the selection on observables approach. However, when interpreting the results one must always have in mind the possibility that not all bias has been removed. We would expect the college quality effect to be biased upwards by omitted variables, while measurement errors in college quality are expected to bias the effect towards zero.

When implementing the selection on observables assumption in practice, the literature proposes two main methods: regression and matching. One advantage of matching is that it does not impose the linear function form like the regression model does. In addition, matching makes it possible to examine the support condition. However, matching requires discrete groups for comparison, which demands a transformation of the continuous quality

variables into binary or multinomial measures. This transformation results in a loss of information. In addition, regression is more efficient and less complicated to apply.[25] Previous studies also show that the choice of method does not affect the results that much.[26] To avoid losing information, and because of the simplicity of the method, the regression technique is preferred in the present study.[27]

According to Black and Smith (2006), it is not enough to rely on one proxy for quality. College quality is multi dimensional and one single proxy of quality may measure quality with error and introduce bias. Therefore, to capture the effect of quality, three different college characteristics are considered: proportion of teachers with a PhD, teacher per student ratio and grade point average from upper secondary school among contemporary students. These characteristics include both variables that relate to input (proportion of teachers with a PhD, teacher/student ratio) and a variable that relate to peer group or selectivity (grade point average of contemporary students). We recognize that it is difficult to find correct and exact measures of college quality, but argue that these measures are likely to be highly correlated with college quality. In addition, the measures included in the present study are also used in previous studies on the effect of quality on earnings in the US and are further motivated by the fact that they are used in the Swedish National Agency of Higher Education's evaluations of college quality.[28]

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[25] For a more detailed description of matching methods; see, e.g. Heckman et al. (1998) and Imbens (2004).

[26] See e.g. Black and Smith (2004) and Black et al. (2005). Long (2008) finds some evidence of positive selection bias in the OLS results, but that the three alternative methods (the approach proposed by Dale and Krueger (2002), instrumental variables and matching) rarely produce findings that are significantly different from the OLS results.

[27] An alternative to the selection on observables approach is to employ the traditional instrumental variable method. However, it is well known that it is difficult to find valid instruments for education variables. In our case, we have not found any variable that has a significant direct effect on college quality in combination with no effect on earnings. Thus, the instrumental variable technique is not possible to use in the present study.

[28] See, e.g., Black et al. (2005), Black and Smith (2006), Long (2008), and the Swedish National Agency for Higher Education (2008a).

Quality enters the model both as separate variables and as an index. First, we utilize separate college characteristics and estimate the effect of those quality variables using OLS. Since some of the quality variables are highly correlated (see Table A3 in the Appendix), the models are estimated with one quality variable at a time.[29] Control variables are added in different steps, and separate analyses are performed for men and women. Second, a quality index is constructed using the first principal component from a principal component analysis.[30] This index combines the information in the three quality variables into one single measure. The index is included in the equations which are then estimated by OLS.

When using OLS, we model the relationship between our covariates, X, and the conditional mean of our response variable Y (earnings) for a given value of the explanatory variable x. To consider if the effect of college quality varies over the income distribution, we also employ quantile regressions. Originally, Koencker and Basset (1978) suggested quantile regressions as a more robust alternative to OLS.[31] Quantile regression models the relationship between X and the conditional quantiles of Y (for a given x), instead of the conditional mean of Y. Any quantile can be chosen (in our case we use deciles). Quantile regressions have several advantages over OLS. For example, the quantile regression estimator gives less weight to outlier data points of the outcome variable, decreasing the impact such observations may have on the result. In addition, it relaxes the restrictions on the parameters to be constant across the

[29] Table A4 in the Appendix presents the results from OLS regressions when adding all three quality variables at the same time and as a comparison, also the results when introducing them separately into the estimations. The results show that when including them separately (without other covariates), all three have a positive and significant effect on earnings, while when jointly including them only one of them has a positive and significant estimate, the other two are negative and insignificant.

[30] The index is constructed in a similar way as in Black and Smith (2004). The constructed index results in a ranking of colleges that corresponds to our a priori expectations of college quality. For example, the old colleges receive a higher ranking than the more recently established colleges.

[31] The idea behind quantile regression is formally described in Koenker and Basset (1978) and Koenker and Hallock (2001). An application to returns to schooling is provided by Buchinsky (1994).

entire distribution of the dependent variable. In our setting, this is a main advantage since we are interested in whether the earnings restriction affects the result, i.e., if the parameters differ over the distribution.

5 Results

Tables 2-4 present the results for the individual quality variables while Table 5 presents the results for the quality index. To be able to interpret the estimated effect as an effect of college quality on productivity/wages, the analysis will only consider individuals who reported annual earnings above 200,000 SEK in 2005 (corresponding to a monthly salary of about 16,666 SEK). The three quality variables and the index have been introduced separately in the models, i.e., every model has been estimated four times. There are six different specifications. The first specification includes the quality variable and a constant, while specification two adds basic characteristics (sex, age, age squared and children). Specification three also includes parental characteristics (parents level of education, their ages and if they are born in Sweden) and the forth specification adds college education information (field of study, obtained credits and if the student has obtained a degree). The fifth specification adds the student's GPA from upper secondary school to the previous information and this specification is our baseline specification which is used in the quantile regressions and in the sensitivity analysis.

Region of work could be an important determinant of earnings due to, e.g., regional differences in wage levels. The effect of college quality could be biased if students end up at labor markets with different income levels based on which college quality they received. To consider this, we also estimate a sixth model which adds controls for region of work to specification 5. However, since it is questionable to condition on covariates that may be

determined by college quality, it is not obvious to include region of work and specification 5 is still our preferred model.

5.1 OLS estimates

Let us start by considering specification 1-5, i.e. the specifications that do not include region of work. The results for the quality variable Proportion of teachers with a PhD are presented in Table 2. The effect of Proportion of teachers with a PhD is positive and significant for specification 1-5. The effect decreases as more controls are added and for the baseline specification 5 the estimate is relatively small. Comparable results are found for GPA of contemporary college beginners in Table 3. The effect of GPA of contemporary college beginners is positive and significant but small. The results for Teacher/student ratio is presented in Table 4. The effect of Teacher/student ratio is weaker than the effect of the other two quality measures. When only including Teacher/student ratio, and when adding basic controls, the effect is positive and significant but if we add college education controls, the positive effect disappears. However, the less significant results for Teacher/student ratio are not surprising, since the variation is much smaller in that quality indicator.

The Quality index combines the information in the three separate college characteristics into one single variable. Table 5 shows the results for the Quality index. The result of the Quality index is similar to Proportion of teachers with a PhD and GPA of contemporary college beginners, i.e., there is a small positive and significant effect on annual earnings for all specifications. The size of the estimated effect decreases as more controls are added. To consider if the results for the Quality index are driven by one of the quality variables, we have also constructed indexes that combine only two college

Table 2: The effect of Proportion of teachers with a PhD on annual earnings

	(1)	(2)	(3)	(4)	(5)	(6)
Earnings restriction (1000 SEK)	>200	>200	>200	>200	>200	>200
Basic controls	no	yes	yes	yes	yes	yes
Parental controls	no	no	yes	yes	yes	yes
College education controls	no	no	no	yes	yes	yes
GPA	no	no	no	no	yes	yes
Region of work	no	no	no	no	no	yes
Prop of teachers with a PhD	0.100*** (0.011)	0.100*** (0.010)	0.081*** (0.011)	0.086*** (0.011)	0.062*** (0.011)	0.018 (0.011)
Adj. R^2	0.008	0.083	0.089	0.121	0.130	0.178

Note: The number of observations is 11,344. The dependent variable is log earnings in 2005. All regressions include a constant term. **Basic controls** include controls for sex, age, age squared and number of children in four different age categories. **Parental controls** include dummy variables indicating whether the parent is born in Sweden, parents' level of education and parents' ages. **College education controls** include credits, dummy variables for field of study and a dummy variable indicating no college degree. **GPA** is percentile ranked grade point average from upper secondary school. **Region of work** includes dummy variables for region of work. Standard errors are reported in parentheses. ***, ** and * indicate significance on the one, five and ten percent level respectively. Complete results from the regressions are available from the author by request.

Table 3: The effect of GPA of contemporary college beginners on annual earnings

	(1)	(2)	(3)	(4)	(5)	(6)
Earnings restriction (1000 SEK)	>200	>200	>200	>200	>200	>200
Basic controls	no	yes	yes	yes	yes	yes
Parental controls	no	no	yes	yes	yes	yes
College education controls	no	no	no	yes	yes	yes
GPA	no	no	no	no	yes	yes
Region of work	no	no	no	no	no	yes
GPA of contemporary college beginners	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.001*** (0.000)	0.000 (0.000)
Adj. R^2	0.010	0.085	0.091	0.122	0.130	0.175

Note: The number of observations is 11,344. The dependent variable is log earnings in 2005. The models are explained in Table 2. Standard errors are reported in parentheses. ***, ** and * indicate significance on the one, five and ten percent level respectively. Complete results from the regressions are available from the author by request.

Table 4: The effect of Teacher/student ratio on annual earnings

	(1)	(2)	(3)	(4)	(5)	(6)
Earnings restriction (1000 SEK)	>200	>200	>200	>200	>200	>200
Basic controls	no	yes	yes	yes	yes	yes
Parental controls	no	no	yes	yes	yes	yes
College education controls	no	no	no	yes	yes	yes
GPA	no	no	no	no	yes	yes
Region of work	no	no	no	no	no	yes
Teacher/student ratio	0.401*** (0.095)	0.388*** (0.092)	0.291*** (0.092)	0.155 (0.095)	0.027 (0.095)	-0.033 (0.093)
Adj. R^2	0.002	0.077	0.085	0.116	0.127	0.175

Note: The number of observations is 11,344. The dependent variable is log earnings in 2005. The models are explained in Table 2. Standard errors are reported in parentheses. ***, ** and * indicate significance on the one, five and ten percent level respectively. Complete results from the regressions are available from the author by request.

