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Job Creation, Heterogeneous Workers and Technical Change:
Matched Worker/Plant Data Evidence from Norway

Abstract:
Using matched worker/plant level data for Norway, theories explaining the change in skill composition are assessed using direct evidence on the job creation and destruction for high, medium and low skilled workers. Skill based job creation is analysed in detail for plants in a high-skill service sector and in low- and high-tech manufacturing sectors. Given a compressed wage structure in Norway and increased supply of high skilled workers, the supply of skills may also explain the changed skill composition. In order to disentangle the supply and demand effects, we fix the skill level by analysing the job creation process for skills within cohorts of workers.

Keywords: Job creation, heterogeneous workers, heterogeneous plants, technical change.

JEL classification: J23, J63, O33.

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1 Introduction

In advanced industrialised countries, the 1980s and 1990s have been characterised by a strong relative employment shift in favour of skilled workers. Many countries have witnessed changing labour market outcomes for unskilled workers such as falling relative wages and/or rising unemployment rates.[1] The consensus that has emerged is that these developments may be explained by an excess demand for skills that is due to either skill-biased technological change or increased trade with developing countries.[2] The idea that skill-biased technological change is the key explanation has been supported by two main analyses: analysis of the pattern of skill composition and analysis of wage premiums to workers using computers. The competing explanation has also been supported by empirical findings, but remains more controversial.

The present paper analyses the effects of trade and technology on changes in skill composition at the plant level using linked employer-employee data for Norway. Several characteristics of the Norwegian economy make this country an ideal case for the analysis of effects of trade and 'threat of trade'. First, the Norwegian economy is a very open one. Moreover, as noted by various authors, Norway demonstrates a compressed wage structure that has not changed much over time, cf. Aaberge, Bjørklund, Jannti, Pedersen, Smith and Wennemo (2000), Hægeland, Klette and Salvanes (1999) and Kahn (1998).[3] As a consequence, we do not expect changes in import competition or 'threats of trade' that shift industry product demand, or employment shifts in the same direction, to be dampened by wage adjustments. Thus, a threat of trade may easily become reality.

Two features of our analysis distinguish it from most of the empirical literature on skill-biased technological change and trade. First, and most importantly, our data allows an analysis of whether the change in skill composition is taking place for all the plants in each sector or whether the reallocation of jobs is across plants, resulting in a greater dispersion of skills across enterprises. In addition, we consider whether increased heterogeneity of skill composition across plants or segregation of skills across plants is related to plant-specific measures of technological change. Second, using a linked employer-employee data set such as ours in the analysis of gross employment changes enables us to test whether the impact of trade and technology for different education categories and worker cohorts is found primarily along the gross creation or gross destruction margins.

[1] Murphy and Welch (1992), Katz and Murphy (1992) Katz, Loveman and Blanchflower (1995), Edin and Holmlund (1995), and Entorf, Gollac and Kramarz (1999).

[2] A third explanation for changes in the wage dispersion and skill differentials is changes in labour market institutions. See for instance Gosling and Machin (1995) and Kahn (1998).

[3] Kahn (1998) and Hægeland et al. (1999) analyse two possible explanations for why the Norwegian wage structure is compressed. The present paper analyzes the structure of changed demand for skills.

The motivation for these two areas of focus is as follows:

The motivation for investigating whether the change is taking place in all plants in a sector or whether there is a reallocation of jobs across business enterprises lies in the fact that the implications of these two outcomes are vastly different. Increased demand for skilled workers, driven by, for instance, technological change, could take place in all plants in a sector, and thus be realised as a change in the skill mix in all plants. Alternatively, skill upgrading may occur via reallocation of skilled jobs and workers from certain plants to others, measured as between-plant reallocation. The latter implies a tendency towards greater dispersion across businesses, thus predicting greater segregation in the labour market across plants.

Theoretical work by Kremer (1993) and Kremer and Maskin (1996) on the effect of skill-biased technological change predicts changes in skill mix, productivity, and wages across plants, not changes for all plants. In the model, the main reason for this prediction is that technological change may lead to less substitutability of skills in production, while tasks within a plant could become stronger complements. The latter mechanism could lead to matching of workers of similar skills in plants.

Support for these processes is provided by Kremer and Maskin (1996) and especially by Dunne, Foster, Haltiwanger and Troske (2000), with industry-level data by Caselli (1999). In addition, work by Foster, Haltiwanger and Krizan (1998) suggests that there are important profitability gains that result from the reallocation of factors of production from less productive to more productive plants within narrowly defined sectors in the US.

The fact that we utilise plant-level data allows us to decompose job reallocation into that within and that between plants, and the linked employer-employee data allows us to conduct this decomposition for workers of different skill or education levels. Moreover, as we have access to plant-level information on investment in physical capital, we are able to construct a plant-level index of machine capital vintage Mairesse (1978). This enables us to test whether technological change (as shown by this index) can explain reallocation of jobs and workers, and thus whether increased segregation between plants is driven by technological change or, alternatively, by increased trade competition. An additional question that we consider in connection with skill mix and technological change is whether restructuring occurs through changing production lines and the introduction of new technology for continuing plants, or through new plant entries with new capital and highly skilled workers combined with exiting of old plants with less skilled workers. Once again, given our detailed, linked employer-employee data set, which also identifies plant exit and entry, we are able to separate job creation and job destruction by skill differences of plant turnover (entry and exit) and job turnover for continuing plants.

We exploit the gross worker and gross job framework in our setting to obtain a much more detailed picture of the employment effects of trade and technological change, cf. Davis and Haltiwanger (1992) and Burgess, Lane and Stevens (2000). As the gross job flow literature distinguishes between expanding and contracting plants along a scale of worker types, and as we can link these changes to changes in pattern of trade at the sector level and indices of technological change at the plant level, we are thus able to derive two contending hypotheses. We may investigate whether increased import competition leads to displacement of low skilled workers or whether new jobs are not created for low skilled workers in plants facing stiffer foreign competition. The distinction between these two is not apparent from an analysis of net changes that does not distinguish between job creation and job destruction. However, the two will have different policy implications. In fact, displacements from increased trade or technological change are the greatest concern of policy makers and the general public, and both private and public adjustment costs depend primarily on gross changes.

In a similar vein, we are also able to test whether the change in employment for high and low skilled workers is found at different margins, i.e. involving job creation or job destruction, from technological change. This is, in fact, one of the features that distinguishes our approach from the standard approaches taken in the skill-biased technological change literature (see Chennels and Reenen (1999) for a review of the literature).

The structure of our paper is as follows: In Section 2 we provide a description of the data set and a brief overview of the Norwegian economy. Section 3 includes a detailed description of our methodology, with particular emphasis on the connection between the gross job and worker literature and plant-level models of dynamic demand for labour. Section 3 also presents a discussion of the change in skill composition in the Norwegian economy. The conclusion is that the change in Norway is at the same level of magnitude as that in other OECD countries, as measured by the standard decomposition formula, cf. Berman, Bound and Griliches (1994). In Section 4, we argue that the gross worker and job reallocation flows represent important changes in the Norwegian economy and that the changes are in favour of highly educated workers. Once more, the focus is on the question of the margin at which these changes are found. Are the changes in skill composition occurring through displacement of low educated workers or through a higher degree of job creation for the highly educated? Analyses are carried out for manufacturing and a selected service sector, here the financial sector. The motivation for including a service sector is the possibility that the aggregation from plants to sector for manufacturing may arbitrarily aggregate high skill and low skill plants. We then show that the findings represent permanent or long-term structural changes, not mere cyclical fluctuations.

An important assumption in previous studies of changing skill composition is that an observed change in skill composition may only be explained by a change in the demand for skills; it may not be explained by an increase in the general level of education in the workforce. The supply of medium and highly educated workers has increased in Norway in the 1980s and 1990s. An increased supply of education is necessary if the skill composition in a country is changing towards a higher level of education. However, the issue at stake is whether it is supply or demand that is the cause of the change (see, for instance, Caselli (1999)). In other words, the question is whether we are witnessing the birth of 'new' jobs, where plants demand and create new task requirements, or whether 'old jobs' are merely being filled with more highly educated workers. We are able to address this question in part by fixing the supply of education and evaluating the pattern of job changes for education categories within worker cohorts.

In Section 5, we decompose the aggregate changes into between-plant changes and changes taking place within all plants. We also analyse the role of restructuring via plant exit, entry, and continuation. In Section 6.1 we provide descriptive statistics to link the observed changes in gross job flows for different skill levels to observed changes in import and export competition and to the index for technological change. As descriptive statistics will hide heterogeneity across plants, we specify dynamic plant-level demand functions for job and worker flows. In doing so, we consider expanding and contracting plants separately for total hires and for various categories of workers.

As our aim is to test the competing hypotheses of trade and technological change effects on job and worker reallocation, we augment the demand functions by indices for trade and technological change. This is done in Section 6.2. Further, since plant-level heterogeneity is of particular interest, we introduce plant-level measures of technology (machine capital vintage) in order to analyse this heterogeneity. We also carry out the analyses in an industry (3-digit)-fixed effect framework in order to focus on between-plant changes within industries. We proceed to test the robustness of our results by including other plant and industry variables that might explain a possible link between, for instance, job destruction rates and exposure to trade or technological change. Section 7 presents our conclusion.

2 The Norwegian Economy and Data Set

In this section, we provide a brief overview of the Norwegian economy in the period of our analysis, as well as a description of our data set. It is our contention that Norway represents an exception to the general OECD tendency towards a widening wage gap in general and increased returns to education in particular. This feature of the Norwegian economy makes it an ideal case for the investigation of trade effects, as employment effects are not dampened by wage adjustment. In order to argue that the Norwegian economy is an interesting case in this respect, we must also demonstrate that it shares patterns of trade and R & D investment with other OECD countries if we are to generalise on our conclusions. Thus, we shall compare the Norwegian manufacturing sector under analysis here with that in other OECD countries along these dimensions to show that the patterns in question are similar over countries.

2.1 Data description

In this paper, we draw on numerous data sources. Most important is the linked employer-employee data set based on different administrative files from Statistics Norway, supplemented with plant-level information on economic performance for plants from the annual census for manufacturing, see Halvorsen, Jenssen and Foyn (1991). The main data set has also been supplemented with trade statistics at the 5-digit ISIC level in order to construct import penetration measures from the trade statistics from Statistics Norway. We have also added information on which R&D category each 3-digit industry belongs to. In addition, the OECD sector level (about 3-digit ISIC) STAN database has been used as the basis for an international comparison of import and export shares in the manufacturing sectors, as well as for R&D intensity in the manufacturing sector. The data period extends from 1986 to 1994.

In these administrative files, individuals are identified by their personal identity code and plants by an identification code. This enables us to match persons to plants and to combine information on education, age, tenure etc. with employer characteristics at the individual level. Our database contains annual information for all employed individuals over the age of 16 and all plants in Norway. The employers are identified at the plant level through an identification code dependent on geographical location and independent of ownership conditions. We restrict our attention to plants with an average size of at least five employees, since plant- or firm-specific information is not available for plants below five employees. When merging the data from the manufacturing sector census file for the econometric analysis, the match by plant numbers was foumd to be about 90 percent.

In the second quarter each year every worker is matched to his/her main employer. The start date of this match is provided by the main employer, as is the stop date. For each worker, the following information is available for the period from 1986 to 1994: working hours per week, union membership, whether the worker holds multiple jobs, annual income, education, and basic demographic background variables. Education level is based on the normal duration of the education and includes only completed programs of education (and highest attained) education. All courses of formal education exceeding 300 hours are registered. The employers are identified at the plant level by an identification code that is dependent on geographical location and independent of ownership conditions. A number of plant-specific variables are available for our study: plant and firm size, value of production, insurance value of capital, value added, and investment.

For the econometric analysis only workers with full-time jobs (30 hours or more per week) were included. For the descriptive statistics all workers were used. See the Appendix for precise definitions.

2.2 Characteristics of the economy

2.2.1 Wage distribution, returns to education and employment

In the following, we present a brief overview of the Norwegian labour market to serve as a background for the analysis. As in most other countries, the Norwegian labour market has experienced a decrease in the supply of low-educated workers as the share of the total labour force has declined since the 1980s. The supply of medium- and highly educated workers has increased, shown in Figure 1.

Figure 1 here.

It has been well documented elsewhere that the Norwegian economy is characterized by a very compressed wage distribution and that there has not been any widening of the gap in the period under analysis here, i.e. 1986-1994 (Aaberge et al. (2000), Hægeland et al. (1999) and Kahn (1998)). In this section, we show in Figure 2 that this is also true for the relative earnings of the education categories of workers we are using in the present analysis. The 90/10 percentile ratio for the whole economy using all full-time workers is also shown.

Figure 2 here.

This feature also holds true for this data set using full-time workers. In other words, there has not been an increase in wage dispersion over time and the relative status of real earnings between highly and medium- and highly and low-educated workers is very stable over time. Returns to education in the data period are presented in Figure 3, where log earnings are estimated as a function of experience and tenure as second order polynomials, with a dummy for gender and years of education as a linear term. Results for the whole economy and for manufacturing, private services and the public sector are presented.

Figure 3 here.

Returns to education, which have been an important cause of the change in the earnings distribution in many countries, have been quite stable over time in Norway, as also shown in Hægeland et al. (1999). Returns to education in general are at the lower end of the scale, compared to other countries. Although there are substantial differences across sectors, with the public sector with the lowest returns to education and private services with the highest, returns to education within each sector have been stable over time, as is seen from Figure 3.

The period we are analyzing is also one that witnessed increased unemployment in the Norwegian economy. The unemployment rate rose from about 2 percent in 1986/87 to 6 percent in 1993. As relative wage changes in the economy have been minimal, this may have led to changes in quantities instead. This would imply higher relative unemployment rates for the low-educated workers. In Figure 4 we present unemployment rates for three education categories along with the relative unemployment rates for the three worker categories used in the study.

Figure 4 here.

It is clear that the unemployment rate was increasing from 1988/89 on, and that it was higher for the low-educated workers. However, the relative unemployment rates between the medium- and low-educated and between the high- and low-educated are quite stable over time. There do not appear to have been any important changes in the relative unemployment rates, even if no changes have taken place in the relative earnings if we measure along formal education, as we do in the present study.

2.2.2 Trade and technology

It is important to our analysis to situate the Norwegian economy in an international context with respect to technology and trade. We have done so by utilizing information from a data set compiled by the OECD, known as STAN (the Standardised Analytical Database). In this industry (3-digit ISIC level) panel data, base measures of R&D and trade have been constructed to provide internationally comparable industry-level figures. The data set is based on information provided by central statistics agencies in the member countries.

Industry-level R&D expenditure is measured as the amount of R&D conducted by sector. Information on value added per industry is also included. As we concentrate primarily on the manufacturing sector in what follows, we have chosen to construct a measure of R&D intensity defined as R&D expenditure by the manufacturing sector, divided by value added.

Figure 5 here.

In Figure 5, development in R&D intensity in Norway's manufacturing sector is compared to development in the same sector in Sweden and the UK. These two countries were chosen for two main reasons. The first is that Sweden and the UK represent examples of a comparable small economy and a large economy, respectively. The second is that the UK is one of the key examples of a country with a widening wage gap, and the impact of technology has been cited as one of the most important explanations here.

As seen in the figure, R&D intensity was highest in Sweden in the period in question, and it increased sharply from 1990 onwards. The UK, which has clearly witnessed a striking shift in the distribution of wages in favour of the highly skilled, demonstrates a higher R&D intensity than Norway, though not much higher, as seen in the figure.[4] It is relevant to note in this connection that R&D intensity in the Norwegian IT sector (ISIC 382, 383, 385) is very high compared to the OECD average, as pointed out by Klette and Moen (1999). Thus, the effect of technological change on the demand for skills is expected to be no less in the Norwegian manufacturing sector than it is in the other OECD

[4] In Machin, Ryan and Van Reenen (1996), Table 1, the same data set is used and the US and Denmark are included, in addition to Sweden and Denmark. The US ranks first in R&D intensity and Denmark is far behind the UK (and Norway).

countries. It is important to note this feature, as we use these sectors as the R&D-intensive sectors in the first part of the econometric analysis.

In Figure 6, the development of the share of imports and exports relative to total production for the manufacturing sector in the three countries is presented.

Figure 6 here.

For the economy as a whole, including primary sectors such as fisheries, timber production, oil and gas, Norway demonstrates a very high export share of GDP (Baldwin, Forsli and Haaland (1995)). In this sense, the manufacturing sector in Norway, as presented in Figure 6, has a relatively modest export share. The export share for the manufacturing sector is ranked between Sweden and the UK. On the other hand, import competition is expected to have a more significant impact on Norwegian manufacturing, since this sector's share of imports is highest: imports reach 40 percent of GDP for Norway.

3 Demand for labour at the plant level

This section shows how the concepts of gross flows of jobs and workers are embedded in the standard dynamic demand function for labour used in the literature. Since the present paper focuses on the restructuring process, and especially on whether we observe changes for all plants in a sector or whether there is reallocation between plants, we show how measures of between and within plant reallocation are derived. We also consider the role of exit and entry of plants in the reallocation of jobs. Lastly, the plant level demand functions for gross job and worker flows are specified for the econometric analysis.

3.1 The relationship between labour demand and gross job and worker flows

In order to argue for analyzing plant-level gross hires and separations, as well as job creation and destruction, it may be useful to see how the model of gross job and worker flows is embedded in the standard dynamic labour demand model. In order to see the relationship, let us reconsider how the net employment change for plant e at time t for worker type j, $\Delta L_{e,j,t}$, i.e. the employment change for type j of workers, is a result of gross flows of workers:

$$\Delta L_{e,j,t} = H_{e,j,t} - S_{e,j,t} \tag{1}$$

The focus of the standard dynamic labour model, net change of workers, $\Delta L_{e,j,t}$, is given as the left-hand side of equation 1. As seen from the right-hand side the employment change in period t is the result of the number of hires, $H_{e,j,t}$, and separations, $S_{e,j,t}$. The focus in this paper will be on both the net change of workers or jobs at the plant level and on the gross flows of workers behind the net changes, i.e. on hires and separations of workers.

First, following the job turnover literature, the left-hand side is referred to as net job creation for a plant, $NJC_{e,j,t}$. For a plant e for worker category j, we have job creation $JC_{e,j,t}$ if $NJC_{e,j,t}$ is positive, while a negative flow is denoted job destruction $JD_{e,j,t}$. Consequently, focussing on the gross flows of jobs at the plant level means that we are distinguishing between plants that are: expanding in jobs, either in general or in a particular worker category, reducing in size, or remaining stable. Thus, this basically implies analyzing a dynamic demand function at the plant level, but distinguishing between plants that are expanding, $\Delta L_{e,j,t} > 0$ or decreasing in size for a particular type of workers, $\Delta L_{e,j,t} < 0$. By assessing jobs that are destroyed, for instance for low skilled workers, and jobs that are created for high skilled workers, both as a consequence of increased trade and technological change, we obtain a much broader picture of the changes taking place. Some plants expand and others contract in the scale of different worker types, and since we are able to link these changes to changes in the trade pattern at the sector level, and to indices of technological change at the plant level, we also obtain a much more detailed picture of plant heterogeneity. For instance, we are able to distinguish between hypotheses such as: increased import competition leads to displacement of low skilled workers, or new jobs are not created for low skilled workers in plants hit by tougher competition from abroad. Although it may not be obvious from analyzing net changes, as there is no distinction between job creation and job destruction, these two outcomes of trade have vastly different policy implications. Similar hypotheses exist for the effect of skill-biased technological change. This is, in fact, one of the distinguishing features of the present paper as compared to the standard skill-biased technological change/trade literature (see Chennels and Reenen (1999) for an overview of the literature). We will also consider the combination of job creation and job destruction, i.e. net job creation, in order to assess the combined or net effect of plants expanding and reducing total employment or employment for certain worker groups.

Secondly, the composition of the work force in a plant may also be changed by replacing one type of workers with another without changing the scale of the plant or the number of jobs. This will be the other aspect of *gross* changes at the plant level: changes of the composition of workers at the plant level given the number of jobs. Separations include both voluntary quits and firings, and hires include both replacing separated workers and hiring new workers in order to expand. Note that there may be hires and separations even if the net job change is zero, i.e., $\Delta L_{e,j,t} = 0$. As compared to the dynamic labour demand model, estimating hires and separation functions is to estimate dynamic demand functions for plants with positive hires, and separately from plants with positive separations.

Hire and separation functions at the plant level are different from job creation and job destruction functions at the plant level, since hires includes all hired workers, including those replacing other workers, and separations includes workers separating but being replaced. This may be seen from the following decomposition of equation 1:

$$\Delta L_{e,j,t} = H_{e,j,t} - S_{e,j,t} = JC_{e,j,t} + R_{e,j,t} - \left(JD_{e,j,t} + S^R_{e,j,t}\right) \tag{2}$$

Total hires, $H_{e,j,t}$, can be decomposed into creation of jobs, $JC_{e,j,t}$, and rehires, $R_{e,j,t}$, of workers due to workers quitting or workers displaced for other reasons. Separations may be decomposed into destruction of jobs or plants' reducing the total size of the plant or one worker group, $JD_{e,j,t}$, and separations which are being replaced, $S^R_{e,j,t}$. The later is referred to as churning or replacement flows in the literature, and consists of the sum of hires and separations (equal in equilibrium) due to replacement, $R_{e,j,t} + S^R_{e,j,t}$.[5] Replacement separations can be split into quits and fires, but we cannot distinguish between these in the data.[6]

3.2 Decomposing job flows in between and within sectors and plants

The question of how to measure the role of within and between plant reallocation of different categories of workers is vital to our analysis. In the following we will show how these entities may be retrieved. The role of exit and entry of plants in the reallocation of workers will also be shown. However, first we define the measures of job and worker reallocation for different education categories at the sector level.

In order to assess the job creation and destruction rates for sectors, we convert the measures into rates and aggregate over plants. The aggregate job creation rate for education type j ($JCR_{j,t}$), from $t-1$ to t, is the aggregate increase in jobs of education type j for plants expanding in education type j, divided by the level of jobs of education type j. Adopting the standard established by Davis and Haltiwanger (1992), we use as the denominator the average of the present and previous size of education type j. The advantage of this measure is that it incorporates exit and entry rates in a natural way. The job destruction rate ($JDR_{j,t}$) is then defined in a similar way by the aggregate reduction of education type j from time $t-1$ to t, and using the mean of the present and previous size of education type j as the denominator. Job creation can be due to both new entry ($ENTRYj,t$) and to expansion ($INCR_{j,t}$) of established plants, and job

[5] I follow the literature here and assume no vacancies, which implies that replacement hires, $R_{e,j,t}$, and replacement separations, $S^R_{e,j,t}$, are equal in equilibrium.

[6] However, by using a business-cycle indicator to identify whether replacement separations have a pro- or counter-cyclical pattern, it has been shown that most of these changes are pro-cyclical, which is a strong indcation that most of the changes are quits. This is also supported by studies from other countries, e.g. Hamermesh, Hassink and van Ours (1996).

destruction can be due to exit ($EXIT_{j,t}$) and reduction ($DECR_{j,t}$) in continuing plants. We can therefore determine whether restructuring is mainly the result of entry/exit or of established plants changing their production lines. The total job reallocation rate ($JRR_{j,t}$) is the sum of job creation and job destruction, and net job creation change ($NJCR_{j,t}$) is the difference between the job creation rate and the job destruction rate. The following rates for job creation (entry, increment for established plants), and job destruction (exit, declining) for skill type j, may thus be defined as:

$$ENTRY_{i,t} = \frac{2}{L_{i,t-1} + L_{i,t}} \sum_{\substack{e \notin E_{i,t-1} \\ e \in E_{i,t}}} L_{e,t} \tag{3}$$

$$INCR_{j,t} = \frac{2}{L_{j,t-1} + L_{j,t}} \sum_{\substack{e \in E_{e,j,t-1}, E_{e,j,t} \\ dL_{e,j,t} \geq 0}} |L_{e,j,t} - L_{e,j,t-1}|$$

$$EXIT_{i,t} = \frac{2}{L_{i,t-1} + L_{i,t}} \sum_{\substack{e \in E_{i,t-1} \\ e \notin E_{i,t}}} L_{e,t-1}$$

$$DECR_{j,t} = \frac{2}{L_{j,t-1} + L_{j,t}} \sum_{\substack{e \in E_{e,j,t-1}, E_{e,j,t} \\ dL_{e,j,t} \leq 0}} |L_{e,j,t} - L_{e,j,t-1}|$$

respectively, where $E_{e,j,t}$ is the set of establishments with employment of skill type j in year t, and $L_{j,t}$ is the total employment of type j, defined by: $L_{j,t} = \sum_{e \in E_{j,t}} L_{e,j,t}$. The gross job creation and gross job destruction *rates* of industry i in year t for worker type j are given by:

$$JCR_{j,t} = INCR_{j,t} + ENTRY_{j,t} \text{ and } JDR_{j,t} = DECR_{j,t} + EXIT_{j,t} \tag{4}$$

respectively. The net job creation rate and job reallocation rate are given by:

$$NJCR_{j,t} = JCR_{j,t} - JDR_{j,t} \text{ and } JRR_{j,t} = JCR_{j,t} + JDR_{j,t} \tag{5}$$

In addition to the total job reallocation rates for each education category, we are interested in how the restructuring process takes place and especially whether the change in skill composition is taking place for all plants in each sector or whether reallocation of jobs is across establishments. Measures of between and within plant reallocation may be retrieved by deriving the between plant job reallocation measure and the total job reallocation measure. The between plant reallocation rate is the standard job reallocation for all worker categories taken together:

$$BJRR_t = JCR_t + JDR_t \tag{6}$$

Weighting the job creation and job destruction rates for each education type by the share of skill types, the total job reallocation measure for both within and between plants can be constructed:

$$\begin{aligned} TJRR_t &= \frac{L_{l,t}}{L_t}\left(JCR_{l,t} + JDR_{l,t}\right) \\ &+ \frac{L_{m,t}}{L_t}\left(JCR_{m,t} + JDR_{m,t}\right)\frac{L_{h,t}}{L_t}\left(JCR_{h,t} + JDR_{h,t}\right) \end{aligned} \tag{7}$$

where l, m, h are indices for low, medium and highly educated workers we use in the paper. The within plant job reallocation measure is then the difference between total job reallocation and the between job reallocation measure:

$$WJRR_t = TJRR_t - BJRR_t \tag{8}$$

Note that the job reallocation rates for each education group may be higher than the job reallocation rates at the plant level for all skills taken together. The reason is, of course, that it may well be that changes in skill mix within plants may take place, e.g. from low to high skills, without changing the size of the plants.

3.3 Econometric specification of plant level dynamic demand functions

In order to assess the effect of technological change and trade on the demand for different skill levels of workers, we will specify plant-level dynamic demand functions for gross job changes and gross worker changes as described in Section 2.1 for three skill categories.