Table 5: The effect of the Quality index on annual earnings

	(1)	(2)	(3)	(4)	(5)	(6)
Earnings restriction (1000 SEK)	>200	>200	>200	>200	>200	>200
Basic controls	no	yes	yes	yes	yes	yes
Parental controls	no	no	yes	yes	yes	yes
College education controls	no	no	no	yes	yes	yes
GPA	no	no	no	no	yes	yes
Region of work	no	no	no	no	no	yes
Quality index	0.014*** (0.001)	0.013*** (0.001)	0.011*** (0.001)	0.011*** (0.001)	0.007*** (0.001)	0.001 (0.001)
Adj. R^2	0.008	0.083	0.090	0.121	0.129	0.175

Note: The number of observations is 11,344. The dependent variable is log earnings in 2005. The models are explained in Table 2. Standard errors are reported in parentheses. ***, ** and * indicate significance on the one, five and ten percent level respectively. Complete results from the regressions are available from the author by request.

characteristics. Including these indexes in the models yield similar results as the three-variable index and does not add to the analysis.[32]

To assess the importance of the income restriction, the models are also estimated with a lower earnings restriction corresponding to 150,000 SEK.[33] The results are in the same direction, positive and significant for specification 1-5, but the estimates are somewhat smaller than for the higher earnings restriction. This indicates that college quality has a more positive effect for individuals in the higher income groups than for individuals with lower earnings. The impact of the earnings restriction will be further investigated in the quantile regressions in Section 5.3.[34]

The overall pattern from Table 2-5 shows that college quality has a positive effect on subsequent earnings for individuals who are established on the labor market eight years after they began their college studies. However, the estimated effects are small. If we consider the estimates of specification 5 in Table 5, increasing the quality index by one standard deviation, results in a 1 per cent increase in annual earnings from labor. At mean value of the outcome variable, this corresponds to 251 SEK per month, which is a small reward for a rather large increase in quality.[35] The significance tests of the estimates show that the effect is larger than zero, but the economic value is negligible.

If students who attend colleges of different qualities also sort into different labor markets, and we fail to control for region of work, the effect of college

[32] The results from this sensitivity analysis are found in Table A5 in the Appendix.
[33] The results are not reported here, but could be obtained from the author on request.
[34] We have also estimated specification 5 for a sample with no earnings restriction where only positive earnings are required. When including all individuals with positive earnings, all four quality variables have a negative effect on annual earnings. However, since analyzing the impact of college quality on labor supply lies beyond the aim of this paper this result will not be explored further.
[35] For readers familiar with Swedish colleges, the magnitude of a standard deviation increase in the quality index corresponds to moving from Mälardalen College to Luleå University or from Luleå University to Lund University.

quality could be biased. Therefore, a model which includes region of work has also been estimated. The results are presented in Table 2-5, and correspond to the sixth specification. When including region of work, the positive effect of college quality disappears. The estimate is insignificant for all quality variables, and for Teacher/student ratio it even changes signs. This result implies that the positive effect of college quality could be influenced by the individuals' choice of region to work in. If students from colleges of high quality are more likely to be working in labor market regions with high wage levels, and we fail to include controls for region of work, we may overestimate the effect of college quality. However, since region of work may be endogenous in the earnings equation it is not obvious that it is correct to control for region of work and the results should be interpreted with caution.

5.2 Separate estimates for men and women

The large data set at hand enables us to consider the possible heterogeneity of the effect of college quality. The effect of college quality is not necessarily constant, i.e., the effect could be different for different groups of students. For example, studies based on US data have found that the effect of college quality is weaker for women than for men.[36] Earlier Swedish studies reveal a similar pattern for the effect of college choice, i.e., the effect of college choice is stronger for men than for women.[37] To see if the effect of quality differs by gender, we run separate regressions for women and men. Estimates for specification 5 and 6 are reported. The results are presented in Table 6-9.

[36] See e.g. Black et al. (2005).
[37] See e.g. Gartell and Regnér (2005).

Table 6: The effect of Proportion of teachers with a PhD for women and men

	Women		Men	
	(5)	(6)	(5)	(6)
Earnings restriction 1,000 SEK)	>200	>200	>200	>200
Basic controls	yes	yes	yes	yes
Parental controls	yes	yes	yes	yes
College education	yes	yes	yes	yes
GPA	yes	yes	yes	yes
Region of work	no	yes	no	yes
Proportion of teachers with a PhD	0.054*** (0.014)	0.026* (0.014)	0.061*** (0.016)	0.005 (0.016)
Adj. R^2	0.131	0.179	0.057	0.104
Number of observations	4,842	4,842	6,502	6,502

Note: The dependent variable is log earnings in 2005. All regressions include a constant term. **Basic controls** include controls for age, age squared and number of children in four different age categories. **Parental controls** include dummy variables indicating whether the parent is born in Sweden, parents' level of education and parents' ages. **College education controls** include credits, dummy variables for field of study and a dummy variable indicating no college degree. **GPA** is percentile ranked grade point average from upper secondary school. **Region of work** includes dummy variables for region of work. Standard errors are reported in parentheses. ***. ** and * indicate significance on the one, five and ten percent level respectively. Complete results from the regressions are available from the author by request.

Table 7: The effect of GPA of contemporary college beginners for women and men

	Women		Men	
	(5)	(6)	(5)	(6)
Earnings restriction (1,000 SEK)	>200	>200	>200	>200
Basic controls	yes	yes	yes	yes
Parental controls	yes	yes	yes	yes
College education	yes	yes	yes	yes
GPA	yes	yes	yes	yes
Region of work	no	yes	no	yes
GPA of contemporary college beginners	0.001*** (0.000)	0.000 (0.000)	0.001*** (0.000)	0.000 (0.000)
Adj. R^2	0.131	0.176	0.058	0.104
Number of observations	4,842	4,842	6,502	6,502

Note: The dependent variable is log earnings in 2005. The models are explained in Table 6. Standard errors are reported in parentheses. ***, ** and * indicate significance on the one, five and ten per cent level respectively. Complete results from the regressions are available from the author by request.

Table 8: The effect of Teacher/student ratio for women and men

	Women		Men	
	(5)	(6)	(5)	(6)
Earnings restriction (1,000 SEK)	>200	>200	>200	>200
Basic controls	yes	yes	yes	yes
Parental controls	yes	yes	yes	yes
College education	yes	yes	yes	yes
GPA	yes	yes	yes	yes
Region of work	no	yes	no	yes
Teacher/student ratio	-0.001	-0.030	0.006	-0.084
	(0.117)	(0.114)	(0.145)	(0.142)
Adj. R^2	0.128	0.178	0.005	0.104
Number of observations	4,842	4,842	6,502	6,502

Note: The dependent variable is log earnings in 2005. The models are explained in Table 6. Standard errors are reported in parentheses. ***, ** and * indicate significance on the one, five and ten percent level respectively. Complete results from the regressions are available from the author by request.

Table 9: The effect of the Quality index for women and men

	Women		Men	
	(5)	(6)	(5)	(6)
Earnings restriction (1,000 SEK)	>200	>200	>200	>200
Basic controls	yes	yes	yes	yes
Parental controls	yes	yes	yes	yes
College education	yes	yes	yes	yes
GPA	yes	yes	yes	yes
Region of work	no	yes	no	yes
Quality index	0.006***	0.002	0.007***	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Adj. R^2	0.130	0.179	0.057	0.104
Number of observations	4,842	4,842	6,502	6,502

Note: The dependent variable is log earnings in 2005. The models are explained in Table 6. Standard errors are reported in parentheses. ***, ** and * indicate significance on the one, five and ten percent level respectively. Complete results from the regressions are available from the author by request.

In contrast to previous studies, the results do not support that men and women have different returns to college quality. For the preferred model, specification 5, the estimates for women and men are similar with some exceptions. The estimates for Proportion of teachers with a PhD, GPA of contemporary college beginners and the Quality index are all positive and significant and of the same size. This indicates that both men and women have a positive effect of college quality, but the effect is very small. Teacher/student ratio differs, with a negative estimate for women while the estimate for men is positive, but none of these estimates are significantly determined. If we turn to specification 6 where region of work is included in the model, all estimates become much smaller, some even turn negative, but besides Proportion of teachers with a PhD for women, all become insignificant. This suggests that both men and women sort into labor markets based on college quality.

5.3 Quantile analysis

The effect of college quality could also vary depending on the student's position in the income distribution. For example, if labor supply decisions are affected by college quality, e.g. if students that have been exposed to a certain quality level are more likely to choose part time work, we would expect heterogeneous effects of college quality on earnings. In addition, if employers recruit students for top positions from top quality colleges, students in the highest part of the income distribution may have a stronger effect of college quality than students in the lower parts. To explore this heterogeneity, quantile regressions have been performed. Since the purpose of the quantile regressions is to explore whether there are differences in the effect of college quality over the income distribution, we include all individuals with positive earnings from labor in 2005, i.e., we use a larger sample than in the earlier estimations where an income restriction was applied. The estimated model corresponds to the

fifth specification, i.e., we control for GPA, but not for region of work. The results are presented in Table 10.

The quantile regressions show that the effect of college quality differs substantially depending on what conditional quantile of the outcome variable that we choose to estimate. Up to the 60th percentile, there is a significant and negative effect of college quality. The effect becomes less negative over the distribution. For the 70th and 80th percentile, there is no effect of college quality, but at the 90th percentile, college quality has a positive and significant effect. When considering the sub samples of men and women, we find diverging results. In the first half of the distribution, the effect is similar, both in magnitude and significance. College quality has a negative and significant effect, both for men and women, with slightly larger negative estimates for men in the bottom percentile. However, if we consider the top percentiles, the results show that the positive effect found for the whole sample was driven by a positive effect of college quality for women. Women have a positive effect of college quality, both in the 80th and the 90 percentile. For men, the effect is negative for all percentiles, but it is not significant in the second half of the earnings distribution.

The quantile regressions reveal that the effect of college quality differs over the earnings distribution, with negative effects in the first half of the distribution and small positive or no effects in the second half of the distribution. Since earnings are a combination of wage and labor supply, the negative estimates in the bottom percentiles are likely to be heavily influenced by differences in labor supplies. There are several reasons to why an individual have low earnings or a low labor supply. The individual could be unemployed or be working part time. Other possible explanations are periods of parental leave or sick leave. Some of these explanations may be correlated with college quality and bias the estimates. Since the effect of college quality on labor

Table 10: Quantile regression estimates of the effect of college quality on earnings

	All	Women	Men
Income percentile	Quality index estimate	Quality index estimate	Quality index estimate
p10	-0.102***	-0.102***	-0.140***
	(0.017)	(0.020)	(0.023)
p20	-0.061***	-0.068***	-0.071***
	(0.009)	(0.014)	(0.010)
p30	-0.033***	-0.031***	-0.029***
	(0.006)	(0.007)	(0.005)
p40	-0.016***	-0.014***	-0.015***
	(0.004)	(0.004)	(0.004)
p50	-0.008***	-0.008***	-0.006**
	(0.002)	(0.003)	(0.003)
p60	-0.004**	-0.002	-0.001
	(0.002)	(0.003)	(0.003)
p70	-0.000	0.000	-0.003
	(0.002)	(0.003)	(0.002)
p80	0.002	0.007**	-0.001
	(0.002)	(0.003)	(0.002)
p90	0.005*	0.008**	-0.003
	(0.003)	(0.003)	(0.004)
Number of observations	17,554	8,954	8,600

Note: The dependent variable is log earnings in 2005. Only individuals with positive earnings are included. All regressions include a constant term, basic, parental and college education controls and GPA. **Basic controls** include controls for sex (excluded for the sub samples of men and women), age, age squared and number of children in four different age categories. **Parental controls** include dummy variables indicating whether the parent is born in Sweden, parents' level of education and parents' ages. **College education controls** include credits, dummy variables for field of study and a dummy variable indicating no college degree. **GPA** is percentile ranked grade point average from upper secondary school. Bootstrap standard errors are reported in parentheses. ***, ** and * indicate significance on one, five and ten percent level respectively

supplies are beyond the scope of this paper, we will not explore this result further. In addition, to understand the impact of college quality on labor supply, a more in dept study that focus on employment and labor market attachment is required.