The starting point is that a plant has a production function with input in three labour categories, with non-labour input and with capital combined into value added output separable from other material input. Facing exogenous prices in the input markets, the plant minimizes the cost of producing a planned level of value added output each year. Applying Shepard's lemma we can then derive the conditional demand functions for each labour input expressed as a function of wages and planned output, and expanded with factors such as proxies for technology and trade. In our case we specify dynamic demand functions and define variables in changes, since we consider gross changes of jobs and workers, cf. Hamermesh (1995). Further, we assume that there are two types of plants since we consider gross changes. And following Hamermesh (1995), a plant either creates jobs for a particular worker category (or hires workers of that category) or it destroys jobs for a particular worker category (or separates workers of that category). The following plant-level econometric specification for plant e for gross job creation and job destruction and for gross hires and separations is then used for three labour categories – here we present only for job changes, and not hires and separations – for plants expanding in size for one of the three worker categories, i.e. for $JCR^l_{e,t} \geq 0$, or $JCR^m_{e,t} \geq 0$ or $JCR^h_{e,t} \geq 0$, respectively.

$$\begin{aligned} JCR^l_{e,t} &= \alpha \sum_j \Delta w_{e,j,t} + \beta \Delta q_{e,t} + \gamma T_{e,t} + \delta \Delta TR_{s,t} + \lambda I^c_{s,t} + \varepsilon_{e,t} \\ JCR^m_{e,t} &= \alpha \sum_j \Delta w_{e,j,t} + \beta \Delta q_{e,t} + \gamma T_{e,t} + \delta \Delta TR_{s,t} + \lambda I^c_{s,t} + \varepsilon_{e,t} \\ JCR^h_{e,t} &= \alpha \sum_j \Delta w_{e,j,t} + \beta \Delta q_{e,t} + \gamma T_{e,t} + \delta \Delta TR_{s,t} + \lambda I^c_{s,t} + \varepsilon_{e,t} \end{aligned} \tag{9}$$

Similarly, the specification for plants reducing in size in one of the three categories is, i.e., for $JDR^l_{e,t} \geq 0$,or $JDR^m_{e,t} \geq 0$ or $JDR^h_{e,t} \geq 0$, respectively:

$$\begin{aligned} JDR^l_{e,t} &= \alpha \sum_j \Delta w_{e,j,t} + \beta \Delta q_{e,t} + \gamma T_{e,t} + \delta \Delta TR_{s,t} + \lambda I^c_{s,t} + \varepsilon_{e,t} \\ JDR^m_{e,t} &= \alpha \sum_j \Delta w_{e,j,t} + \beta \Delta q_{e,t} + \gamma T_{e,t} + \delta \Delta TR_{s,t} + \lambda I^c_{s,t} + \varepsilon_{e,t} \\ JDR^h_{e,t} &= \alpha \sum_j \Delta w_{e,j,t} + \beta \Delta q_{e,t} + \gamma T_{e,t} + \delta \Delta TR_{s,t} + \lambda I^c_{s,t} + \varepsilon_{e,t} \end{aligned} \tag{10}$$

In the specification we have defined three gross job creation and three job destruction functions for three categories of workers. The worker groups are defined by the general education level ($l$ow=up to ten years, $m$edium=between 10 and 14 years, and $h$igh=15 years and more). $\Delta w_{e,j,t}$ is the change in wage for each worker category for each plant. $\Delta q_{e,t}$ is the change in value added for each plant e. $I^c_{s,t}$ is a business cycle indicator specified in order to control for business cycle changes, since the focus in this paper is primarily on structural changes from trade and technological change and not on business cycle fluctuations in the demand for labour. $\varepsilon_{e,t}$ is the standard error term. As is standard in the job flow literature, the manufacturing wide net job creation rate was used as an indicator for the business cycle. $T_{e,t}$ is a variable consisting of two different indicator variables for technological change. First we test a general measure, which is a 3-digit industry level classification, into high-, medium- and low-tech industries based on R&D expenditure. The R&D measure defines three digit industries as low-, medium- and high-tech industries and thus two indicator variables are defined with low-tech sectors as the reference category (See the Appendix for definitions). Alternatively, we use a more interesting plant level measure of the machine capital vintage. This measure is due to Mairesse (1978), and is constructed using investment data in machine capital. The argument for using this variable, is that through investments old plants may acquire the most recent technologies and that new technology is embodied in the latest vintages of capital. Thus new capital is better or more productive than old capital not only because of wear and tear but because new capital is more productive than the old capital even when the old capital was new (Johansen (1959), Johansen (1972); Solow (1956), Solow (1960)). Since we want to estimate the effect of the vintage of capital isolated from the effect of the age of the plant, we introduce the age of the plant also in this equation. So far, most studies of skill-biased technological change have used industry-level data. Thus, a detailed indicator of the vintage of the capital at the plant level is also a novel feature of this study. $\Delta TR_{s,t}$ is a 2 dimensional vector including the 5-digit import penetrating ratio and the export penetration ratio. The variables are defined in the Appendix.[7] Since most of the recent literature shows that the within industry component of adjustment is very important, we also estimate specifications where we include industry fixed effects (3-digit level). With industry fixed effects, the results are to be interpreted as changes over time in job creation and destruction within an industry. In order to control for other factors that may explain a relationship between trade and/or technological change, we also estimate specifications where we include other plant and sector specific variables in order to check the robustness of our results. The variable is a p-dimensional vector of plant and industry specific variables encompassing these control variables.

The link between import competition and employment reallocation is relatively straightforward. A change in import competition shifting industry product demand will tend to shift employment in the same direction. Changes in export competition work in the same way. The magnitude of the employment effect will depend on the nature of the labour market and the characteristics of the wage setting. In a system with very flexible wage setting, wage adjustment is expected to dampen the employment effect. As shown in the previous section there has been little change either in the wage distribution in general or in the relative wages for the groups of workers we are analyzing. It has been argued that this has been due to a centralized system of wage bargaining in which the biannual negotiations account for 40 to 60 percent of the wage change. By exploiting this particular feature of the Norwegian institutional setting we should actually be able to identify trade effects on employment if they are important.

In addition to the general reallocation of labour resulting from changes in import and export competition, different effects are expected for different skill levels of workers if different skill levels are imperfect substitutes. One of the advantages of the present study is that we can identify whether changes in the composition are the result of jobs being destroyed or workers being displaced for the different skill groups following import competition, or whether jobs are being

[7] For a discussion of the use of quantity measures of trade as opposed to price measures under different assumptions of market structure, cf. Kletzer (1998). It should also be pointed out that using quantity measures of trade does not capture " threat of trade" contained in some theoretical approaches linking the worsening labour market positions of the less skilled to trade.

created in the sectors with positive export conditions. Although we would expect reallocation for all categories of workers, we would, in particular, expect gross job destruction for low educated workers following increased import competition. We would not, however, necessarily expect reduced job creation for low-skilled workers in sectors hit by a negative trade shock. For highly educated workers the effect may be opposite; they may be relatively insulated from negative trade shocks, but new job openings in sectors with positive trade shocks may attract highly educated newcomers in the labour market.

The effect of technological change as an explanatory factor for the change in the skill composition is a stronger increase in net job creation for highly educated workers as compared to low-skilled workers. This follows as the skill-biased technical change implies a complementarity relationship between technology and skilled workers. However, since plants that are investing in new technology may also expand production in general, they may demand more workers of all categories in addition to changing the composition of the work force. Behind the net job creation pattern we expect to find strong positive gross job creation for highly and possibly medium-educated workers. One hypothesis may also be that workers with low education are being displaced from plants with new technology. The alternative here is that the impact from skill-biased technical change is only via the job creation margin and not the job destruction margin; low skilled workers are not displaced from plants investing in new technology; they are just reallocated from plants with old technology to plants investing in new technology.

4 Changes in the skill composition in the Norwegian manufacturing and financial sector.

The purpose of this section is to document the change that has taken place in the skill composition of the Norwegian economy and to demonstrate that it is at the same level of magnitude as for other OECD countries. First, we present results using the standard decomposition in between and within sectors to obtain a first impression of the type of changes taking place and to compare with other studies. Then we do a more detailed analysis of gross flows of jobs and workers for three education categories. We also compare the changes in the manufacturing sector with the changes in the financial sector. Then we show that these changes represent a permanent structural change and not only business cycle fluctuations.[8]

[8]Manufacturing is by far the largest sector, comprising on average 7909 plants (>5 employees) and employing about 280 000 workers in this period. Banking and insurance is only about one-fifth the size in plants and workers. The relative shares of different skill groups also differ between the two sectors. The low skill share is, on average, 57 percent in manufacturing ,whereas it is only 28 percent in banking and insurance. Thus, banking and insurance is a more human capital-intensive sector with a share of 61 percent for medium-skilled and 11 percent for high-skilled. Over the period there is a decline both in manufacturing and banking and

4.1 Decomposition of changes in the proportion of high-, medium- and low-educated workers.

As seen from Table 1, the overall reduction in the employment share for low-educated workers in manufacturing is about 12 percent. This reduction is matched with a strong increase in the employment share of medium-educated workers amounting to 10 percent over the period. The increase in high skilled has been about two percent. The change in the financial sector is similar but less dramatic - starting from a much higher human capital level as measured by years of education. The share of low-educated workers decreased by about six percent and the share of high-educated workers by 4.1 percent. It is important to note that these figures for the change in the work force composition are at the same order of magnitude as those for other countries. Thus Norway demonstrates the same pattern as they do.

Table 1 here.

Decomposing changes in skill proportions into within and between sectors shows that most of the change took place within sectors at a four-digit level (ISIC), both in manufacturing and in the financial sector.[9] The following standard decomposition formula was used: the aggregate change in skill proportion over the time period, ΔP^j, can be decomposed as follows: $\Delta P^j = \sum \Delta S_i \bar{P}_i^j + \sum \Delta P_i^j \bar{S}_i$, where i=1,... ,n is the number of industries, P_i^j is the share of skill type j in industry i, S_i is the employment share in industry i, and a bar above the variable denotes the time mean. As can be seen from the last columns in Table 1, about 90 percent of the change is due to changes within sectors. This is indirect evidence of skill-biased technical change and therefore supports the findings of previous work, cf. Berman et al. (1994), Machin (1995), Hansson (1996), Berman, Bound and Machin (1998) and Haskel (1996). Given the importance of intra-sector changes we will now assess what is behind these net changes in the work force composition over time in Norway by exploiting the matched data set.

4.2 The pattern in job creation and destruction in Norwegian manufacturing and financial sector

When comparing the mean of the annual rates of job creation and destruction for education groups in manufacturing,as shown in Table 2, it is clear that the average job reallocation rates differ over education categories. The net job creation rate ($NJCR$) for low-educated workers is negative with a reduction rate of four percent annually, while both medium- and highly educated workers have a positive net job creation rate of one and five percent, respectively. For each

insurance in the number of plants and total employment.

[9]The number of 4-digit ISIC sectors in banking is limited (only 5) as compared to 75 for manufacturing, so the between and within sector skill change has a somewhat different interpretation.

low-educated job destructed, only 0.67 jobs have been created (JCR/JDR). For medium- and highly educated workers 1.08 and 1.22 jobs have been created for each job destroyed.

Table 2 here.

As an indication of the importance of worker reallocation between plants, in addition to the role of job reallocation, the total hire and separation rates are also included in Table 2. The number of hired workers per job created (HR/JCR) varies between 1.3 and 1.9 for the different education categories, and the number of separated workers for each job destroyed varies between 1.5 and 1.8. This implies that reallocation via worker flows above job reallocation between plants is also of vital importance. These figures are also similar to those found in the literature (Burgess et al. (2000) Albæk and Sørensen (1998), Hamermesh et al. (1996)). In sum, there is a clear tendency in manufacturing, which in aggregate shows a declining employment level of three percent in this period. This tendency is that jobs created for medium- and highly educated workers are in excess of jobs destroyed, while jobs created for workers with a low education level are outnumbered by jobs destroyed. Hence there is quite a strong substitution away from low- to highly skilled workers.

A similar picture emerges for the financial sector. Considering the mean of annual rates, only 0.72 jobs are created for each low-educated job destroyed while 1.12 jobs are created for each highly educated job destroyed. Jobs for low-educated workers thus decreased annually by four percent, while jobs for highly-educated workers increased annually by two percent. One important difference between the two sectors is that jobs for medium-educated workers on average decreased over the period considered in the financial sector, whereas the number of jobs for this group increased in the manufacturing sector. Hence, a complementary relationship appears to exist between low- and medium-educated workers in banking and insurance. The difference between the positive net job creation rate for highly educated group and the negative job creation rate for low-educated group is also less in the financial sector than in manufacturing. This indicates somewhat less restructuring from low- to highly educated. However, the employment shares of high- and medium-educated are higher at the outset in the financial sector, and a lower substitution effect between highly educated and low-educated is thus expected. The importance of worker reallocation between plants is as important in the financial sector as in the manufacturing sector, in that 1.5 hires is taking place for each job created, and *vice versa* for the separations to jobs destroyed.

By considering the gross job creation and job destruction rates given in Table 2, we are able to identify which of the two is the driving force behind the net substitution effect. We notice that it is the gross job creation rates and not the gross job destruction rates which explain the negative net job creation rates for low-skilled workers and the net increase in jobs for high-skilled workers both in manufacturing and in the financial sector. Hence, it is the "new" jobs being established which cause the change in skill composition between plants and not the fact that jobs for low-educated are disappearing at a higher rate. Jobs are disappearing for all education levels, and in manufacturing gross job destruction is actually higher for the highly educated workers than for medium- and low-educated workers.

As an additional analysis we assess whether this between plant reallocation of jobs for different types of workers takes place in plants that are changing the scale of production simultaneously, i.e. downsizing or increasing in size. We split the data set into expanding, contracting and stable plants. In this way, we can relate restructuring to overall change in the size of plants.

Table 3 here.

In Table 3, we see that there is a symmetry in the percentage of plants that are expanding and contracting; 47 and 46 percent respectively, while the employment level is unchanged in seven percent of the plants. If we concentrating on the net job creation rates ($NJCR$), a clear tendency is apparent: expanding plants create a larger degree of high-skill jobs, whereas declining plants destroy relatively more low-skill jobs. Thus, the structural change as represented by skill substitution is taking place along with changes in the size of plants: downsizing occurs mainly in low-skill jobs, while size expansion occurs mainly in high-skill jobs. The same restructuring from low- to high-skill workers is taking place in stable plants, but the level of restructuring is far less here, where the size of the plants is constant.[10] The same pattern is found for the financial sector.