The results also indicate that college quality is a more important factor for women who reach highly paid positions than for men in the same positions.

These results are conditioned on the individuals GPA, i.e., the positive effect of college quality for women are not likely to be driven by ability sorting. One bold explanation to the difference between men and women may be that women need a signal of competence and ability to be considered for highly paid positions by the employers while men could have a great career regardless of the quality of their education. This explanation is related to women's, on average, weaker position on the labor market, with lower paid jobs and less career opportunities. Another explanation could be that career oriented women, to a larger extent than career oriented men, attend high quality colleges. This unobserved motivation and career focus are not necessarily captured by GPA and the estimates for the highest percentiles for female students could therefore be biased upwards. However, even though a statistically significant effect of college quality is found for women in the highest income percentiles, the economic significance is small and the results should be carefully interpreted.

The results from the quantile regressions also illustrate the implications of the earnings restriction. Obviously, the level of the earnings restriction affects the results. Since the focus in this paper is to capture the effect of college quality on wages/productivity rather than on labor supply, a rather high earnings restriction was imposed. Choosing a lower earnings restriction may produce insignificant estimates while choosing no restriction may result in a negative effect. The quantile regressions also show that there are different effects in different parts of the income distribution, implying that the effect on wages/productivity may differ from the effect on earnings/labor supply.

5.4 Sensitivity analysis

As a sensitivity analysis we have divided the earnings restricted sample into several sub samples to see if there are some groups that are driving the results. The samples are based on parental background, position in the GPA

distribution and fields of degree. The results are found in Table A6-A8 in the Appendix.

Let us start with the sub samples based on parental background. Two samples were formed, one with individuals who had no college educated parents, one with individuals with at least one college educated parent. The results for specification 5 are almost identical for the two groups, indicating that college quality has a similar effect for these two groups of individuals. In addition, the result implies that the unobserved preferences that are related to parental background are not influencing the results.

The second sub samples were constructed based on the individual's position in the GPA distribution and specification 4 is estimated, i.e. we do not control for the individuals GPA. Individuals with higher GPA appear to have a larger positive effect of college quality and for the individuals with the highest GPA, the effect remains even after controlling for region of work. However, students in the highest GPA group are to a large extent attending colleges of high quality and consequently, these estimates are difficult to interpret. In addition, the estimates are relatively small and the economic significance questionable.

In the main samples, both students who obtain a degree and students who end their studies without a degree are included. The controls for field of studies are based on the last course that the student obtains credits for. This is, of course, not a perfect measure of an individual's field of study. However, we have perfect information about field of degree for students who obtain a degree. To see if the effect of college quality varies by field, we estimate specification 5 (without the field controls) for seven sub samples, based on what field the individual has obtained the degree in. The results indicate that the effect of college quality differs by field of study. For individuals with a degree in technology or medicine/social work, college quality has a positive effect, while

it has a negative effect for individuals with a degree in teaching or science. All significant effects, except for science, disappear when adding controls for region of work.[38] However, as for the other estimations, the effects are small. The diverging results for different fields also emphasize the need of field specific quality variables. If college quality varies within colleges, using average values per college introduces bias when students are matched to a quality level that most likely are measured with error.

6 Concluding remarks

The purpose of this paper was to estimate the effect of college quality on students' subsequent earnings in Sweden. The analysis provides some interesting results. First, when only including students who have annual earnings above 200,000 SEK, i.e., individuals who are established at the labor market, college quality has a significantly positive effect. However, the estimates are relatively small, and the economic significance is questionable. When considering women and men separately, similar effects are found. But once again, the effects are very small. A quantile regression analysis was performed to consider if the effect of college quality differs over the income distribution. The analysis showed that college quality has a negative effect in the lower part of the income distribution, while it has a positive effect in the upper part. Separate quantile regressions for men and women showed that men have a negative effect of college quality over the whole distribution, even though the effect is not significant in the upper half. Women on the other hand have a small positive effect in the top percentiles. The quantile regressions provide weak evidence on that women and men gain differently from college quality. A sensitivity analysis also shows that the effect of quality differs by field of study, but not by parental background. The small positive effect of

[38] This result is not reported in Table A8 but is available from the author on request.

college quality is, at least partly, explained by where the individual choose to work after leaving college. There appears to be a sorting of students from high quality colleges to labor market regions with higher income levels, or regions with better possibilities for full time work.

Earlier Swedish studies have estimated the effect of attending different colleges. The results have been diverging, some find an effect of college choice (e.g. Gartell and Regnér, 2005; Lindahl and Regnér, 2005), others find no effect of college choice (Eliasson, 2006a, 2006b). This study confirms the conclusions in Eliasson's studies. College quality and consequently, college choice are not major determinants for students' subsequent earnings in Sweden. What appears to matter more is who you are (ability) and what you study (fields) while the link between college quality and earnings is weak.

The results also indicate a less positive effect than comparable US studies. The US studies mainly find a positive effect of college quality while this analysis finds a positive, but economically insignificant effect on an outcome comparable to wages, and even a negative effect in the lower part of the income distribution. Why does not college quality matter for students' future earnings/wages in Sweden? One explanation could be that the quality variables are measured with error or that they do not capture college quality. However, the US studies use similar quality variables, indicating that measurement error in quality could not be the main reason for the diverging results. A more likely explanation is related to the structure of the university systems and labor markets in the two countries. Higher education in Sweden is mainly publicly provided and the same amount of resources per student is allocated to a given course regardless of which college that provides the education. This implies that all courses in a given field may have similar quality. Even though descriptives show that the quality variables used in this study vary much between colleges, quality audits performed by the National Agency of Higher

Education also indicate that the overall quality is satisfactory. If employers believe that the college quality in Sweden does not differ much and in addition, are relatively high on average, they have less incentive to discriminate wages by college quality. Another possible explanation is that the relatively compressed Swedish wage structure does not give any room for employers to award college quality.

Further research is necessary to explore the importance of college quality. More studies on the heterogeneity of the effect are needed, as well as more evidence from European countries. Exploring if other college characteristics, than the ones included in this study, work as quality indicators, as well as introducing a quality production function are important policy related topics for future research. In addition, including field specific quality variables, to decrease the measurement error in quality that is introduced by using average values per college, is another interesting exercise. It would also be interesting to further investigate the impact on labor supplies by considering other outcomes than earnings, e.g., unemployment and establishment on the labor market.

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Appendix

Table A1: College characteristics

College	Percentage of total students[a]	Proportion of teachers with a PhD	Teacher/ student ratio	Ranked GPA contemporary students (p50)
Lund	8.8	0.69	0.07	57.53
Göteborg	6.0	0.58	0.07	57.53
Stockholm	5.2	0.64	0.05	64.73
Uppsala	7.2	0.72	0.07	60.59
Umeå	7.5	0.65	0.08	44.25
Linköping	9.2	0.45	0.09	58.33
Mid Sweden	5.9	0.24	0.05	31.31
Royal Institute of Technology (KTH)	5.4	0.59	0.08	55.03
Mälardalen	3.7	0.26	0.06	32.52
Örebro	4.0	0.26	0.05	46.43
Luleå	4.4	0.47	0.07	41.64
Karlstad	3.6	0.30	0.05	39.64
Chalmers University of Technology	4.1	0.75	0.08	72.39
Växjö	3.4	0.30	0.04	39.64
Kalmar	2.7	0.29	0.05	35.73
Jönköping	3.1	0.35	0.04	43.69
Gävle	2.4	0.29	0.05	35.41
Stockholm Institute of Education	1.6	0.16	0.06	39.64
Kristianstad	1.9	0.19	0.05	34.75
Dalarna	2.0	0.17	0.05	33.70
Halmstad	1.7	0.29	0.06	36.31
Södertörn	1.1	0.84	0.02	40.27
Borås	1.8	0.21	0.05	34.21
Skövde	1.3	0.30	0.05	38.16
Swedish University of Agricultural Sciences (SLU)	1.4	0.72	0.15	55.03
Karolinska institutet	0.8	0.84	0.21	72.39

[a]The proportions refer to a sample of students who do not change colleges. An income restriction of 200,000 SEK is applied.

Table A2: Descriptives for the non restricted sample

Sample: Earnings restriction	> 0			
	Mean	Std	Min	Max
Annual earnings in 2005 (100 SEK)	2,304	1,209	2	27,782
Women, %	51.0			
Age in 2005	29.1	2.0	26	57
Children, ages 0-3	0.32	0.58	0	3
Children, ages 4-6	0.06	0.26	0	3
Children, ages 7-10	0.02	0.15	0	3
Children, ages 11-15	0.01	0.13	0	3
GPA upper secondary, percentile rank	47.9	28.9	0	99.9
No degree in 2005, %	40.6			
Number of credits	128	63.5	0.3	414
Field of study, %				
Education	2.6			
Humanities	10.4			
Social science	25.5			
Natural science	16.9			
Technology	14.2			
Agriculture	0.35			
Health care	12.1			
Service and transports	4.0			
Unknown/other	3.9			
Parents' characteristics				
Mother from Sweden, %	92.9			
Father from Sweden, %	92.5			
Mother's age 2005	56.8			
Father's age 2005	59.3			
Mother education, missing , %	3.2			
Mother compulsory, %	22.6			
Mother upper secondary, %	35.9			
Mother college education, %	37.9			
Mother PhD education, %	0.35			
Father education, missing, %	6.1			
Father compulsory school, %	26.3			
Father upper secondary school, %	32.9			
Father college education, %	32.7			
Father PhD education, %	1.9			
College characteristics				
Proportion of teachers with a PhD	0.48	0.20	0.16	0.84
Teacher/student ratio	0.06	0.02	0.02	0.21
Percentile ranked GPA among contemporary students at the same college (p50) (/100)	0.49	0.12	0.31	0.72
Quality index	2.18	1.48	0	7.78
Number of observations	17,554			

Table A3: Correlation quality variables

	Proportion of teachers with a PhD	Teacher/student ratio	GPA contemporary students
Proportion of teachers with a PhD	1.00		
Teacher/student ratio	0.52	1.00	
GPA contemporary students	0.80	0.49	1.00

Note: The number of observations is 11,344. An earnings restriction of 200,000 SEK is applied.

Table A4: OLS estimates with all quality variables (column 1) and with each quality variable individually (column 2-4)

	(1)	(2)	(3)	(4)
Proportion of teachers with a PhD	-0.027	0.100***		
	(0.018)	(0.011)		
Teacher/student ratio	-0.169		0.040***	
	(0.112)		(0.095)	
GPA of contemporary students	0.002***			0.002***
	(0.000)			(0.000)
Adj R^2	0.010	0.008	0.002	0.010

Note: The number of observations is 11,344. The dependent variable is log earnings in 2005. An earnings restriction of 200,000 SEK is applied. A constant is included in the regressions. ***, ** and * indicate significance on the one, five and ten percent level respectively.

Table A5: Estimated effects of four different college quality index on annual earnings.

	(1)	(2)	(3)	(4)	(5)	(6)
Earnings restriction (1,000 SEK)	>200	>200	>200	>200	>200	>200
Basic controls	No	yes	yes	yes	yes	yes
Parental controls	No	no	yes	yes	yes	yes
College education controls	No	no	no	yes	yes	yes
GPA	No	no	no	no	yes	yes
Region of work	No	no	no	no	no	yes
Quality index 1 (Prop of teachers with a PhD, Teacher/student ratio, GPA)	0.014*** (0.001)	0.013*** (0.001)	0.011*** (0.001)	0.011*** (0.001)	0.007*** (0.001)	0.001 (0.001)
Adj. R^2	0.008	0.083	0.090	0.121	0.129	0.175
Quality index 2 (Prop of teachers with a PhD, Teacher/student ratio)	0.013*** (0.002)	0.013*** (0.002)	0.010*** (0.002)	0.009*** (0.002)	0.006*** (0.002)	0.001 (0.002)
Adj. R^2	0.005	0.080	0.087	0.119	0.128	0.175
Quality index 3 (Prop of teachers with a PhD, GPA)	0.016*** (0.002)	0.016*** (0.001)	0.014*** (0.002)	0.014*** (0.002)	0.010*** (0.002)	0.002 (0.002)
Adj. R^2	0.001	0.085	0.091	0.123	0.130	0.175
Quality index 4 (Teacher/student ratio, GPA)	0.015*** (0.002)	0.015*** (0.002)	0.012*** (0.002)	0.011*** (0.002)	0.006*** (0.002)	0.001 (0.002)
Adj. R^2	0.007	0.082	0.089	0.119	0.128	0.175

Note: The number of observations is 11,344. The dependent variable is log earnings in 2005. All regressions include a constant term and each model is estimated four times, one for each quality index. **Basic controls** include controls for sex, age, age squared and number of children in four different age categories. **Parental controls** include dummy variables indicating whether the parent is born in Sweden, parents' level of education and parents' ages. **College education controls** include credits, dummy variables for field of study and a dummy variable indicating no college degree. **GPA** is percentile ranked grade point average from upper secondary school. Standard errors are reported in parentheses. ***, ** and * indicate significance on one, five and ten percent level respectively

Table A6: The effect of the quality index for students with or without at least one college educated parent

	At least one college educated parent	No college educated parent
Earnings restriction (1,000 SEK)	>200	>200
Basic controls	yes	yes
Parental controls	yes	yes
College education controls	yes	yes
GPA	yes	yes
Region of work	no	no
Quality index	0.008***	0.008***
	(0.002)	(0.002)
Adj. R^2	0.104	0.142
Number of observations	5,902	5,442

Note: The dependent variable is log earnings in 2005. All regressions include a constant term. **Basic controls** include controls for sex, age, age squared and number of children in four different age categories. **Parental controls** include dummy variables indicating whether the parent is born in Sweden and parents' ages. **College education controls** include credits, dummy variables for field of study and a dummy variable indicating no college degree. **GPA** is percentile ranked grade point average from upper secondary school. Standard errors are reported in parentheses. ***, ** and * indicate significance on the one, five and ten percent level respectively. Complete results from the regressions are available from the author by request.

Table A7: The effect of the quality index for students in different parts of the ability distribution

	GPA 0-25	GPA 26-50	GPA51-75	GPA76-100
Earnings restriction (1,000 SEK)	>200	>200	>200	>200
Basic controls	yes	yes	yes	yes
Parental controls	yes	yes	yes	yes
College education controls	yes	yes	yes	yes
GPA	no	no	no	no
Region of work	no	no	no	no
Quality index	0.004	0.009***	0.005*	0.013***
	(0.003)	(0.003)	(0.003)	(0.003)
Adj. R^2	0.118	0.179	0.134	0.097
Number of observations	3,000	2,882	2,692	2,770

Note: The dependent variable is log earnings in 2005. All regressions include a constant term. **Basic controls** include controls for sex, age, age squared and number of children in four different age categories. **Parental controls** include dummy variables indicating whether the parent is born in Sweden, parents' level of education and parents' ages. **College education controls** include number of credits, dummy variables for field of study and a dummy variable indicating no college degree. Standard errors are reported in parentheses. ***, ** and * indicate significance on the one, five and ten percent level respectively. Complete results from the regressions are available from the author by request.

Table A8: The effect of the quality index for students in different fields of study (the sample only includes students with a degree)

	Teaching	Humanities	Law and social science	Science	Technology	Medicine and social work	Service and transport
Earnings restriction (1,000 SEK)	>200	>200	>200	>200	>200	>200	>200
Basic controls	yes	yes	yes	yes	yes	yes	yes
Parental controls	yes	yes	yes	yes	yes	yes	yes
College education controls	yes	yes	yes	yes	yes	yes	yes
GPA	yes	yes	yes	yes	yes	yes	yes
Region of work	no	no	no	no	no	no	no
Quality index	-0.005**	-0.006	0.006	-0.012*	0.007**	0.008**	0.004
	(0.002)	(0.011)	(0.005)	(0.007)	(0.003)	(0.003)	(0.015)
Adj. R^2	0.154	0.040	0.108	0.070	0.044	0.337	0.049
Number of observations	1,193	169	1,584	613	2,603	884	100

Note: The dependent variable is log earnings in 2005. All regressions include a constant term. **Basic controls** include controls for sex, age, age squared and number of children in four different age categories. **Parental controls** include dummy variables indicating whether the parent is born in Sweden, parents' level of education and parents' ages. **College education controls** include obtained credits. **GPA** is percentile ranked grade point average from upper secondary school. **Region of work** includes dummy variables for region of work. Standard errors are reported in parentheses. ***, ** and * indicate significance on the one, five and ten percent level respectively. Complete results from the regressions are available from the author by request.

IV

Earnings Differences Between Transfer and Non-transfer Students*

Linda Holmlund
Department of Economics, Umeå University
SE-901 87 Umeå, Sweden

Håkan Regnér
Saco, Box 2206
SE-103 15 Stockholm, Sweden

Abstract

Using data on three cohorts of Swedish university entrants, this study examines whether earnings vary between students who change universities and students who do not change. The results show that earnings, during the first years after leaving the university, are significantly lower for students who change universities compared to students who do not change. Earnings differences decrease significantly over time and over the earnings distribution. The pattern in the estimates seems consistent with non-transfer students, who have higher earnings because of their relatively earlier labor market entry, and transfer students catching up because of their additional human-capital investments.

Keywords: College education, University choice, Earnings distribution

JEL Classification: J24, J31

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* We thank Lena Granqvist, Niklas Hanes, Eva Löfbom, Maria Noleryd, Olle Westerlund, Gunnar Wetterberg, Christina Wikström, Magnus Wikström and seminar participants at Umeå University, Saco, and the 2008 European Association of Labour Economists (EALE) meeting for helpful comments. We are especially grateful to Galina Pokarzhevskaya for skillful computer programming and constructive comments.

1 Introduction

For the past 20 years, many OECD countries have experienced an increase in the earnings premium to college education (see, for example, Katz and Autor, 1999). But there is large variation in earnings among college-educated individuals. For example, results for the US show that wages vary significantly across majors (Arcidiacono, 2004) and between students who attended different colleges (Black and Smith, 2004; Dale and Krueger, 2002; Monks, 2000; Brewer, Eide and Ehrenberg, 1999; Behrman, Rosenzweig and Taubman, 1996; Loury and Garman, 1995). Wages of college-educated workers also depend on type of college degree and whether or not the student switched colleges (Light and Strayer, 2004). In comparison, there is little evidence on the impact of college choice or variation in earnings among the college-educated workforce in Europe.

One issue that is high up on the European political agenda is the mobility of college students. For example, mobility of students is one of the key objectives of the Bologna process and there are special EU-programs that promote mobility in education. Even though students in Europe have become more mobile, little is known about the consequences (e.g. in terms of earnings) of combining courses from different colleges. This paper fills a gap in the literature by examining earnings differences between students who switch colleges and students who do not.

This study uses a large administrative dataset of all Swedish university entrants in 1995, 1996, and 1997 and focuses on students who switch between Swedish colleges. Data reveal that (*i*) more than 30% of the students changed universities at least once,[1] (*ii*) students change to all types of universities, and

[1] Transfer students are students who obtained credits at more than one university.

(*iii*) students who change universities have higher educational attainments than students who do not change. This suggests that students might change universities to improve their human-capital. Transfer students' additional human-capital investments may improve their careers and result in higher subsequent earnings, compared to students who do not change universities. Students might also change for reasons other than to improve their human-capital. For example, they might change to a university that is closer to where they grew up (to be near family and friends) or to be in an area in which they can pursue their hobbies. If students change for one of those reasons, transferring might be uncorrelated with earnings, or even be negatively correlated.

To our knowledge, there is only one previous study that examines earnings of students who switch universities.[2] Using survey data on US college students, Light and Strayer (2004) analyze the impact of all types of college transfers. Based on their data, we calculate an average transfer rate of about 30% in the US (calculated as the average over transfer students with varying degrees), which is similar to the transfer rate in our data.[3] Light and Strayer estimate a log-earnings equation with transfer patterns as right-hand side variables. They control for individual ability (AFQT scores), number of public colleges in state, and enrollment duration, assuming that ability adjusts for the non-random selection of transfer students. They find that students who change universities receive about 6% higher wages than those who do not change.