4.3 Long-run effects

The strong annual pattern, particularly in gross job creation for certain education groups, leading to substitution from low to high skill workers, represents a continuing structural change, since we know that jobs created and destroyed represent permanent changes (Klette and Mathiassen (1996); Salvanes (1997)). Hence, the substitution away from low-skilled to high-skilled workers is even more pronounced when we consider the change in a longer time trend. Table 4 provides four-year movements of education based job turnover measures.

Table 4 here.

The long run rates show a clear pattern of increased employment of highly-educated workers as compared to medium- and low-educated workers in manufacturing. The long-run net job creation rates are 16 and 20 percent for highly educated, whereas the annual rate is, on average, five percent. The net reduction rates for low-educated are 19 and 14 percent, with four percent in the short run. Comparing the two periods, 1986-90 and 1990-94, we can observe a stronger net

[10] Also considering also here the gross job creation and destruction rates, we notice for contracting, a stable and expanding plants that it is the gross job creation rates which differ among skills, providing a lower net job reduction rate for high-skilled group, while the gross job destruction rates are almost equal.

job creation for the highly educated in the latter period in manufacturing, i.e. 20 percent increase compared to 16 percent, while there is significantly weaker job destruction rate for low-educated workers: -19 percent compared to -14 percent. The driving force behind these changes is the fact that the gross job creation for the highly educated is increasing over time, and the job destruction rate has been reduced over time for low-educated group. The latter result may be explained by the startling recovery from the major recession in 1988-89, slowing down the reduction of low-skilled workers.

In the financial sector, we also note that there is a strong cumulative effect of the gross job turnover rates as reported by the long-run job rates. However, some differences are worth noting. There is a distinct difference between the first and second periods for the financial sector that cannot be found for manufacturing. While a reduction of the low-educated group and an increase in the number of highly-educated group is found in both periods in manufacturing, this is only apparent in the first period in the financial sector. In the second period, all education categories are decreasing although at a higher rate for low-educated and medium-educated.

Certain characteristics of the development of the financial sector can shed some light on this pattern. Employment had been surging after the deregulation of the financial markets in the early eighties and during the boom in the mid-eighties, and the sector experienced a downturn from 1989 that led to a major downsizing of the sector. Actually, the difference between the long-run effects of gross job creation and net job creation observed between the first and the last four-year period disguises an even stronger shift in the skill composition in the late 1980s. In 1987 and 1988 positive net job creation took place for all skills.

4.4 Supply or demand effects?

The supply of low-educated workers measured as a share of the total labour force has declined since the 1980s, and the supply of medium and highly educated workers has increased, as we saw from Figure 1. There has been a particularly high increase in supply of medium- and highly educated workers with undergraduate university degrees. Given this increased supply of high- and medium educated workers, together with a clear pattern of job creation and job destruction in favour of highly educated workers in all sectors, including the high skill service sector, it is not clear whether the change is due to demand or supply effects. Increased supply of education is necessary if the skill composition is changing towards a higher education level. However, the question is whether supply or demand is the cause of the change. In other words, the question is whether it is "new" jobs with new task requirements that are demanded and created by the plants, or whether it just the "old" jobs that are filled with more educated workers. For the US and UK, both an increased relative wage for high-skilled workers and an increased supply of educated workers indicate that a change in demand for educated workers is driving the change in the composition. So far, as we saw in Section 2, there is no clear-cut information for the Norwegian economy supporting a change in the relative wage over skills in favour of highly educated workers. In contrast, the structure of industrial relations in Norway, with a compressed wage structure with little wage flexibility, favors alternative or additional factors explaining the change in skill composition. One alternative is that vacant positions are just filled by more educated workers as the supply of skills is increased via a higher education level. Thus, the wage structure is not flexible, but the skill requirement for the jobs may be flexible for the "old" jobs.

We will partly try to disentangle the supply effect and demand effect for skills by fixing the education level for old and new cohorts of workers. Then we check whether the same net job creation pattern for different education levels of worker demonstrates the same pattern within each cohort. If such a pattern is found this means that it can not only be a change in the supply of more educated workers from the more recent cohorts that explains the overall increase in more jobs for highly educated. Changes in demand may be important also. Of course, fixing education levels for each cohort does not fix the total market supply since cohort/education categories are potential substitutes. But this provides an indication of the effect of demand for skills, not only a supply-driven response of filling the same jobs with more educated workers from new cohorts.

We fix the education level by splitting the data set into cohorts of workers. It is reasonable to assume that very little education is taken after the age of 25, and hence the supply effect is held fixed. We use only the data set consisting of workers above 25 years of age in 1986, which is the first year in our panel data set. We then follow the pattern of job creation for the three education groups of different cohorts of workers of 25 years of age or more in 1986. The following cohorts were defined. Cohort 1, those aged 25-34 in 1986; cohort 2, those aged 35-44 in 1986; cohort 3, those aged 45-54 in 1986; and cohort 4, those aged 55-64 in 1986. For each cohort, the education level is fixed, and hence if a pattern is found for the different cohorts similar to the general picture of substitution between skills as reported in Table 1, it can only be due to a change in the demand for skills.[11] There might well be differences over cohorts in that older workers may be more strongly connected to their jobs. But, a difference in job creation between skills within cohorts should still hold if a change in demand is important.

Figure 7 here.

Figure 7 presents the net job creation rates ($NJCR$) for the four cohorts, and for the aggregate that does not control for skill supply. The main result shown in Figure 7 is that the same pattern of a higher degree of net job creation for

[11] It would have been preferable to follow all cohorts starting at 25 years of age over the entire working period. However, due to data limitations we can only study skill-based job creation and destruction for the period 1986-94.

highly educated than for low-educated workers exists for all cohorts, with the exception of cohort 3. Within every cohort in the period 1986-94, however, an emerging pattern of higher net job creation for high- compared to less-educated workers is not due to a change in supply of skills, in that low-skilled workers leave their jobs and the labour force, and new and more skilled workers enter the labour force and fill the vacant positions. Holding the supply of education fixed still provides higher net job creation for high- and medium-educated workers compared to low-educated. Hence, there is a difference in demand for education groups that is at least partly responsible for the difference in job creation over education levels, as shown in Table 1 or as represented in Figure 7a. Although the education difference in net job creation holds for all cohorts (with the exception of cohort 3; workers born from 1941 to 1950), there is a difference in the level of net job creation between cohorts which also indicates a supply effect explaining the overall job creation pattern. For the two youngest cohorts, those born in 1951-60 and 1961-70, the net job creation rate is higher, especially for medium- and high-skilled workers (in Table I in the Appendix the net job creation and gross job creation/destruction rates are given for the four cohorts). The difference between cohorts, a higher net job creation rate for highly educated young workers than for old workers, partly reflects the effect of retirement of old workers (cohort 4 is between 63 and 72 years of age in 1994) and partly the effect of entrance into the labour market of higher educated workers, following the trend of a higher education level in society at large. From Table I in the Appendix, we see that the net job creation rate is very large, 32 percent, for highly educated for the youngest cohort, and negative for the two oldest cohorts, also for highly educated.

In sum, our results seem to confirm both that there it a difference in demand for education groups which can explain the overall pattern of high job creation for educated highly workers, and that this is a supply effect in that the higher education level over time has lead to a replacement effect from low to highly educated workers. The fact demonstrated in Table 1, that it is gross job creation and not destruction that drives the skill substitution, supports demand driven change, i.e. that it is new jobs with new tasks requiring higher skills that are created.

5 Skill upgrading for all plants or only some?

At the core of the present paper is an analysis of whether the observed reallocation of resources is taking place for all plants in each sector or whether reallocation of jobs is across establishments. The analysis so far could not distinguish between these different hypotheses. This is an important question, since increased demand for skilled workers, driven for instance by technological change, could take place for all plants in a sector and thus be realized as a change in skill mix within all plants. Alternatively, the skill upgrading may take place via reallocation of skilled jobs from some plants to other plants, measured as between plant job reallocation. The latter implies a tendency to greater dispersion across establishments and thus greater segregation in the labour market across plants. The fact that we have plant level data allows us to decompose job reallocation within and between plants, and the since it is linked employer-employee data we can assess decompositions for different workers by aggregating over individual workers sharing the same human capital characteristics. In this case, the most relevant is education level. Secondly, another question regarding skill mix changes is whether the restructuring takes place by changing production lines and introducing new technology in continuing plants, or via new entrants with new vintage capital expanding in high skilled workers and exiting of plants with low skilled workers. Given again our detailed linked employer-employee data set that also identifies exit and entry of plants, we can separate job creation and destruction by skill differences in plant turnover (exit and entry of plants) and job turnover in continuing plants.

5.1 Within and between plant job reallocation

Job creation and job destruction rates between different education groups at the plant level, account for both expansion and contraction in the aggregate work force, as well as changes in the composition of skills within plants, i.e. the relative level of highly-, medium- and low educated workers. The decomposition of job creation within and between plants are provided in Table 5, using the decompositions given in equations 6 to 8.

Table 5 here.

It follows from Table 5 that job reallocation between low, medium and highly skilled jobs within plants is on average three percent in the manufacturing industry and four percent in the financial sector, accounting for 13 percent and 15 percent of the total job reallocation respectively. Hence, while *within* plant upgrading of the work force takes place to some degree and, is consistent with technology upgrading within all plants, *between* plant changes are most important. This is a very important result: heterogeneity among plants within sectors leads to reallocation of workers between plants. As shown in theoretical work, by for instance Kremer (1993) and Kremer and Maskin (1996), one reason for the dispersion among plants may well be the effect of skill-biased technical change. This result is also interesting in the light of recent empirical findings. Foster et al. (1998) find that there are important productivity gains from reallocation of resources between plants within narrowly defined sectors. Our results also suggest potential gains from reallocation of resources between plants. We will pursue this in Section 5 by trying to assess which factors may further explain the observed dispersion among plants. First, we use more aggregate information on technological change and change competition from trade, and then we apply plant-level information in the econometric analysis.

5.2 Exit, entry and continuing plants

In Table 6, we present total job turnover decomposed into job turnover due to turnover of plants - exit and entry - and job turnover in continuing plants. As we have established that most of the skill upgrading takes place within sectors and between plants, the question we ask now is whether skill-biased job creation is due to entering plants with a higher level of highly educated employees, or whether it is due to skill substitution in continuing plants.

Table 6 here.

It follows from the results in Table 6 that increased job creation for highly educated workers is predominantly due to changes in the composition of the work force in continuing plants, and not entry of new plants. Net job creation (increasing minus decreasing plants) in continuing plants contributes 75 percent of the 4 percent net reduction of low-skill jobs in manufacturing, while and 25 percent is reduction from net entry (entry minus exit). The increase of five percent highly educated is due only to net increase by continuing plants (increasing minus decreasing plants). Entry of new plants contributes only 17 percent of gross job creation for high skilled workers. The impact of plant turnover in net job creation is higher in the financial sector.

In sum, both in manufacturing and the financial sectors, restructuring via new entrants with new vintage capital and exit of plants are quite important in explaining the substitution away from low- to high-skilled workers, although restructuring in continuing plants through changes in production lines is most important.

6 Skill-biased technical change or trade?

We have found a strong effect of a substitution away from low- to high- and medium educated workers in net job creation both in manufacturing and in a high-skill service sector. The changes are shown to be long-term structural changes, and occur for all cohorts of workers, indicating a change in demand for skills by the plants and not only the fact that younger and more educated workers are replacing older and less educated workers without changing the tasks in the jobs. And last and highly important; most changes take place within industries and between plants, indicating heterogeneity over plants, where some plants expand in the number of workers and some contract. In this section we will assess this heterogeneity by connecting the measures for reallocation of jobs to explicit measures of technological heterogeneity and then examine the skill-technology complementarity to the alternative hypothesis of trade effects. To begin we provide descriptive statistics for job reallocation and a measure of technological change and the exposure to foreign trade. Then we undertake an econometric analysis by estimating plant level gross demand functions, where we include measures of plant-level technology and trade.

6.1 Descriptive statistics

6.1.1 Job creation and R&D intensity

As seen in the upper panel of Table 7, the surprising result is that plants in high-tech industries, as classified by the OECD standard, have the highest degree of net job reduction for all skill types (the classification is given in the Appendix).[12] The next question to analyze is how the downsizing process takes place in terms of changes in skill composition.

Table 7 here.

The downsizing and restructuring process demonstrates certain common features and some differences among industries characterized by different levels of Research and Development, as seen from the mid panel of Table 7. One main result from the lower panel of Table 7 is that there is a higher gross job creation rate for highly educated workers, relative to low- and medium-educated workers, independent of the degree of R&D. This pattern is in accordance with the hypothesis of skill-biased technical change in all sectors. The pattern of skill substitution found in the high-skill service sector reported in Table 2 also supports this interpretation. On the other hand, although the restructuring process is more pronounced for high-tech industries than for medium- and low-tech, it is not clear that the skill substitution is stronger in the high-tech industries. In fact, the restructuring process in low- and medium-tech industries is somewhat unexpectedly characterized by a stronger tendency towards net job creation for high-skilled in low/medium-tech industries, although the reduction of low-skill workers is higher in high-tech industries. However, as can be seen from the upper panel of Table 7, the downsizing of plants in the high-tech sector is stronger than in the low- and medium-tech sectors, which means that the apparently relatively modest increase in high-skill job creation in the high-tech sector may be quite strong. Further, at the outset the level of skill intensity is also much higher in the high-tech than in the low-tech sector.

Again, to emphasize the importance of heterogeneity within sectors, we used equations 6 to 8 to decompose the total job reallocation in within and between plants within each R&D sector. The results are given in Table 8. Again, we find that the reallocation of jobs takes place between plants, and not within all of the plants even within each of the three R&D sectors. Note also that the degree of heterogeneity obtained by the within plant share of job reallocation is highest in the high-tech sectors where also the total reallocation of jobs is highest.

[12] This is also found in Klette and Førre (1998) who use a different data set for the Norwegian manufacturing sector data from 1982-92.

6.1.2 Job displacement and trade exposure

In Table 9 we examine the job flow patterns in manufacturing as a function of the foreign trade exposure. Foreign trade exposure is here defined as the import penetration ratio (imports as a share of sales minus exports). The quintiles are based on the pooled industry year trade data matched in with employer-employee data.

Table 9 here.

From the upper panel, where the aggregate job flow rates for all three worker categories are presented, the pattern is that there is a positive net job creation rate for low levels of import penetration and a negative net job creation rate for high degrees of import competition. Higher gross job destruction rates are mainly the reason for this. This result is in contrast to the results obtained for the US by Davis, Haltiwanger and Shuh (1996), Table 3.5. They find no relationship between job turnover rates and international trade. From the lower panel of Table 9 where we split the gross job flow rates in the three worker categories within each import competition quintiles, none of the gross flow measures in the table indicate that greater exposure to trade reduces job security.

In sum, there is no clear-cut evidence from considering the average job creation and destruction patterns within each R&D group for skill-biased technical change as the driving force in the change in the skill composition. The change appears to be equally strong in all R&D groups, providing weak evidence of skill-biased technical change. However, the classification into technology groups here is relatively rough and at the industry levels; hence, heterogeneity at the plant level within each industry may be large. This is clearly shown in that the between plant reallocation is very high even within each R&D category. Further, from the descriptive statistics we find some indication of displacement of all education categories of workers in sectors exposed to international trade. However, we do not find differences in job flow rates for different worker categories and exposure to import competition.

6.2 Skill biased technical change or trade? Econometric analysis

The descriptive statistics for average gross job differences between groups of plants using direct measures of trade and technological change did not reveal any striking patterns supporting skill-biased technical change or trade as explanations of the change in the skill pattern, although some indication of a general trade effect was found. However, the within group heterogeneity for plants may be quite large, and in order to examine this we will undertake an econometric analysis. In fact some preliminary testing of plant heterogeneity within groups using the standard deviations of the job flow measures by technology groups showed a quite high degree of heterogeneity within each R&D group, as did the results in Table 8.

Three specifications of plant-level dynamic demand equation for three educations categories in the econometric analysis will be presented. First, we introduce 3-digit industry-level measures of R&D, as well as 5-digit industry-level measures of changes in export and import penetration. We will undertake the analyses in an industry (3-digit) fixed effect framework in order to focus on between plant changes within industries, and introduce a business cycle indicator in order to isolate structural changes. Then, in addition to the measures of change in trade exposure, we will introduce a plant-level measure of technology, in order to analyze the plant level heterogeneity. As the last specification, we introduce other plant and industry variables to help control for other factors which may explain a potential link between job destruction rates and exposure to trade or technological change.

As we discussed carefully in Section 3.1, the job creation and job destruction model to be estimated here is embedded in the dynamic demand model for labour, as described for instance in Hamermesh (1995). In this respect it is highly related to the standard literature on employment effects of trade/skill-biased technical change, which are usually estimated as direct or inverse demand functions (or in rare cases systems of demand equations) expanded with measures of technical change and trade (see for instance Haskel (1999), Berman et al. (1998), and Chennels and Reenen (1999) for an overview).[13]

6.2.1 Basic econometric results

In Table 10 we present the results from the first specification for the Tobit estimation for plant level gross job creation and job destruction functions for the three worker groups given equations in equations 9 and 10, as well as equivalent functions for plant-level gross hires and separations of workers, and the net job creation rate. The first specification uses the changes in import and export competition and industry-level classification into high, medium and low R&D-intensive industries, and no industry fixed effects.

Table 10 here.

Considering the job creation equations first, Table 10, column 1 shows first of all that the changes in wages have the expected signs in that the own-price effect for all three worker groups is negative. It also appears that low- and medium-educated workers are complements, while both are substitutes for the highly educated. Hence, there are indeed differences between the different groups of workers. Note also that the job creation rates are, as expected, pro-cyclical, and that both medium- and low-educated workers are less stable over the cycle than the highly educated. Turning to the general results for the job destruction

[13] It must be noted, however, that all of these models are reduced form models of the effect of trade and technical change and, as such, only capture the relative empirical magnitudes and thus serve as summaries of the data.

equations provided in column 2 for the three education groups of workers, the signs of the own- and cross-price effects are also here as expected, and confirm the results in the job creation functions. Note that these have the opposite sign of the job creation functions, since only plants reducing the number of jobs are included in this regression and job destruction is defined in absolute terms. The job destruction rates are as expected counter-cyclical, and the medium-educated workers are more stable over the cycle than the low-educated, while the highly educated are also here independent of the cycle. For the gross hires and separation equations reported in columns 3 and 4 these results basically carry over. The change in production does not contribute to the changes in jobs for any worker category.

Next we consider the effect of technology measured in this specification by industry level R&D intensity. Note that these changes are above changes due to business fluctuations, since an indicator for the business fluctuation is already included, and the results are thus mainly to be interpreted as structural changes. We notice that there is a positive effect on job creation for all three education groups in R&D intensive industries and a weaker effect for medium- and highly educated in medium R&D-intensive industries as compared to low R&D-intensive industries. However, the job creation effect is much stronger in medium and high R&D intensive industries for the highly educated than for the low- and medium-educated, as may be seen from the size of the parameters reported. When extending the analysis to plants that are not only expanding or contracting in size, by including rehires and layoffs explaining compositional changes at the plant level, we note from column 3 that the highly educated workers are hired to a greater extent in high and medium intensive sectors than in sectors with low R&D intensity. Medium and low educated workers are only mildly in higher demand in medium intensive R&D sectors. Also job destruction rates are higher for highly educated workers in medium- and high-R&D intensive industries, as are gross separation rates. This result suggests an interesting feature of the change taking place, in that within-sector heterogeneity among plants in the medium and high intensive R&D sectors is important for this group of workers, since some plants within these sectors hire and some reduce the number of highly educated workers. This result also support the finding in Table 8 of apparently more heterogeneity in the industries characterized by a high R&D intensity. To a lesser extent, this is true for the medium- and low-educated workers. We will assess the plant-level heterogeneity further in the next set of regressions by introducing plant level measures of technology and including sectoral dummies.

If we focus on the alternative hypothesis of trade, the reported results indicate a change in the skill composition from trade in that jobs are being destroyed for low- and medium-educated workers in sectors with increased import competition. At the same time fewer are destroyed in sectors with improved export conditions. Job creation is unaffected by changes in trade conditions for both these worker categories. Highly educated workers are completely unaffected by changes in trade conditions in this specification of the model. These results carry over to the gross hires and gross separations reported in columns 3 and 4. The net effect of these processes of job creation and gross hires and job destruction and gross separations, given in column 5, indicate strongly, as expected, the reduction of the number of low-educated workers in sectors hit by tougher import competition, and reallocation to sectors with improved export conditions.[14]

In summary, our results so far support effects on reallocation of jobs and workers caused by changed trade conditions leading to a changed composition of workers between plants, as well as predicted effects on the reallocation of workers caused by technological change (R&D intensity). The strong degree of within sector heterogeneity, especially in sectors with high R&D intensity, is also noteworthy. Within these sectors some plants are expanding in highly educated workers and some are cutting the number of highly skilled workers in these sectors. We will proceed to try to analyze this observed plant level heterogeneity by introducing a plant-level measure of technology in the next section.

6.2.2 Plant level technology effects within sectors

In Table 11 we present the results of introducing the vintage of machine capital at the plant level as a measure of technological change (along with the age of the plant to isolate the age of capital from the age of the plant). The analysis is undertaken as a within-industry analysis (3-digit fixed effect framework) in order to focus on between-plant changes within industries.

The focus in the discussion of these results will primarily be on the effect of technological change, since all the other results including effect of prices, business cycle properties and even trade effects carry over from the previous specification. There is one very interesting change in the impact of trade in this specification. We now find that there is increased job creation (and gross hires) for highly educated workers in industries experiencing improved export possibilities, while job creation (and gross hires) are somewhat reduced in sectors meeting increased import competition. Still, job destruction for highly skilled workers is unaffected by trade changes.

Turning to the measured effect of the vintage of capital, the measure is defined as having a higher value, the older the capital or the less reinvestment that has taken place. Hence, the expected sign is negative if plants with newer machine

[14]The impact of trade on job displacement is probably downward biased and inconsistent since trade most likely is endogenous. For instance common unmeasured cost shocks will induce a correlation between the error term in the displacement equation and the import penetration variable leading to a downward bias of the displacement effect (see for instance Revenga (1997)). In our context then the presented results may be considered as lower bounds of the effects. Further, using import penetration measures at the 5-digit industry level while the dependent variable at the plant level induces a downward bias in the standard error for the estimated import penetration coefficient Moulton (1986). This we control for by using Moulton (1986) suggestion for correction.

capital, for instance, create more jobs of a particular category. From column 1 in Table 11, we notice that we, indeed, find a quite strong effect of the vintage of capital on the creation of new jobs for all three worker categories. Thus, the plant-level index of technological change is able to explain reallocation of jobs between plants within 3-digit sectors. As expected, the job creation effect in plants with new vintages of capital, i.e. plants reinvesting in new physical capital, is stronger for the highly educated than for the low- or medium-educated. This implies a complementarity relationship between new physical capital and the highly educated workers. This result is also supported from hires in general, including replacement hires.

Considering job destruction given in column 2, there is less job destruction for all worker categories in plants with new vintages of capital and *vice versa:* a higher degree of job destruction for plants with old vintages of capital. Again, there is a difference between low- and medium-educated versus highly educated in that job destruction is lower for the highly educated in plants with new vintages of capital. This is shown in column two as a higher vintage capital effect for job destruction (column 2) for the highly educated as compared to the low- or medium-educated, meaning that plants with old vintages of capital have a higher job destruction rate for highly educated than for the two other worker categories. Again, the same pattern appears for the gross separation equations given in column 4, with the exception that highly educated workers now are unaffected by gross separations. Hence an important finding of this paper is that, in general, there is a reallocation of jobs from plants with old to new vintages of capital for all worker categories, but this is most pronounced for the highly educated. This points to technological change as a driving force behind a change in demand for labour in favour of highly higher educated workers in the Norwegian economy in addition to changing trade conditions. Also, since we are able to decompose the net job changes into plants that are expanding or reducing the number of the particular worker category, we find that this process differs over plants within sectors. Some plants expand in higher educated in particular and also in workers in general, i.e. those plants with new vintages of capital. Some reduce the number of highly educated workers: the plants with old vintages of capital. The effect of new technology on net job creation where all the plants are taken together again supports the finding of higher demand for all worker categories in plants with new vintages of capital. Note also that the age of the plant has a separate effect that is similar to the age of the physical capital.

6.2.3 The robustness of our results

First, the impact of import competition on job destruction and job creation could well be due to alternative causes. The same is true for the technological change hypothesis. For instance, the import competing industries are also, in general, low-skill industries. Some of these skills are also plant- or firm-specific which also means that workers with a high level of plant-specific human capital have a stronger attachment to the plant, resulting in less turnover. Hence, a low level of plant-specific human capital in import competing industries may well explain a lower attachment to the plants in these sectors and not the fact that the plants are exposed to more volatility from trade. We control for these factors in various ways. First, for all specifications we have already introduced plant-level wages for the three worker categories. One reason for doing this is that we expect, from human capital theory, that employers and employees share the returns to specific human capital investments. Hence the workers with higher specific human capital command a higher wage. The wage rate is also expected to compensate for other factors, such as the general human capital level, so in addition to the average wage we include a proxy for the plant-specific human capital, defined by the mean accumulated tenure by education group. Furthermore, we want to control for the size composition of plants in the different sectors, so we introduced the log of plant size. For instance, import competing sectors may consist of relatively small establishments, which may explain the higher level of job destruction as an alternative explanation to trade exposure. In addition, R&D intensive sectors are expected to consist of capital-intensive plants. That may explain the results there. Hence, we include the capital-labour ratio. Differences in imperfections in the labour and product markets over sectors may also explain differences in job flows. For instance, the import competing sectors consist of smaller sized plants which, for this reason, are expected to command lower market power. Plants with high market power may share the rents with the workers, and the higher wage is expected to reduce turnover. Hence, the high job destruction rate in the import-competing sector may be due to a low degree of market power and/or low degree of unionized workers. The concentration in the market is included by the firm level Herfindahl index, and the plant-level union density is introduced to capture the imperfection in the labour market. Industry fixed effects are also included in this specification. The precise definitions of the variables are given in the Appendix.

Table 12 shows that the effects of both skill-biased technical change and trade are still significant when all the other variables are included. The included additional variables also have plausible signs, but we do not go into detail on the effect of the different variables. Nor do we report the results, since this is not the objective of this paper. The effects of both technology and trade are only slightly reduced when the control variables are introduced. Some changes are noticeable, however. There is now a significant net job creation effect for highly educated workers in sectors with improved export conditions, and reduced net job creation for highly educated workers in sectors with increased import competition. Moreover, these effects disappear for low skilled workers, as is seen from the upper panel of Table 12. Since we have the gross job flows behind the net changes, we are able to see what causes this change in net job changes and whether the trade still has an effect in reallocation of workers. Trade is still important but different for low- (and medium-educated workers) and highly educated workers. For low- and medium-educated workers trade still affects job destruction; plants with increased import competition decrease the number of low- and medium-educated employees and plants with improved export possibilities decrease the number of these workers less. However, neither plants in sectors with improved export possibilities nor plants in sectors with increased import competition change the number of new jobs for these workers. With a somewhat weakened effect on job destruction in this specification with all the controls, the net job creation effect disappears although trade is still important in explaining displacement of low- and medium-skilled workers in sectors with increased import competition and reduced displacement in sectors with improved export possibilities. For the highly educated, the effect of trade is still different. First of all, these workers do not experience increased displacement caused by increased import competition, as seen from the columns reporting job destruction and total separations. Secondly, with the specification where the controls are included, job creation for the highly educated is improved for plants in sectors with an improvement in export possibilities. This then leads to positive net job creation for highly educated workers in these sectors. To sum up, the effect of trade is found along different margins for the low- (and medium-) educated and the highly educated: displacement effects are found for the first group and job creation effects for the second group of workers.