[2] Kane and Rouse (1995) and Hilmer (2000) provide two related studies. Kane and Rouse consider only a particular type of transfer students (non-degree recipients who attended both two- and four-year colleges). Hilmer considers various types of transfer students and estimates inter-group variation in terms of college quality rather than in terms of consequences of college transfer on wages.

[3] Data exist on percentages of college drop-outs in most European countries (see, for example, OECD, 2008). But we have not found a study that reports data on percentages of European students who switch colleges.

They also find that transfer students are at least as likely as non-transfer students to earn a degree.

This study provides the first estimates of the earnings differences between transfer and non-transfer students for a non-US country. In addition, it includes quantile regression estimates of the earnings gap, which can tell us whether the average estimates are driven by students in specific parts of the earnings distribution. The large data set allows separate regressions for various sub-samples, which facilitates further analyses of heterogeneity in the results. This study also investigates whether the results vary between students who switch to universities of varying observed quality.

The results show that Swedish transfer students have significantly lower earnings than non-transfer students during the first years after leaving the university, but the earnings differences decrease over time. The earnings differences also decrease over the earnings distribution. One possible explanation to the results is that non-transfer students have higher earnings because of their relatively earlier labor market entry and transfer students catch up because of their additional human-capital investments.

The rest of this paper is structured as follows. Section 2 contains representative facts about higher education in Sweden. Section 3 presents the theoretical framework and the empirical strategy, while Section 4 describes the data. Section 5 reports the estimated earnings differences between students who change universities and students who do not change and the results from the sensitivity analyses. Section 6 presents conclusions.

2 Higher education in Sweden

In 2008, Sweden had 36 universities and university colleges, besides independent education agencies/organizations that were entitled to award higher education degrees or diplomas. In all, Sweden had 61 higher education organizations in 2008. In the 1980s, the number of registered students hovered around 190,000. During the early 1990s, this figure started to rise and grew at a steady pace until 2005. In 2006, about 390,000 students were enrolled in various higher education organizations.

Universities have permanent public funds for research and postgraduate education and can award doctoral degrees. Generally, university colleges do not award doctoral degrees.[4] In Sweden, colleges and universities provide the same type of undergraduate education (often identical courses) and award similar undergraduate degrees. Transfers among these colleges and universities are rather easy. Universities are mostly located in larger cities, while colleges are scattered throughout the country. For simplicity, the terms university and college are used interchangeably throughout this paper. During the 1977–1993 period, Sweden's parliament (and government) regulated the higher education system in detail. Since 1993, higher education institutions have gradually gained increased autonomy in organization of studies, use of resources, and general administration. But the government still decides which university is allowed to award a certain degree. A university can lose its rights to award a degree if the observed quality of education is considered too low.

There is a supply constraint on higher education, so admission to some programs and courses is selective. Selection of students in Sweden is

[4] Four university colleges have the same rights as universities but these colleges are restricted to *one research area* only: Blekinge Institute of Technology (*technology*), Malmö University College (*medical sciences*), Kalmar University College (*natural sciences*), and Mälardalen University College (*engineering*).

transparent and almost exclusively based on GPA from upper secondary school or a university aptitude test (SweSAT). Studies are organized as programs or as single courses. Until 2006, Sweden had a credit-point system in which a normal 40-week academic year corresponded to 40 credit points.[5] Degrees from all government-recognized higher education institutions have equal official value.

Higher education is free of charge for all students, and the government provides financial support to Swedish students and immigrants who hold a permanent residence permit. This support is twofold: grants and loans, which combined, constitute student aid of about SEK 7,500 (≈ EUR 800) per month in 2008. Parents' or spouse's income or wealth do not affect the amounts that students receive, and universities do not provide financial support to students.

3 Theoretical framework and empirical strategy

A substantial proportion of university students switch universities during their studies. When they switch universities, they may also consider the benefits and costs of changing academic fields and whether to graduate. These types of students do not fit into Becker's (1964) standard human-capital model, which assumes that there are no uncertainties about schooling decisions. In the traditional human-capital framework, utility maximizing students choose the college education that offers the highest discounted returns, and the decision is made before enrollment. In short, students simply choose a path and stay on it.

Early on, Comay et al. (1973) introduced the idea that human-capital accumulation should instead be seen as a dynamic process. They develop a

[5] The Swedish credit point system was aligned to other European countries in 2007 which implies that a normal 40 week academic year now corresponds to 60 higher education credits. Credit points in our data correspond to the old system.

model that treats the educational decision as a sequential decision problem. Exogenously specified probabilities drive the college decision, and there are no uncertainties about earnings. Altonji (1993) also treats education as a sequential choice, but in contrast to Comay et al., Altonji assumes that the choice is made under uncertainty. Heckman et al. (2003, 2006) describe further extensions of these approaches. Although, no model explicitly discusses why students switch colleges; the models suggest that a human-capital decision is not a once-and-for-all decision and that a decision can be changed at each level. In addition, the aforementioned papers suggest that benefits and costs of the investments affect the education decision-making process.

Based on this theoretical base, Light and Strayer (2004) discuss several reasons why students change colleges. They focus on the issue of match quality and argue that students may decide to change colleges after reassessing costs and benefits of their investment options. Students continuously learn about the institutions and their own capacities and might change because they believe that they will benefit more from being at a different institution. They might also change after receiving new information about the future payoffs of particular programs. Further, students can change to lower their living expenses or to improve their part-time employment prospects.

Switching colleges might enable direct and indirect effects on earnings. A positive direct effect occurs if students (who switch) improve their opportunities for skill acquisitions beyond what is reflected in their formal college education (for example, degree, number of credits, and academic fields). Students, who initially enroll at a small university that focuses on undergraduate education, might change to one that focuses on research or to one with specialized programs. A positive indirect effect occurs from changing colleges if the change increases the probability of graduating. For example, students who start at a college with too much peer pressure or demanding

teachers might consider dropping out of college. If they instead change to one in which attitudes are different, then they might finish their studies or take courses required for certain jobs.

Human-capital investments or optimal match quality do not necessarily drive a student's transfer decision. Students may also change colleges to come closer to friends and family or to be in a different social environment (for example, fewer students, smaller campuses, and varying leisure activities). In addition, genuine movers could dominate the group of college transfer students, that is, individuals who are more mobile than other students. These students may be less likely to commit to a particular college or program. They may also be less stable on the labor market, which implies that they more often change jobs and are more willing to take on short-term employment. Employers might consider transfer students to come from a group of predominantly bad matches and to be less reliable individuals.[6] A transfer then signals lower productivity and may be a criterion that employers use when screening job applicants. Consequently, a positive relationship between changing colleges and earnings might *not* exist.

The following equations for earnings and transfer decision describe the empirical problem of estimating earnings differences between transfer and non-transfer students:[7]

$$\ln(Y_{it}) = \beta_{0t} + \beta_{1t} X_{it} + \beta_{2t} \Delta C_i + \varepsilon_{it} \tag{1}$$

$$\Delta C_i^* = \alpha_1 Z_i + \eta_i, \;\; \Delta C_i = 1 \;\; if \;\; \Delta C_i^* > 0, \;\; \Delta C_i = 0 \; otherwise \tag{2}$$

[6] This is related to literature on job mobility, match quality, and adverse selection. See, e.g., Jovanovic (1979), Greenwald (1986), Gibbons and Katz (1991), and Widerstedt (1998).
[7] This is a conventional setup in the non-experimental evaluations literature (see e.g. Heckman et al. 1999).

In Eq. (1), log yearly earnings of individual i in period t, Y_{it}, is a function of a vector of individual characteristics, X_{it}; a dummy variable that indicates if the individual has switched universities ΔC_i; and a transitory disturbance, ε_{it}. The coefficient on ΔC_i, denoted β_{2t}, captures the earnings differences between transfer and non-transfer students. As previously discussed, we expect $\beta_{2t}>0$ if students change to improve their human-capital. If factors unrelated to individuals' marketable skills drive the decision to change universities, then β_{2t} is expected to be zero or even less than zero. It is also negative if employers believe that the productivity of transfer students is lower than that of non-transfer students.

Eq. (2) specifies the underlying transfer decision, where individuals change universities if the latent variable ΔC_i^* exceeds zero. The latent variable is a function of the observed Z_i (which may include X_i variables), and unobserved η_i variables. In the present study, we do not use the estimates of the decision equation to adjust for selection of transfer students. Using Eq. (1), we focus instead on whether there are earnings differences between transfer and non-transfer students. But if the decision to change colleges is due to observed characteristics, the inclusion of Z_i variables adjusts for the potential non-random decision to change colleges.

Note that the present study does not seek to identify the causal relationship between switching colleges and earnings. Instead, we want to investigate whether or not there is an earnings gap between the groups and suggest an empirical framework for future studies. The aforementioned empirical framework clearly shows underlying potential sources of selection, which

might be present in work done by Light and Strayer (2004) and in our study. In contrast to Light and Strayer, we have a rich dataset that allows us to examine how grades from upper secondary school, family background, and choices of university types affect the results.

To obtain further insights into potential heterogeneity in the impact of changing colleges, we use quantile regression (see, for example, Buchinsky, 1994; Koenker and Basett, 1978). We estimate the θ^{th} percentile of Y_i conditional on individual characteristics (X_i), observed selection variables (Z_i) and the dummy variable that indicates if an individual has changed universities (ΔC_i). q_θ, which is the value of Y_i conditional on X_i and ΔC_i in percentile θ, is assumed to be linear in these variables. The following equation is estimated:

$$q_\theta(Y_i) = \beta_{0\theta} + \beta_{1\theta} X_i + \beta_{2\theta} \Delta C_i + Z_i \lambda_\theta + \varepsilon_{\theta i} \quad (3)$$

The coefficients are interpreted as the earnings premium in percentile θ of the conditional earnings distribution. The method uses all observations, which means that the sample size in each percentile is weighted by the total sample size. The method is also robust to outliers of the dependent variable. In addition, heteroscedastic-consistent standard errors (bootstrapped standard errors) are estimated.

The quantile regression was developed to analyze potential heterogeneity in the effects of a particular variable, here, the ΔC_i variable. The estimates of the quantile regressions will tell us if students in a particular part of the income distribution drive the average estimates and provide information about the

mechanisms behind the results. For example, if the quantile regression estimates reveal that earnings of transfer students are significantly lower at the bottom of the distribution but are similar at the top, then students at the bottom of the earnings distribution drive the average OLS estimates.

4 Data

Data were obtained from Statistics Sweden (SCB) records and include all Swedish-born college entrants during the 1995-1997 period. SCB collects data about college education from universities' records. In Sweden, schools and universities are required to report individuals' educational attainment to SCB. Most universities use identical reporting systems.[8] So data on education are of high quality at individual and university levels. Students were followed for 12 semesters. For each semester, information is available regarding the college they attended, the courses they completed, and the number of credits they earned. If they achieved a degree, there is detailed information about the level and academic field.

The dataset also includes individual register data from 1993, 1995, 1998, 2000, 2002, 2003, 2004, and 2005. Analyses in this study focus on the 2002-2005 period. Data include standard individual characteristics (age, marital status, and children), basic work-related data (sector, region of work, and unemployment) and parental characteristics (age, origin, and education level). Information is also available regarding compulsory school (years 1–9) grades and upper secondary school (years 10–12) grades for students who left

[8] Most universities report students' educational attainments in LADOK, an IT system. Among the major colleges, only the Stockholm School of Economics uses a different system and is thus not included in the analyses.

compulsory school in 1988 or later and upper secondary school in 1990 or later. Gross yearly earnings (outcome variable) are based on tax records.[9]

Table 1 presents basic information about outcomes of higher education of all university entrants 1995-1997, which were measured six years after enrollment. Column 1 shows that 67.1% of those who entered college in 1995 studied at one college only; as many as 25.4% studied at two universities, and 7.5% studied at three or more universities. The percentages are similar for those who began studying in 1996 and 1997. This implies that about one-third of the students changed universities at least once.

We imposed the following restrictions on the data. No missing data on educational attainment, college type, and grades from upper secondary school was permitted, and all students must have earned some credits.[10] Independent program providers and colleges specialized in nursing, music, art, and dance were excluded because similar restrictions were invoked in previous Swedish studies; instead, we focused on universities and colleges with many students.[11] To ensure that individuals are attached to the labor market and to reduce the likelihood of being in college, all individuals must have some earnings in all outcome years, namely, 2002-2005.[12] Self-employed individuals are not

[9] Earnings include all job-related income (formally, all income for which employers had to pay payroll tax). This is a standard outcome measure in Swedish educational studies (see e.g. Isacsson, 2004).

[10] In 1995, 1996, or 1997, 163,166 students were registered as college entrants; 11,356 of these entrants did not earn credits and are thus excluded. We only have GPA data on individuals who left upper secondary school in 1990 and onward. We ran regressions on individuals without GPAs, but the results lead to the same conclusions as those reached in this study. The GPA restriction reduces the sample by 45,645 individuals.

[11] This reduces the sample by 4,421 individuals. Table A1 in the Appendix shows the included universities, the distribution of students, and the percentages of transfer students. At four universities/colleges, the transfer rate exceeds 40%.

[12] This reduces the sample by 17,672 individuals.

Table 1: The outcome of higher education, six years after enrollment

	University entrants 1995	University entrants 1996	University entrants 1997
Studied at			
One university, %	67.1	64.5	63.2
Two universities, %	25.4	27.6	28.4
Three or more universities, %	7.5	7.9	8.4
Changed universities			
Once, %	14.9	15.5	15.6
Twice, %	6.4	6.1	6.3
At least three times, %	11.6	13.9	14.9
Obtained at least			
One degree, %	57.3	56.2	55.2
Two degrees, %	7.0	7.4	7.8
Number of			
Credits earned	119.7	120.8	123.9
	(67.3)	(66.7)	(66.2)
Semesters in college	6.3	7.0	7.2
	(3.1)	(3.3)	(3.3)
Credits earned for those without a degree	79.6	78.8	82.5
	(63.4)	(63.1)	(63.8)
Credits earned for those with a degree	149.6	153.5	157.6
	(53.0)	(48.7)	(46.0)
Semesters in college for those without a degree	4.8	5.4	5.6
	(3.3)	(3.5)	(3.5)
Semesters in college for those with a degree	7.3	8.3	8.5
	(2.6)	(2.5)	(2.4)
Number of observations	51,145	51,477	49,188

Note: The samples include all college entrants who obtained at least 0.1 credits during a six-year period after enrollment. Standard deviations are within parentheses.

included. We excluded transfer students who have changed universities more than once.[13] The final sample consists of 61,410 individuals.

Table 2 reports mean sample characteristics of university entrants used in this study and odds ratios from a logistic regression of individual characteristics on

[13] Exclusion of students, who changed more than once, reduces the sample by 19,025 individuals. A few individuals are also excluded because of missing values on some of the variables used in the analyses.

the likelihood of changing colleges. Because no major differences exist in individual characteristics among the three cohorts and because we ran regressions for all university entrants together, the mean values are based on the complete sample. But there are separate means for students who changed colleges (transfer students) and those who did not change (non-transfer students).

Earnings of transfer students are lower than earnings of non-transfer students, but the earning spread is wider for transfer students. Earnings of transfer students grow faster than earnings of non-transfer students. There are more women and fewer married individuals among transfer students than among non-transfer students. Transfer students have much stronger family backgrounds (much higher percentage of mothers and fathers with college educations) and slightly higher grades from upper secondary school. Table 2 also shows that transfer students earned about 15 credits more than non-transfer students, which corresponds to 15 weeks of full-time studies. This suggests that transfer students took more courses and probably stayed longer in college than non-transfer students.[14]

Column 4 (calculated odds ratios) in Table 2 indicates that age decreases the likelihood of changing universities and that the odds of changing are higher for women. Students who were married in 1995 were less likely to change universities than those who were not married. The probability of changing is also lower for students in most academic fields compared to students in humanities. Moreover, students with parents who are not college educated have a lower probability of changing, while students with fathers who have a doctoral degree have higher probability of changing, compared with students who have college-educated parents. In addition, university entrants in 1996

[14] Transfer students in the US also stay longer in college (Light and Strayer, 2004).

Table 2: Mean sample characteristics and odds ratios

	Non-transfer students	Transfer students	Odds ratio
Annual earnings			
2005 (SEK 1,000)	252.3	233.0	
	(128.4)	(142.1)	
2004 (SEK 1,000)	237.1	212.9	
	(118.0)	(130.4)	
2003 (SEK 1,000)	221.6	188.6	
	(112.0)	(120.9)	
2002 (SEK 1,000)	199.8	158.6	
	(108.4)	(111.3)	
Age, 1995	19.9	19.6	0.93***
	(2.0)	(1.8)	
Women, %	51.3	58.9	1.32***
Married (men and women), 2005, %	25.4	21.4	
Married (men and women), 1995, %	0.68	0.40	0.72*
Children, ages 0–6, 2005, %	34.0	26.6	
Children, ages 7–15, 2005, %	3.1	2.0	
Upper secondary GPA	49.1	50.3	1.00***
	(28.9)	(28.2)	
% with a degree, 2005	60.0	59.2	
Number of credits	127.1	141.9	
	(62.3)	(57.5)	
Area of first course			
Teacher education, %	5.7	4.1	0.52***
Humanities, %	23.8	33.7	Ref
Social science, %	28.6	30.7	0.79***
Natural science, %	28.5	21.7	0.58***
Technology, %	4.7	3.4	0.59***
Agriculture, %	0.18	0.05	0.19***
Medicine, %	7.4	4.9	0.47***
Personal services and logistics, %	0.78	0.11	1.04
Mother's education			
Compulsory, %	23.4	19.5	0.80***
Upper secondary, %	35.6	33.3	0.88***
College education, %	37.6	43.4	Ref
Graduate work, %	0.36	0.56	1.18
Father's education			
Compulsory, %	27.1	22.8	0.81***
Upper secondary, %	33.0	31.2	0.89***
College education, %	32.0	36.7	Ref
Graduate work, %	2.0	2.9	1.19**
University entrants			
1995, %	34.0	35.4	Ref
1996, %	34.3	33.1	0.91***
1997, %	31.7	31.5	0.89***
Number of observations	50,782	10,628	61,410

Note: Standard deviations are in parentheses. GPAs are percentile ranked. Parental education does not add to 100%, because of missing data. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

and 1997 have lower probability of changing universities than students who began studying in 1995.

5 Empirical findings

The dependent variable is the logarithm of gross yearly earnings. Three different models are considered. Model 1 controls for basic individual characteristics (women, age, and age squared), parental background characteristics (age, origin, and level of education), GPA (percentile-ranked GPA from upper secondary school), and cohort dummies (dummies for year of university entry). This model controls mainly for factors that tend to have a large effect on individuals' education decisions.

Models 2 and 3 add a number of explanatory variables to model 1. Model 2 also includes number of children in various age categories, marital status, a dummy variable which is 1 if the student has a degree, number of credits, number of credits squared, and eight subject areas (based on first course). That is, here we added family factors and outcomes of individual college decisions. Model 3 adds to model 2 ten sectors of employment, county of work,[15] a dummy variable that indicates unemployment experience during the outcome year and potential work experience.[16] This model adjusts for differences in choices on the labor market. For expositional purposes, we only report the estimate of ΔC_i, the dummy variable that indicates if the individual switched universities.[17]

[15] Labor market selection might correlate with university selection. For example, local students may never intend to move, and college education at some universities can be designed to meet needs of local businesses. But the variable might fully capture regional earnings differences in Sweden.

[16] Potential work experience is calculated as (years of age - years in college - 19). On average, students leave upper secondary school at age 19.

[17] Table A2 in the Appendix reports some estimates of other right-hand side variables.

First we estimate all three models for the complete sample and for men and women separately. Then we investigate whether the results depend on choice of university. And finally, we examine whether the results vary over the earnings distribution.

5.1 Baseline estimates

Table 3 reports baseline estimates of earnings differences between students who change universities and students who do not change universities.[18] The model 1 estimates indicate that students who change universities have significantly lower earnings in all years compared to students who do not change universities. The estimated earnings differences decrease significantly over time, from about 33% in 2002 to 9.5% in 2005. The pattern in the model 2 estimates is similar to model 1. The model 2 estimates also decrease over time. But inclusion of college-related variables leads to smaller earnings differences between transfer and non-transfer students in the early years but larger earnings differences in later years, compared to model 1.

The pattern in the model 3 estimates is the same as in the other models, but model 3 suggests smaller earnings differences between the groups. It predicts that transfer students have about 5% lower earnings in 2005. The model 3 estimates show that choice of regional labor market and employment sector explains quite a large percentage of earnings differences between transfer and non-transfer students. Although the magnitude of earnings differences varies across models, all models suggest that students who change universities have lower earnings than students who do not change.

[18] The complete results from the regressions are available from the authors upon request.