7 Concluding remarks

Using matched worker/plant level data for Norway, we test the importance and structure of the change in skill composition in the Norwegian economy. Trade and technology explanations for the change in skill composition are assessed using direct evidence on job creation and destruction for workers with high-, medium- and low education levels. The following main results were found:

First, aggregating up to industry level-data, the same level of changes in the work force composition is found for the Norwegian economy as for other countries. Most of the changes are also taking place *within* sectors, thus supporting skill-biased technical change. Turning to the job flows behind the net changes, we find that the net job creation rates are negative for low-skilled workers, positive for medium-skilled and strongly positive for highly skilled workers. This strong effect of substitution away from low-educated to highly educated workers and medium educated workers was prevalent both in manufacturing and in a high-skill financial sector. The gross job creation rates are different across education groups, while job destruction rates are very similar; thus, jobs requiring low skills are not disappearing. In fact, newly created jobs due to plant expansion and entry of plants is the driving force in the shift in employment composition. The restructuring is a permanent process in that the long-run skill-based job creation rates show persistence over time. We find the same pattern both in manufacturing and in the financial services. To test whether vacant positions are merely being filled by more educated workers as the supply of education increases, or whether the trend is driven by demand for educated workers, we fixed the supply of education by analyzing job creation for each education category by cohorts of workers, thus isolating the demand. The results show that there is a difference in demand for education groups of workers over all cohorts of workers. So, the aggregate difference in job creation over skills cannot only be due to an increased supply of workers taking the jobs of less qualified workers. Of course, each plant changing the composition of skills in the plant may substitute between cohorts of workers and this will obviously take place since the younger cohorts' share of the labour force is increasing and older cohorts' share is decreasing.

A very important result is that when decomposing the aggregate changes into between-plant changes or changes taking place within all plants, we find that between plant changes are most important. In other words, there is a reallocation of workers from some plants to others. This is a very important result that indicates that heterogeneity among plants within sectors leads to reallocation of workers between plants. As shown in theoretical work by, for instance, Kremer (1993), Kremer and Maskin (1996) and Caselli (1999), one reason for the dispersion among plants may well be the effect of skill-biased technological change. This result is also interesting in the light of recent empirical findings. Foster et al. (1998) find that there are important productivity gains from reallocation of resources between plants within narrowly defined sectors. Our result also points in the direction of potential gains from reallocation of resources between plants. When testing whether the changes are due to plant turnover (exit and entry of plants) or turnover by established plants, we found that most restructuring took place for established plants, although worker reallocation due to entry/exit of plants is significant.

We then assess this heterogeneity by connecting the measures for reallocation of jobs to explicit measures of technological heterogeneity. The alternative hypotheses of trade and technological change are first assessed using descriptive statistics. There is no clear evidence in considering the average job creation and destruction patterns within each R&D group of plants for skill-biased technical change as the driving force in the change in the skill composition. The change appears to be equally strong in all R&D groups, providing weak evidence of skill-biased technical change. However, the classification into technology groups here is relatively rough and at the industry level, and heterogeneity at the plant level within each industry may be large. This is clearly shown in that the between plant reallocation is very high even within each R&D category. Further, from the descriptive statistics we find some indication of displacement of all education categories of workers in sectors exposed to international trade. However, we do not find differences in net job creation rates for different worker categories and the exposure to import competition.

An econometric analysis is then undertaken by estimating plant-level dynamic demand functions for gross demand for jobs and workers where we include measures of plant level technology and trade to explain the observed changes in gross flows of jobs and workers. Using first a sectoral level R&D measure as an index for technology and 5-digit level measures of change in import and export penetration, our results support the effects on reallocation of jobs and workers caused by changed trade conditions and technological change (R&D intensity). Another notable result is that there appears to be a strong degree of within-sector heterogeneity, especially in sectors with high R&D intensity. Within these sectors some plants are expanding in highly educated workers and some are reducing the number of highly skilled workers. Trade and technology have a different type of impact on the gross margin of changes. The reported results on the impact of trade indicate a change in the skill composition from trade in that jobs are being destroyed for low- and medium-educated workers in sectors with increased import competition. At the same time, fewer are destroyed in sectors with improved export conditions. Job creation is unaffected by changes in trade conditions for both these worker categories. Highly educated workers are completely unaffected by changes in trade conditions. These results carry over to gross hires and gross separations. The net effect of these processes of job creation and gross hires, and job destruction and gross separations, indicate strongly, as expected, the reduction of the number of low educated workers in sectors hit by tougher import competition and their reallocation to sectors with improved export conditions.

As plant level heterogeneity is of special interest, since most of the reallocation of jobs is taking place between plants within sectors, we introduce a plant-level measure of technology, the vintage of machine capital, in order to analyze this heterogeneity. This analysis is undertaken in an industry (3-digit) fixed-effect framework in order to focus on between-plant changes within industries. An important finding of this paper is that, in general, there is a reallocation of jobs from plants with old to plants with new vintages of capital. This takes place for all worker categories, but this is most pronounced for the highly educated. This points to technological change as a driving force behind changes in demand for labour in favour of highly educated workers in the Norwegian economy. In addition, changing trade conditions also have an impact. The age of the plant has a separate and similar effect as the age of the physical capital. This result is supported when we test the robustness of the results by introducing plant-level control variables that may explain the impact of trade and technology on job turnover.

To sum up the econometric results: we find support for skill-biased technological change to explain the change in the increased relative demand for highly educated workers via a positive gross job creation effect, especially for plants with new vintages of capital from plants with old vintages of capital. Note that the changes are taking place through a reallocation of resources between plants. The plant-level measure of technology, the vintage of the plant level machine capital, is an important explanatory factor here. Further, as opposed to most studies in this literature, we also find a strong impact from trade in that low- and medium-educated workers are being displaced from sectors hit by increased competition from abroad, while highly educated workers are basically insulated from negative trade effects. This result challenges previous findings from for instance the UK and comparative studies for OECD countries, where no support for trade effects is found (see Berman, Machin and Bound, 1998, Machin and Van Reenen 1998, Haskel, 1998).

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Appendix

Data set construction and descriptive statistics

7.1 Person characteristics

Worker categories by general education level. Education level is based on the normal duration of the education and includes only completed (and highest attained) education. All formal education courses exceeding 300 hours are registered. We also use a three-category discrete measure of skill, based on the level of education. These levels of education are calculated according to the "Nordic Key for Classification of Education" comparable to the "International Standard of Classification of Education" (ISCED). The grouping of individual educational courses by educational level is based on observation of the normal duration of the educational activities. The standard is organized with 9 educational levels. Following this standard we have defined "low-educated" as up to the third level, which is equivalent to 10 years of education. "Medium-educated" is defined as education from the third up to the fifth level, which is equivalent to normal education duration of 14 years, not leading to an academic degree. "High-educated" is three years of college/university leading to an academic degree.

Plant characteristics

We use age index measure due to **?** for the capital equipment in order to define the *vintage of machine capital*:

$$A_t = \left[K_{t0}^V p_v \bar{a}_t^v + I_{t0} p_{t0} (t - t_0) + ... + I_{t-1} p_{t-1} (1)\right] / K_t$$

where

$$K_t = K_{t0}^V \bar{p}_v + I_{t0} p_{t0} + I_{t1} p_{t1} + ... + I_{t-1} p_{t-1},$$
$$K_t^V = K_t - (I_{t0} + ... + I_{t-1})$$

and, I_t = nominal investments (purchase less sales) in capital equipment, K_t = real stock of capital equipment in period t, K_t^V = nominal stock of capital equipment of vintage V in period t, p_t is the price index in year t (the whole sale price index), $\bar{a}_t^v$ is the mean age of capital equipment acquired before t_0, which is the first time period data is available for (i.e., 1977). For plants established prior to 1977, we computed a proxy for $\bar{a}_t^v$ based on aggregate machine capital and investment data in the industry that the plant belonged to (at the 4- and

5-digit SIC level). Statistics Norway supplied industry aggregate investments and capital data.

The age index definition implies that in year $t = t_0$ the age index $A_t = 1$. If real investments $I_v p_v$ are identical in all years, investments in period $t-1$ will increase the age index A_t more than investments in the subsequent period t due to the factor $(t - t_v)$ in the age index equation. We only use the age index for machine capital in our model, as the performance of plants should be less affected by the age of building capital. The age of the plant is defined as the year of establishment of the plant which is provided in the data.

Plant size is defined as the logarithm of the total number of workers at the plant level including also part time workers. *Tenure* is defined as the number of years worked for each employer. Both are calculated as plant level averages by the three education levels. Market concentration of the plant is defined as Herfindahl index of the gross share per year production in total sector gross production at the 5-digit ISIC level of the firm the plant belongs to. Note that this measures shares of production, thus not sales. So, for example, in a very open sector, a plant producing a high share of domestic production may still only have a low share of domestic or international sales. The *share of union members at the plant level* is calculated as the number of union members to the number of workers. The real (1990) logearnings is derived using the annual plant wage payment to the worker (including salaries and wages in cash and kind. The earnings at plant level for the three educations were calculated on the basis of the individual wages. The consumer price index was used to derive the wage variable in 1990 values. As an exclusion criterion we used an hourly wage rate, and excluded an hourly wage rates below 30 kroner per hour and above 500 kroner per hour, since these are obviously either below or above possible wage rates. *The capital labour ratio* is calculated as the value of capital relative to the number of workers. The capital value is based on the fire insurance value of the buildings and machinery. Following Griliches and Ringstad (1971) and Klette (1999), we estimate the capital services as follows:

$$K_{i,t} = R_{i,t} + (\rho + \delta^m)\,\bar{V}^m_{i,t-1} + \left(\rho + \delta^b\right)\bar{V}^b_{i,t-1}$$

where $R_{i,t}$ is rental costs of machinery and buildings for equipment rented by the plant. ρ is the real return to capital, where we used the standard returns used in public investment projects. i.e. 7 % . δ^m and δ^b are depreciation rates for machinery (0.06) and buildings (0.02) taken from the Norwegian National Accounts. $\bar{V}^m_{i,t-1}$ and $\bar{V}^b_{i,t-1}$ are the values of the plants' machinery and buildings based on insurance values, calculated as the average for the present year, the year before and the year after, using the " perpetual inventory" method. Investments are assumed to take place at the end of each year. As noted by Klette (1999), one problem with the fire insurance values reported separately for buildings and machinery by the plants is that there are missing variables. The procedure of taking the average over three years is an attempt to reduce this problem.

Classification in high-, medium-, and low R&D intensive industries

Sectors classified as *high R&D intensity are sectors* in Manufacture of electronic equipment (ISIC 383). *Medium R&D intensity sectors* are Manufacture of industrial chemicals (ISIC 350-352), Manufacture of machinery (ISIC 382), Manufacture of transport equipment (ISIC 384), and Manufacture of professional and scientific instruments, photographic and optical goods (ISIC 385). *Low R&D intensive sectors* are Manufacture of food (ISIC 310-314), Manufacture of textiles (ISIC 320-322), Manufacture of wood (ISIC 330-342), Manufacture of paper (ISIC 340-342), Petroleum refining (ISIC 353-354), Manufacture of rubber and plastic (ISIC 355-356), Manufacture of mineral products (ISIC 360-369), Manufacture of basic metals (ISIC 370), Manufacture of fabricated metals (ISIC 380-381), Other manufacturing (ISIC 390).

Import and export penetration

Import penetration by 5-digit ISIC sectors is defined as : Imports/(Value added+ import-exports). Export penetration by 5-digit ISIC sectors is defined as : Exports/(Value added+import-exports). Based on these measures we calculated the change in import and export shares used in the econometric analysis. This data is from trade statistics for Norway collected by Statistics Norway.

Table I. Annual averages of different cohorts by skill level. Manufacturing.

	JCR			JDR			JRR			NJCR		
Cohort	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High
1: 1961-70	0.19	0.23	0.50	0.22	0.18	0.18	0.41	0.41	0.68	-0.03	0.05	0.32
2: 1951-60	0.13	0.14	0.23	0.16	0.15	0.20	0.28	0.30	0.43	-0.03	-0.01	0.04
3: 1941-50	0.11	0.12	0.18	0.14	0.14	0.20	0.25	0.26	0.39	-0.02	-0-01	-0.02
4: 1931-40	0.09	0.11	0.13	0.14	0.14	0.18	0.24	0.25	0.31	-0.05	-0-03	-0.05

Table 1. Decomposition of changes in proportion of low-, medium- and highly educated workers. 1987-1994. Manufacturing and financial sectors.

Manufacturing			
Skill type	Total change in share	Change between industries (4-digit)	Change within industries
Low skilled	-0.1207	-0.0061	-0.1146
Medium skilled	0.1001	0.0059	0.0942
High skilled	0.0206	0.0002	0.0204

Financial sector			
Skill type	Total change in share	Change between industries (4-digit)	Change within industries
Low skilled	-0.0604	0.0058	-0.0661
Medium skilled	0.0191	-0.0107	0.0298
High skilled	0.0413	0.0049	0.0363

Table 2. Job and worker flows and employment shares (ES) for low-, middle- and highly educated workers in manufacturing and financial sectors. Mean values 1987-94.

	Manufacturing							Financial sector						
	HR	JCR	SR	JDR	JRR	NJCR	ES	HR	JCR	SR	JDR	JRR	NJCR	ES
Educat.														
Low	0.19	0.10	0.23	0.15	0.25	-0.04	0.58	0.19	0.13	0.23	0.17	0.31	-0.04	0.29
Medium	0.24	0.14	0.23	0.13	0.27	0.01	0.38	0.22	0.14	0.22	0.15	0.28	-0.01	0.61
High	0.31	0.23	0.25	0.17	0.40	0.05	0.04	0.27	0.19	0.25	0.17	0.36	0.02	0.10

Table 3. Job flows by skills in expanding, stable and contracting plants. Manufacturing and financial sectors.

Plant type	**Educ.**	**Manufacturing**					**Financial sector**				
		JCR	JDR	JRR	NJCR	ES	JCR	JDR	JRR	NJCR	ES
Contracting	Low	0.00	0.27	0.27	-0.27	0.27	0.01	0.32	0.33	-0.31	0.12
	Med.	0.02	0.25	0.27	-0.23	0.17	0.00	0.29	0.29	-0.29	0.27
	High	0.11	0.27	0.38	-0.16	0.02	0.05	0.30	0.35	-0.25	0.05
Stable	Low	0.03	0.05	0.08	-0.02	0.04	0.04	0.06	0.10	-0.02	0.02
	Med.	0.07	0.04	0.11	0.03	0.03	0.03	0.02	0.05	0.01	0.05
	High	0.22	0.17	0.29	0.05	0.001	0.12	0.08	0.20	0.04	0.01
Expanding	Low	0.25	0.01	0.26	0.25	0.27	0.32	0.02	0.34	0.30	0.14
	Med.	0.31	0.01	0.32	0.30	0.18	0.33	0.00	0.33	0.33	0.28
	High	0.39	0.07	0.46	0.32	0.02	0.39	0.03	0.42	0.36	0.05

Table 4. Long-run movements by skill in the manufacturing and financial sectors.

	Manufacturing				Financial sector			
	JCR	JDR	JRR	NJCR	JCR	JDR	JRR	NJCR
1986-90								
low	0.19	0.38	0.57	-0.19	0.33	0.39	0.72	-0.07
medium	0.29	0.29	0.58	0.00	0.35	0.31	0.67	0.05
high	0.47	0.31	0.78	0.16	0.52	0.36	0.88	0.16
1990-94								
low	0.20	0.34	0.55	-0.14	0.18	0.40	0.57	-0.22
medium	0.30	0.34	0.55	-0.14	0.19	0.34	0.52	-0.15
high	0.51	0.27	0.57	0.03	0.33	0.35	0.68	-0.02

Table 5. Between-plant and within-plant job reallocation. Manufacturing and financial sector.

	Between Plant Job Reallocation		Within Plant Job Reallocation		Total Job Reallocation	
Year	Manufact.	Finance	Manufact.	Finance	Manufact.	Finance
1987	0.21	0.24	0.04	0.04	0.25	0.28
1988	0.26	0.30	0.03	0.03	0.29	0.33
1989	0.26	0.27	0.02	0.02	0.28	0.29
1990	0.22	0.39	0.03	0.03	0.25	0.42
1991	0.21	0.28	0.04	0.03	0.25	0.31
1992	0.27	0.23	0.03	0.04	0.30	0.27
1993	0.23	0.21	0.02	0.03	0.25	0.24
1994	0.23	0.22	0.03	0.02	0.26	0.24
Mean	0.24	0.27	0.03	0.03	0.27	0.30

Table 6. The importance of exit and entry in job reallocation in the manufacturing and financial sectors.

	Manufacturing				Financial sector			
Education	ENTRY	INCR	DECR	EXIT	ENTRY	INCR	DECR	EXIT
low	0.04	0.06	0.10	0.05	0.04	0.09	0.11	0.06
medium	0.04	0.10	0.09	0.05	0.04	0.09	0.09	0.06
high	0.04	0.19	0.13	0.04	0.04	0.15	0.11	0.06

Table 7. Job creation and job destruction by education level in low tech and high tech industries.

Technology	JCR	JDR	JRR	NJCR	ES
Low tech	0.10	0.13	0.23	-0.03	0.65
Medium tech	0.11	0.12	0.22	-0.01	0.26
High tech	0.13	0.17	0.30	-0.04	0.09

Technology	Educ. level	JCR	JDR	JRR	NJCR	ES
Low tech	Low	0.10	0.14	0.25	-0.04	0.41
	Medium	0.14	0.14	0.28	0.00	0.23
	High	0.24	0.18	0.42	0.06	0.02
Med. tech	Low	0.10	0.14	0.24	-0.04	0.13
	Medium	0.13	0.12	0.25	0.01	0.11
	High	0.20	0.14	0.34	0.06	0.13
High tech	Low	0.12	0.19	0.31	-0.07	0.04
	Medium	0.15	0.17	0.31	-0.02	0.04
	High	0.22	0.19	0.42	0.03	0.01

Table 8. Between-plant and within-plant job reallocation.

	Between Plant Job Reallocation	Within Plant Job Reallocation	Total Job Reallocation
Low R&D intensity	0.23	0.03	0.26
Medium R&D intensity	0.22	0.03	0.25
High R&D intensity	0.30	0.02	0.32

Table 9. Job flows by education level by import penetration ratio. Manufacturing 1987-94.

Import penetration	JCR	JDR	JRR	NJCR
1. quintile	0.11	0.10	0.21	0.01
2. quintile	0.13	0.11	0.24	0.02
3. quintile	0.08	0.11	0.19	-0.03
4. quintile	0.11	0.12	0.23	-0.01
5. quintile	0.11	0.12	0.19	-0.02

	Skill level	JCR	JDR	JRR	NJCR
1. quintile	Low	0.08	0.13	0.21	-0.05
	Medium	0.11	0.11	0.22	0.00
	High	0.15	0.10	0.25	0.05
2. quintile	Low	0.08	0.14	0.22	-0.06
	Medium	0.13	0.13	0.26	0.00
	High	0.16	0.11	0.27	0.04
3. quintile	Low	0.06	0.14	0.20	-0.08
	Medium	0.06	0.11	0.17	-0.05
	High	0.10	0.08	0.18	0.02
4. quintile	Low	0.06	0.13	0.19	-0.07
	Medium	0.13	0.10	0.23	0.03
	High	0.15	0.14	0.29	0.01
5. quintile	Low	0.06	0.14	0.20	-0.08
	Medium	0.09	0.11	0.20	-0.03
	High	0.16	0.13	0.29	0.03

Table 10. Results from Tobit estimation: Trade and Technology

Low educated workers

	Job Creation		Job Destruction		Hires		Separations		Net Job Creation	
Business Cycle	1,251E-02	*	-9,792E-03	*	1,273E-03		-3,858E-03	*	3,979E-03	*
	(2,954E-03)		*(9,822E-04)*		*(1,508E-03)*		*(7,425E-04)*	*	*(1,232E-03)*	
Δwage low skilled	-1,180E-07		5,630E-08		-2,270E-07	*	2,650E-08		-1,700E-07	*
	(1,680E-07)		*(5,730E-08)*		*(8,780E-08)*		*(4,300E-08)*		*(7,130E-08)*	
Δwage medium skilled	-3,200E-07		1,810E-07	*	-1,620E-07	*	7,370E-08	*	-1,620E-07	
	(1,330E-07)		*(4,590E-08)*		*(6,990E-08)*		*(3,430E-08)*		*(5,630E-08)*	
Δwage high skilled	4,650E-07	*	-2,080E-07	*	2,650E-07	*	-6,240E-08	*	2,500E-08	
	(9,820E-08)		*(3,270E-08)*		*(5,030E-08)*		*(2,470E-08)*		*(4,130E-08)*	
Δproduction	-9,950E-13		-8,330E-11		4,820E-11		2,050E-11		-4,200E-11	
	(4,100E-10)		*(1,280E-10)*		*(1,980E-10)*		*(9,850E-11)*		*(1,690E-10)*	
Δimport penetration	-1,341E-02		7,785E-03	*	-4,621E-03		6,397E-03	*	-7,219E-03	*
	(8,942E-03)		*(2,960E-03)*		*(4,541E-03)*		*(2,254E-03)*		*(3,641E-03)*	
Δexport penetration	1,311E-03		-9,050E-04	*	1,271E-04		-9,110E-04	*	-8,154E-04	*
	(8,655E-04)		*(2,861E-04)*		*(4,388E-04)*		*(2,180E-04)*		*(3,543E-04)*	
R&D2	2,784E-03		5,609E-03		1,842E-02	°	7,334E-03		3,551E-03	
	(1,923E-02)		*(6,456E-03)*		*(9,897E-03)*		*(4,870E-03)*		*(8,056E-03)*	
R&D3	7,098E-02	*	4,689E-03		2,273E-02		-2,608E-02	*	4,429E-02	*
	(2,883E-02)		*(9,757E-03)*		*(1,504E-02)*		*(7,439E-03)*		*(1,215E-02)*	
Constant	-4,609E-01	*	-1,307E-01	*	1,115E-01	*	1,070E-01	*	8,139E-02	*
	(1,374E-02)		*(4,590E-03)*		*(6,605E-03)*	*	*(3,254E-03)*		*(5,337E-03)*	
R-Squared	0,0009		0,0046		0,0009		0,0031		0,1521	
Number of Obs.	34408		34408		34408		36408		34408	

Medium Educated Workers

	Job Creation		Job Destruction		Hires		Separations		34408	
Business Cycle	1,265E-02	*	-7,964E-03	*	6,117E-03	*	-1,350E-03		3,690E-03	*
	(3,003E-03)		*(1,511E-03)*		*(1,878E-03)*		*(9,691E-04)*		*(1,460E-03)*	
Δwage low skilled	-4,800E-07	*	7,220E-10		-5,690E-08		1,790E-07	*	-2,260E-07	*
	(1,700E-07)		*(8,510E-08)*		*(1,060E-07)*		*(5,490E-08)*		*(8,220E-08)*	
Δwage medium skilled	-4,730E-07		3,020E-07	*	-6,480E-07	*	-1,870E-07	*	-2,060E-07	
	(1,380E-07)		*(6,940E-08)*		*(8,560E-08)*		*(4,420E-08)*		*(6,670E-08)*	
Δwage high skilled	4,400E-07	*	-2,840E-07	*	3,060E-07	*	-5,440E-08	°	2,570E-07	*
	(9,720E-08)		*(4,820E-08)*		*(5,970E-08)*		*(3,060E-08)*		*(4,740E-08)*	
Δproduction	-7,520E-11		-5,780E-11		4,500E-11		8,120E-12		-1,340E-11	
	(3,920E-10)		*(2,020E-10)*		*(2,420E-10)*		*(1,240E-10)*		*(1,990E-10)*	
Δimport penetration	8,211E-04		1,206E-02	*	-4,986E-03		1,534E-03		-3,547E-03	
	(9,093E-03)		*(4,559E-03)*		*(5,647E-03)*		*(2,893E-03)*		*(4,248E-03)*	
Δexport penetration	2,740E-05		-1,196E-03	*	1,723E-04		-4,030E-04		3,445E-04	
	(8,835E-04)		*(4,429E-04)*		*(5,466E-04)*		*(2,803E-04)*		*(4,138E-04)*	
R&D2	3,223E-02	°	5,433E-03		3,639E-02	*	2,045E-02	*	-6,000E-03	
	(1,900E-02)		*(9,743E-03)*		*(1,193E-02)*		*(6,191E-03)*		*(9,373E-03)*	
R&D3	5,152E-02	°	1,498E-02		2,624E-02		3,744E-03		2,798E-03	
	(2,775E-02)		*(1,415E-02)*		*(1,747E-02)*		*(9,053E-03)*		*(1,374E-02)*	
Constant	-2,632E-01	*	-3,144E-01	*	1,773E-01	*	5,672E-02	*	1,670E-01	*
	(1,344E-02)		*(7,515E-03)*	*	*(8,111E-03)*	*	*(4,244E-03)*		*(6,274E-03)*	
R-Squared	0,001		0,0024		0,0016		0,0013		0,0009	
Number of Obs.	33568		33568		33568		33568		36975	

High Educated Workers

	Job Creation		Job Destruction		Hires		Separations		Net Job Creation	
Business Cycle	-2,793E-03		-7,635E-03		1,785E-03		4,662E-03		-4,162E-03	
	(1,353E-02)		*(5,492E-03)*		*(8,859E-03)*		*(3,706E-03)*	*	*(3,823E-03)*	
Δwage low skilled	2,620E-06	*	-6,080E-07	°	1,520E-06	*	3,730E-07		1,010E-06	*
	(8,320E-07)		*(3,460E-07)*		*(5,470E-07)*		*(2,340E-07)*		*(2,370E-07)*	
Δwage medium skilled	3,110E-06		-8,420E-07	*	1,900E-06	*	5,010E-07	*	1,070E-06	
	(7,550E-07)		*(3,280E-07)*		*(5,000E-07)*		*(2,200E-07)*		*(2,140E-07)*	
Δwage high skilled	-6,960E-06	*	8,720E-07	*	-4,220E-06	*	-1,110E-06	*	-2,600E-06	*
	(3,290E-07)		*(1,390E-07)*	*	*(2,090E-07)*		*(9,390E-08)*		*(9,180E-08)*	
Δproduction	1,900E-10		2,800E-10		2,620E-10		1,590E-10		-1,120E-10	
	(8,500E-10)		*(3,570E-10)*		*(5,530E-10)*		*(2,140E-10)*		*(2,690E-10)*	
Δimport penetration	-5,509E-02		-7,719E-03		-2,331E-02		-3,095E-03		-2,993E-03	
	(6,080E-02)		*(2,548E-02)*		*(4,009E-02)*		*(1,716E-02)*		*(1,744E-02)*	
Δexport penetration	5,351E-03		9,911E-04		2,463E-03		5,845E-04		1,085E-04	
	(5,859E-03)		*(2,468E-03)*		*(3,862E-03)*		*(1,656E-03)*		*(1,669E-03)*	
R&D2	1,335E-01	°	6,283E-02	*	1,321E-01	*	1,069E-01	*	-2,266E-02	
	(7,292E-02)		*(2,979E-02)*		*(4,777E-02)*		*(1,980E-02)*		*(2,085E-02)*	
R&D3	4,230E-01	*	1,327E-01	*	3,298E-01	*	1,642E-01	*	5,188E-03	
	(8,835E-02)		*(3,557E-02)*		*(5,809E-02)*		*(2,385E-02)*		*(2,594E-02)*	
Constant	-1,212E+00	*	-8,791E-01	*	-3,807E-01	*	-3,609E-01	*	2,782E-01	*
	(6,638E-02)		*(3,329E-02)*	*	*(4,040E-02)*	*	*(1,814E-02)*		*(1,662E-02)*	
R-Squared	0,0258		0,0083		0,0196		0,0178		0,0312	
Number of Obs.	10052		10052		10052		10052		10052	

Sources: Industrial Statistics and Register Data for Norway, 87-94.