Table 3: Estimates of earnings differences between transfer and non-transfer students

Year	Model 1	Model 2	Model 3
2002	-0.325*** (0.011) *Adj* R^2=0.078	-0.249*** (0.010) *Adj* R^2=0.188	-0.223*** (0.010) *Adj* R^2=0.261
2003	-0.234*** (0.010) *Adj* R^2=0.055	-0.215*** (0.009) *Adj* R^2=0.138	-0.188*** (0.009) *Adj* R^2= 0.234
2004	-0.142*** (0.009) *Adj* R^2=0.064	-0.160*** (0.009) *Adj* R^2=0.145	-0.136*** (0.009) *Adj* R^2=0.249
2005	-0.092*** (0.009) *Adj* R^2=0.079	-0.125*** (0.009) *Adj* R^2=0.166	-0.048*** (0.007) *Adj* R^2=0.479
Number of observations	61,410	61,410	61,410

Note: The dependent variable is log gross yearly earnings. All models include a constant and a dummy variable for changing universities (ΔC). Model 1 also includes women, age, age^2, parental characteristics (age, country of birth, and education of mother and farther), percentile-ranked GPA from upper secondary school and cohort dummies. Model 2 also includes number of children in various age categories, a dummy for marital status, a dummy variable that is equal to one if students have a degree, number of credits, number of credits squared and eight education areas (based on first course). Model 3 includes the covariates from model 2 plus an indicator of unemployment experience during the outcome year, ten employment sectors, county of work, and potential work experience. Standard errors are within parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

The earnings gap narrows rapidly over time, and a hypothesis might be that it shrinks because premiums of the observed factors vary between non-transfer and transfer students. For example, earnings of non-transfer students might be larger because they enter the labor market earlier and thus have larger returns to experience compared to transfer students. Transfer students might catch up because they receive larger returns on their additional investments in college education. The estimates of these variables provide some information about this mechanism. Table A2 in the Appendix displays the estimates, which show that non-transfer students have higher returns on potential experience compared to transfer students in all years except 2005. The pattern over time (for experience estimates) follows the estimated earnings gap pattern between groups.

Table A2 also shows that transfer students have a significantly higher earnings premium for a degree than non-transfer students. The transfer students' estimate is nearly twice the estimate for non-transfer students in all years. This might indicate that transfer students benefit more from investments in college education and might explain why the earnings gap shrinks over time. It is also possible that a degree act as a signal for transfer students but not for non-transfer students. Because if employers believe that transfer students, on average, are adversely selected, a degree might signal a relatively higher productivity.

5.2 Gender-based estimates

The log odds in Table 2 show that women are more likely than men to study at more than one university. Moreover, Albrecht et al. (2003) show that there is a significant gender wage gap on the Swedish labor market, which is wider at the top than at the bottom of wage distribution. If women dominate among transfer students, then female transfer students, who hold relatively low-paid jobs or part-time work, might explain earnings differences between transfer and non-transfer students. So we run separate regressions for women and men. Table 4 reports the results, which show that the pattern in the estimates over time is similar for women and men. For both samples, there are large earnings differences in the first years, which decrease over time. Based on models 1 and 2, earnings differences between those who change and those who do not change are larger among males than females in all outcome years. The difference between the estimates for men and women are smaller in model 3. And in 2005, earnings differences are about as high for female transfer students as for male transfer students.

Model 3 estimates also indicate that transfer students in low-wage regions and sectors explain much of the earnings differences between transfer and non-transfer students. But a significant earnings gap still exists between transfer and non-transfer students. In all, gender-based estimates reject the hypothesis that low-paid female transfer students drive earnings differences between transfer and non-transfer students.[19]

[19] We also ran separate regressions for students who graduated the same year, students with and without a degree, students who come from various regions, students with different observed ability, and students with varying parental background characteristics. The results led to the same conclusions as those presented above.

Table 4: Estimated earnings differences between transfer and non-transfer students, men and women

	WOMEN			MEN		
Year	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
2002	-0.275***	-0.232***	-0.220***	-0.398***	-0.291***	-0.245***
	(0.014)	(0.013)	(0.013)	(0.016)	(0.015)	(0.014)
	Adj R^2=0.040	*Adj* R^2=0.206	*Adj* R^2=0.254	*Adj* R^2=0.107	*Adj* R^2=0.203	*Adj* R^2=0.307
2003	-0.172***	-0.192***	-0.179***	-0.322***	-0.264***	-0.218***
	(0.013)	(0.013)	(0.012)	(0.014)	(0.014)	(0.012)
	Adj R^2=0.017	*Adj* R^2=0.174	*Adj* R^2=0.234	*Adj* R^2=0.067	*Adj* R^2=0.122	*Adj* R^2=0.273
2004	-0.082***	-0.146***	-0.134***	-0.226***	-0.197***	-0.155***
	(0.014)	(0.013)	(0.012)	(0.013)	(0.012)	(0.011)
	Adj R^2=0.016	*Adj* R^2=0.183	*Adj* R^2=0.250	*Adj* R^2=0.043	*Adj* R^2=0.087	*Adj* R^2=0.270
2005	-0.036***	-0.119***	-0.058***	-0.171***	-0.155***	-0.056***
	(0.013)	(0.012)	(0.011)	(0.012)	(0.012)	(0.008)
	Adj R^2=0.015	*Adj* R^2=0.187	*Adj* R^2=0.420	*Adj* R^2=0.029	*Adj* R^2=0.086	*Adj* R^2=0.604
Number of observations	32,295	32,295	32,295	29,115	29,115	29,115

Note: Table 3 describes the models. Standard errors are reported within parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

5.3 University choices

The percentages of teachers with doctoral degrees vary significantly between universities in Sweden (see, for example, Holmlund 2009). If teachers with doctoral degrees provide higher quality education, then students might change so that they are taught by these teachers. But students might also change to a regional college with few teachers with doctoral degrees if the college is in a region in which they can pursue their interests or if the college is located near family and friends.[20] This suggests that observed university quality or regional location might affect students' decision to change universities. If observed university quality or regional location also are correlated with earnings the results in the previous sections might be biased

To examine whether choice of university type matters, we divide universities into three groups based on similar values on observed quality indicators: group 1 (universities of highest observed quality), group 2 (universities of semi-high observed quality), and group 3 (universities of lower observed quality).[21] We compare transfer students with non-transfer students from the same universities. In other words, before the change of universities, the transfer and non-transfer students were enrolled in the same group of universities.

[20] Most Swedish universities/colleges recruit most of their students from the county in which they are located or from neighboring counties, and students are more likely to stay in the region after graduation than to move. If transfer students switch to colleges in low-wage regions, then the estimated earnings gap between transfer and non-transfer students might be due to transfer students choosing to work in a region in which the college is located and thus receive lower wages.

[21] Group 1 includes Lund, Stockholm, Uppsala and Gothenburg universities, Swedish University of Agricultural Sciences, Chalmers University of Technology, Royal Institute of Technology and Karolinska Institutet. Group 2 includes Umeå, Linköping, and Luleå universities. Group 3 includes Södertörn, Borås, Skövde, Mälardalen, Örebro, Karlstad, Växjö, Kalmar, Jönköping, Gävle, Kristianstad, Dalarna, Halmstad, University West, Blekinge Institute of Technology, Mid Sweden University and Stockholm Institute of Education.

Table 5 reports the estimated earnings gap between transfer and non-transfer students conditional upon university choice. Table 5 includes only estimates for 2005, because the purpose of the analysis was to examine whether university choice explains the earnings gap between the groups and not the development over time. Columns 1–3 report the earnings gap conditional upon transfer patterns, and columns 4–6 report the average estimated earnings differences among students who started in the same group of universities. The specifications are the same as those used above.

Results for model 3 in Table 5 suggest that the earnings gap between transfer and non-transfer students is wider for students who started at group 2 and group 3 universities than it is for students who started at group 1 universities. For example, column 8 (last column) in Table 5 shows that the average earnings gap for students, who began studying at a group 1 university, is 3.6% compared with 6.7% for group 2 students and 6.9% for group 3 students. Further, the estimates in column 3 show that group 2 and group 3 transfer students have lower earnings for all types of changes, while group 1 students have lower earnings only for changes to another group 1 university.

Model 3 suggests that there is a significant earnings gap for changes between group 1 universities, but the gap is insignificant for changes from group 1 to group 2 and group 3 universities. Regardless of starting university, the earnings gap is widest for transfers to group 1 universities. Despite differences across universities, these results suggest that transfer students' choices of university do *not* explain the earnings gap between transfer and non-transfer students.

Table 5: Estimated earnings differences between non-transfer and transfer students in 2005, conditional upon university choice

	Model 1	Model 2	Model 3		Model 1	Model 2	Model 3
BEGAN STUDYING AT A GROUP 1 COLLEGE							
Ref group: students who stay at group 1 colleges				*Ref group: students who stay at group 1 colleges*			
Changed from grp 1 to grp 1	-0.141*** (0.021)	-0.148*** (0.020)	-0.057*** (0.015)	Changed from grp 1	-0.107*** (0.015)	-0.092*** (0.015)	-0.036*** (0.011)
Changed from grp 1 to grp 2	-0.138* (0.043)	-0.136*** (0.041)	-0.050 (0.032)				
Changed from grp 1 to grp 3	-0.061** (0.022)	-0.018 (0.021)	-0.009 (0.016)				
BEGAN STUDYING AT A GROUP 2 COLLEGE							
Ref group: students who stay at group 2 colleges				*Ref group: students who stay at group 2 colleges*			
Changed from grp 2 to grp 1	-0.077*** (0.028)	-0.121*** (0.026)	-0.080*** (0.022)	Changed from grp 2	-0.087*** (0.021)	-0.114*** (0.020)	-0.067*** (0.016)
Changed from grp 2 to grp 2	-0.208*** (0.050)	-0.254*** (0.047)	-0.065* (0.038)				
Changed from grp 2 to grp 3	-0.050** (0.033)	-0.042 (0.031)	-0.050* (0.026)				
BEGAN STUDYING AT A GROUP 3 COLLEGE							
Ref group: students who stay at group 3 colleges				*Ref group: students who stay at group 3 colleges*			
Changed from grp 3 to grp 1	-0.088*** (0.020)	-0.198*** (0.019)	-0.090*** (0.017)	Changed from grp 3	-0.074*** (0.014)	-0.165*** (0.014)	-0.069*** (0.012)
Changed from grp 3 to grp 2	-0.066** (0.036)	-0.186*** (0.034)	-0.075** (0.029)				
Changed from grp 3 to grp 3	-0.062*** (0.021)	-0.122*** (0.020)	-0.045*** (0.017)				

Note: There are 24,411 individuals in group 1 colleges, 11,836 in group 2, and 25,163 in group 3. Table 3 describes the models. The *Adj* R^2 varies between 0.061 for model 1 and 0.520 for model 3. Standard errors are within parentheses; ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

5.4 Quantile regression estimates

Individuals who are unemployed, combine work and university studies, or have part-time jobs have lower earnings than individuals who work full time. Students, who try various types of jobs in search of a perfect match, may have shorter or longer spells of lower-paid jobs or unemployment, with lower earnings than students who select a job and stay with it. If transfer students are over-represented in any of these groups, then they will have lower earnings than non-transfer students, which in turn can explain the OLS estimates. In this case, we would expect relatively lower earnings of transfer students at the bottom of the earnings distribution.

When transfer students finally settle for a professional full-time job, their earnings should be about the same as earnings of non-transfer students, given that the OLS earnings gap is due to behavior at the bottom of the earnings distribution. This implies a narrower earnings gap at the top of the earnings distribution. At the top, the individuals probably work full time, and a potential earnings gap must be related to factors other than those at the bottom of the distribution. The quantile regression method provides estimates of the earnings differences between transfer and non-transfer students in various parts of the earnings distribution.

Table 6 reports the estimates of the earnings differences between the groups in 2005 for the same models as those used in previous sections. The estimates should be interpreted as the earnings gap in a particular percentile of the conditional earnings distribution. Table 6 includes only the estimate of the ΔC -variable, and *p10-p90* indicate percentiles of the earnings distribution; *p10* is the 10% of the sample with the lowest earnings (90% earn more) and *p90* is the 10% with the highest earnings (90% earn less).

Table 6: Quantile regression estimates of the earnings differences between transfer and non-transfer students in 2005

Percentile	Model 1	Model 2	Model 3
p10	-0.294*** (0.033)	-0.259*** (0.023)	-0.109*** (0.016)
p20	-0.182*** (0.017)	-0.200*** (0.019)	-0.079*** (0.009)
p30	-0.098*** (0.009)	-0.132*** (0.011)	-0.056*** (0.006)
p40	-0.073*** (0.006)	-0.090*** (0.009)	-0.041*** (0.004)
p50	-0.050*** (0.005)	-0.064*** (0.007)	-0.036*** (0.004)
p60	-0.030*** (0.004)	-0.049*** (0.005)	-0.031*** (0.004)
p70	-0.028*** (0.003)	-0.040*** (0.005)	-0.029*** (0.003)
p80	-0.030*** (0.004)	-0.040*** (0.005)	-0.021*** (0.004)
p90	-0.024*** (0.005)	-0.034*** (0.006)	-0.020*** (0.005)
Number of observations	61,410	61,410	61,410

Note: Table 3 describes the models. Bootstrap standard errors are within parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

The model 1 estimates show that earnings of transfer students are significantly lower than earnings of non-transfer students in all parts of the earnings distribution. But the earnings differences decrease significantly over the distribution. The estimates go from 29.4 in *p10* to 9.8 in *p30*. In *p90*, transfer students only have about 2.5% lower earnings. Obviously, transfer students at the bottom of the earnings distribution explain a significant portion of the estimated average earnings gap. Note, for example, that all percentile estimates above *p30* are less negative than the OLS estimate for 2005 in Table 3.

The other models' estimates are similar to the model 1 estimates. They are more negative at the bottom of the earnings distribution than at the top of the distribution, and percentile estimates above *p30* are less negative than the OLS estimates in Table 3. The level of model 2 estimates is about the same as model 1 estimates, while the model 3 estimates are less negative. Furthermore, model 1 and model 3 estimates are about the same in *p50–p90*.

In all, the results indicate that a large part of the average earnings differences reported in previous sections are due to transfer students at the bottom of the earnings distribution. These students might still be in college, in part-time employment, unemployed or simply between jobs. But there are significant earnings differences also at the top of the earnings distribution. The earnings gap at the top is about 2.5% and amounts to the returns from about one-half year of potential work experience in 2005 (see Table A2). One-half year is equal to one semester in college. Perhaps, this is the lowest cost of postponing labor market entry.

6 Concluding remarks

About one-third of Swedish university entrants studied at more than one university. Based on the earnings estimates in this paper, this decision does not appear to generate extra earnings in the short run. Instead, students who change universities receive significantly lower annual earnings than students who do not change universities. This concerns students who change to universities of higher, observed quality and students who change to universities of lower, observed quality. The pattern in the estimates seems consistent with transfer students spending more time in college and postponing their labor market entry. During that time period, non-transfer students accumulate experience, which results in relatively larger earnings. The earnings differences decrease significantly over time, but transfer students do

not overtake non-transfer students when it comes to earnings during our observation period.

If the trend in the data continues, transfer students might catch up or surpass non-transfer students after a few years. But it is difficult to say whether their long-term earnings growth will compensate for their lower earnings in the first few years in the labor market. If earnings of transfer students continue to grow significantly faster than earnings of non-transfer students, then in the long run, transfer students might pass non-transfer students in terms of earnings. But it is possible that non-transfer students' relatively longer labor market experience actually is worth more than transfer students' additional human-capital investment. Naturally, it is also possible that by changing universities, individuals signal that they may also be more mobile on the labor market, which some employers consider a negative factor.

By adjusting for observed ability and family background, we find that students who change universities have lower earnings, which is in contrast to results reported for the US. There are various explanations for these differences. One may be that the small sample used in the previous US study included a highly selective sample of transfer students or that lack of proper controls for family background and ability resulted in upward-biased estimates of the earnings gap. Another explanation might be that the US study follows students for a longer time period (they do not report how long they follow their students). It is also possible that there are institutional differences between the countries, which affect transfer students. For example, because Sweden's state-run system of higher education guarantees education quality (which among other things means that a university degree is identical across colleges/universities), students might not transfer primarily for the reason of improving their human-capital.

Finding out more about the process that generates the earnings differences between the groups is an issue for future research. Future research on consequences of switching universities must examine factors that affect the decision to change universities and use the information to adjust for selection of transfer students. In addition, one should investigate whether the results are sensitive to choice of empirical model.

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Appendix

Table A1: Distribution of students over universities and percentages of transfer students of college entrants per college

	The sample used in the analyses		All college entrants	
University	Number of students	Percentage who changed colleges once	Number of students	Percentage who changed colleges
Blekinge Institute of Technology	838	15.8	1,894	34.1
Borås	998	10.1	2,246	22.9
Chalmers University of Technology	1,877	11.1	4,080	34.7
Dalarna	1,455	18.5	3,382	25.8
Gävle	1,398	17.2	3,328	25.3
Göteborg	4,755	18.2	11,759	31.4
Halmstad	1,052	23.0	2,712	41.2
Jönköping	1,655	15.2	3,371	24.7
Kalmar	1,417	14.9	3,127	30.8
Karlstad	2,225	14.5	4,964	28.7
Karolinska institutet	398	10.1	1,073	24.1
Kristianstad	1,196	13.6	2,749	34.0
Royal Institute of Technology (KTH)	2,573	10.6	5,621	31.0
Linköping	4,523	13.9	8,816	25.6
Luleå	2,348	14.1	5,050	23.2
Lund	5,321	13.6	15,159	43.7
Stockholm Institute of Education	1,356	9.4	3,486	20.2
Mid Sweden	3,181	14.7	7,669	29.7
Mälardalen	2,196	22.6	5,362	31.0
Skövde	672	14.7	1,552	32.9
Swedish University of Agricultural Sciences (SLU)	489	7.4	1,189	32.1
Stockholm	4,207	28.6	11,747	41.8
Södertörn	355	22.3	1,125	54.1
Umeå	4,965	19.8	10,076	30.8
Uppsala	4,791	24.8	10,646	42.7
West	853	10.7	2,100	26.7
Växjö	1,638	13.9	3,525	33.0
Örebro	2,678	23.5	5,592	30.6
Mean		*17.3*		*33.1*
Number of observations	61,410	61,410	143,400	143,400

Table A2: Estimated returns to experience and college education for transfer and non-transfer students

Group of students	Transfer	Non-transfer	Transfer	Non-transfer	Transfer	Non-transfer	Transfer	Non-transfer
Outcome year	2002	2002	2003	2003	2004	2004	2005	2005
Potential experience	0.129***	0.187***	0.102***	0.130***	0.071***	0.087***	0.048***	0.046***
	(0.017)	(0.006)	(0.015)	(0.006)	(0.015)	(0.006)	(0.011)	(0.005)
Degree (no degree= ref group)	0.794***	0.448***	0.571***	0.282***	0.332***	0.146***	0.077***	0.036***
	(0.023)	(0.009)	(0.022)	(0.009)	(0.021)	(0.009)	(0.016)	(0.008)
Total number of credits	0.000	0.006***	0.000	0.004***	0.001	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
Fields (humanities=ref group)								
Education	0.059	0.081*	0.027	0.012	0.058	0.012	0.006	-0.018
	(0.052)	(0.048)	(0.017)	(0.016)	(0.045)	(0.016)	(0.035)	(0.014)
Social science	0.116***	0.156***	0.092***	0.094***	0.133***	0.094***	0.093***	0.066***
	(0.025)	(0.023)	(0.010)	(0.010)	(0.022)	(0.010)	(0.017)	(0.008)
Natural science	0.152***	0.151***	0.115***	0.121***	0.145***	0.121***	0.114***	0.095***
	(0.028)	(0.026)	(0.010)	(0.010)	(0.025)	(0.010)	(0.019)	(0.008)
Technology	0.085	0.182***	0.192***	0.187***	0.191***	0.187***	0.122***	0.133***
	(0.057)	(0.053)	(0.018)	(0.018)	(0.050)	(0.018)	(0.038)	(0.015)
Agriculture	0.640	0.000	0.180**	0.205**	0.181	0.205**	0.494	0.164**
	(0.451)	(0.420)	(0.083)	(0.081)	(0.396)	(0.081)	(0.303)	(0.068)
Health care	-0.014	0.054	-0.067***	-0.009	0.005	-0.009	-0.017	-0.028**
	(0.049)	(0.046)	(0.016)	(0.016)	(0.043)	(0.016)	(0.033)	(0.013)
Service and transports	0.192**	0.145	0.108***	0.126***	0.183**	0.126***	0.106*	0.038
	(0.095)	(0.089)	(0.040)	(0.039)	(0.084)	(0.039)	(0.064)	(0.033)
Adj R^2	*0.245*	*0.255*	*0.221*	*0.233*	*0.219*	*0.257*	*0.511*	*0.470*
Number of observations	10,628	50,782	10,628	50,782	10,628	50,782	10,628	50,782

Note: The estimated models correspond to model 3 (except for the dummy for changing universities), see Table 3. Standard errors are within parentheses. ***, ** and * denote significance at 1%, 5%, and 10% level, respectively.

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