Notes: Tobit estimator is used. * Refers to a significant coefficient at the 95% confidence level, ° refers to a significant coefficient at the 90% confidence level.

Table 11. Results from Tobit Estimation: Trade and Vintage Capital

	Job Creation	Job Destruction	Hires	Separations	Net Job Creation
Low Educated workers					
Business Cycle	1,758E-02 *	-1,081E-02 *	4,740E-03	-4,126E-03 *	6,830E-03 *
	(2,777E-03)	*(9,863E-04)*	*(1,424E-03)*	*(7,437E-04)*	*(1,187E-03)*
Δwage1	-3,910E-08	3,520E-08	-2,310E-07	-1,010E-09	-2,030E-07 *
	(1,600E-07)	*(5,900E-08)*	*(8,460E-08)*	*(4,400E-08)*	*(7,010E-08)*
Δwage2	2,750E-07 *	1,940E-07 *	-1,670E-07	6,270E-08 °	-1,610E-07
	(1,270E-07)	*(4,710E-08)*	*(6,720E-08)*	*(3,510E-08)*	*(5,530E-08)*
Δwage3	4,290E-07 *	-2,050E-07 *	2,390E-07	-6,000E-08 *	2,100E-07 *
	(9,270E-08)	*(3,280E-08)* *	*(4,770E-08)*	*(2,470E-08)* *	*(3,990E-08)*
Δproduction	1,930E-10	-7,320E-11	8,890E-11	3,750E-11	9,370E-12
	(3,980E-10)	*(1,280E-10)*	*(1,880E-10)*	*(9,910E-11)*	*(1,640E-10)*
Δimport penetra	-1,306E-02	7,388E-03 *	-5,353E-03	5,929E-03 *	-7,498E-03 *
	(8,471E-03)	*(2,962E-03)*	*(4,278E-03)*	*(2,254E-03)*	*(3,504E-03)*
Δexport penetra	1,424E-03 °	-9,032E-04 *	3,463E-04	-8,238E-04 *	8,979E-04 *
	(8,216E-04)	*(2,870E-04)*	*(4,147E-04)*	*(2,188E-04)*	*(3,421E-04)*
Vintage Capital	-3,722E-01 *	8,171E-02 *	-2,207E-01	2,054E-02 *	-1,645E-01 *
	(1,488E-02)	*(5,602E-03)*	*(7,810E-03)*	*(4,119E-03)*	*(6,449E-03)*
Plant Age	-1,588E-02 *	1,537E-03 *	-9,720E-03	8,490E-05	-7,968E-03 *
	(8,507E-04)	*(3,234E-04)*	*(4,523E-04)*	*(2,394E-04)*	*(3,750E-04)*
Constant	7,134E-01 *	-3,244E-01 *	8,192E-01	9,417E-02 *	5,853E-01 *
	(2,764E-02)	*(1,128E-02)*	*(1,485E-02)*	*(7,955E-03)*	*(1,243E-02)*
R-Squared	0,0441	0,022	0,0512	0,0134	0,0481
Number of Obs	34408	34408	34408	34408	34408
Medium Educated Workers					
	Job Creation	Job Destruction	Hires	Separations	Net Job Creation
Business Cycle	1,531E-02 *	-8,381E-03 *	7,377E-03	-1,861E-03 °	5,291E-03 *
	(2,872E-03)	*(1,529E-03)*	*(1,803E-03)*	*(9,743E-04)*	*(1,423E-03)*
Δwage1	-4,230E-07 *	-3,030E-08	-3,270E-08	1,680E-07 *	-1,980E-07 *
	(1,660E-07)	*(8,830E-08)*	*(1,040E-07)*	*(5,650E-08)*	*(8,190E-08)*
Δwage2	-5,210E-07 *	3,280E-07 *	-6,760E-07	-1,800E-07 *	-2,370E-07
	(1,340E-07)	*(7,150E-08)*	*(8,350E-08)*	*(4,520E-08)*	*(6,620E-08)*
Δwage3	3,700E-07 *	-2,730E-07 *	2,660E-07	5,180E-08 °	2,250E-07 *
	(9,340E-08)	*(4,880E-08)* *	*(5,760E-08)*	*(3,090E-08)*	*(4,630E-08)*
Δproduction	7,530E-11	-1,980E-11	1,380E-10	2,520E-11	6,720E-11
	(3,780E-10)	*(2,070E-10)*	*(2,330E-10)*	*(1,250E-10)*	*(1,950E-10)*
Δimport penetra	-1,784E-03	1,219E-02 *	-6,678E-03	1,243E-03	-4,065E-03
	(8,749E-03)	*(4,627E-03)*	*(5,439E-03)*	*(2,908E-03)* *	*(4,141E-03)*
Δexport penetra	4,404E-04	-1,285E-03 *	4,571E-04	-3,521E-04	4,540E-04
	(8,544E-04)	*(4,498E-04)*	*(5,285E-04)*	*(2,830E-04)*	*(4,050E-04)*
Vintage Capital	-3,266E-01 *	9,710E-02 *	-2,240E-01	1,910E-02 *	-1,562E-01 *
	(1,518E-02)	*(8,540E-03)*	*(9,649E-03)*	*(5,286E-03)*	*(7,613E-03)*
Plant Age	-1,377E-02 *	9,737E-04 *	-9,628E-03	1,137E-03 *	-8,835E-03 *
	(8,720E-04)	*(4,887E-04)*	*(5,556E-04)*	*(3,061E-04)*	*(4,413E-04)*
Constant	.7360913 #	-5,235E-01 *	8,687E-01	1,672E-02	6,710E-01 *
	(9,545E-02)	*(1,740E-02)*	*(1,834E-02)*	*(1,025E-02)*	*(1,463E-02)*
R-Squared	0,0315	0,0117	0,0364	0,0093	0,037
Number of Obs	33568	33568	33568	33568	33568
High Educated Workers					
	Job Creation	Job Destruction	Hires	Separations	Net Job Creation
Business Cycle	7,582E-03	-1,002E-02 °	8,232E-03	3,479E-03	-8,936E-04
	(1,321E-02)	*(5,571E-03)*	*(8,693E-03)*	*(3,745E-03)* *	*(3,770E-03)*
Δwage1	2,520E-06 *	-3,020E-07	1,590E-06	1,390E-07	9,240E-07 *
	(8,190E-07)	*(3,580E-07)*	*(5,460E-07)*	*(2,400E-07)*	*(2,380E-07)*
Δwage2	2,870E-06 *	9,510E-07 *	1,770E-06	5,260E-07 *	1,010E-06
	(7,410E-07)	*(3,370E-07)*	*(4,940E-07)*	*(2,240E-07)*	*(2,120E-07)*
Δwage3	-6,540E-06 *	7,660E-07 *	-4,030E-06	-1,010E-06 *	-2,450E-06 *
	(3,240E-07)	*(1,430E-07)* *	*(2,070E-07)*	*(9,560E-08)*	*(9,160E-08)*
Δproduction	6,330E-10	1,550E-10	3,640E-10	2,690E-11	1,010E-10
	(8,410E-10)	*(3,590E-10)*	*(5,490E-10)*	*(2,160E-10)*	*(2,680E-10)*
Δimport penetra	-1,408E-01 *	-1,287E-02	-8,331E-02	-9,020E-03	-2,348E-02
	(6,195E-02)	*(2,663E-02)*	*(4,077E-02)*	*(1,777E-02)* *	*(1,767E-02)*
Δexport penetra	1,327E-02 *	1,293E-03	7,994E-03	9,952E-04	2,081E-03
	(5,933E-03)	*(2,568E-03)*	*(3,907E-03)*	*(1,708E-03)*	*(1,686E-03)*
Vintage Capital	-4,910E-01 *	1,295E-01 *	-3,016E-01	3,068E-02	-1,363E-01 *
	(7,064E-02)	*(3,174E-02)*	*(4,707E-02)*	*(2,105E-02)*	*(2,075E-02)*
Plant Age	-2,441E-02 *	3,591E-03 °	-1,761E-02	5,229E-03 *	-1,169E-02 *
	(4,205E-03)	*(1,891E-03)*	*(2,798E-03)*	*(1,260E-03)*	*(1,231E-03)*
Constant	4,824E-01 *	-1,335E+00 *	7,105E-01	-6,247E-01 *	8,864E-01 *
	(1,428E-01)	*(7,476E-02)* *	*(9,546E-02)*	*(4,528E-02)*	*(4,227E-02)*
R-Squared	0,0383	0,0309	0,0314	0,0438	0,0468
Number of Obs	10052	10052	10052	10052	10052

Sources: Industrial Statistics and Register Data for Norway, 87-94.

Notes: Tobit estimator is used. * Refers to a significant coefficient at the 95% confidence level, ° refers to a significant coefficient at the 90% confidence level.

Table 12. Results from Tobit Estimation: Trade, Vintage Capital Pus Extra Controls

Low Educated Workers

	Job Creation	Job Destruction	Hires	Separations	Net Job Creation
Business Cycle	1,835E-02 *	-1,054E-02 *	4,376E-03 *	-4,542E-03 *	1,835E-02 *
	(3,005E-03)	*(1,091E-03)*	*(1,559E-03)*	*(8,232E-04)*	*(3,005E-03)*
Δwage1	-1,400E-07	1,260E-07 *	-1,680E-07 °	1,180E-07 *	-1,400E-07
	(1,670E-07)	*(6,350E-08)*	*(8,950E-08)*	*(4,720E-08)*	*(1,670E-07)*
Δwage2	-1,880E-07	1,570E-07 *	-1,250E-07 °	4,570E-08	-1,880E-07
	(1,330E-07)	*(5,050E-08)*	*(7,150E-08)*	*(3,770E-08)*	*(1,330E-07)*
Δwage3	3,780E-07 *	-1,840E-07 *	2,160E-07 *	-5,270E-08 *	3,780E-07 *
	(9,670E-08)	*(3,490E-08)*	*(5,030E-08)*	*(2,640E-08)*	*(9,670E-08)*
Δproduction	4,530E-10	-1,020E-10	1,580E-10	3,790E-13	4,530E-10
	(4,720E-10)	*(1,530E-10)*	*(2,220E-10)*	*(1,190E-10)*	*(4,720E-10)*
Δimport penetra	-1,165E-02	8,171E-03 *	-4,653E-03	6,854E-03 *	-1,165E-02
	(8,514E-03)	*(3,038E-03)*	*(4,336E-03)*	*(2,326E-03)*	*(8,514E-03)*
Δexport penetra	1,192E-03	-8,791E-04 *	3,850E-04	-7,968E-04 *	1,192E-03
	(8,362E-04)	*(3,004E-04)*	*(4,278E-04)*	*(2,297E-04)*	*(8,362E-04)*
Vintage Capital	-3,018E-01 *	6,346E-02 *	-1,777E-01 *	2,550E-02 *	-3,018E-01 *
	(1,554E-02)	*(6,071E-03)*	*(8,344E-03)*	*(4,474E-03)*	*(1,554E-02)*
Plant Age	-1,444E-02 *	1,095E-03 *	-9,870E-03 *	-1,701E-04	-1,444E-02 *
	(9,092E-04)	*(3,548E-04)*	*(4,916E-04)*	*(2,631E-04)*	*(9,092E-04)*
Constant	6,704E-01 *	-3,497E-01 *	7,063E-01 *	9,926E-02 *	6,704E-01 *
	(4,818E-02)	*(1,875E-02)*	*(2,562E-02)*	*(1,372E-02)*	*(4,818E-02)*
R-Squared	0,049	0,025	0,0693	0,1027	0,049
Number of Obs	34408	34408	34408	34408	34408

Medium Educated Workers

	Job Creation	Job Destruction	Hires	Separations	Net Job Creation
Business Cycle	1,758E-02 *	-1,120E-02 *	9,059E-03 *	-3,736E-03 *	1,758E-02 *
	(3,061E-03)	*(1,688E-03)*	*(1,933E-03)*	*(1,072E-03)*	*(3,061E-03)*
Δwage1	-4,750E-07 *	1,700E-07 °	-9,220E-08	2,730E-07 *	-4,750E-07 *
	(1,700E-07)	*(9,510E-08)*	*(1,080E-07)*	*(6,010E-08)*	*(1,700E-07)*
Δwage2	-4,190E-07	1,250E-07	-6,250E-07 *	-2,780E-07 *	-4,190E-07 *
	(1,380E-07)	*(7,690E-08)*	*(8,700E-08)*	*(4,850E-08)*	*(1,380E-07)*
Δwage3	3,020E-07 *	-2,560E-07 *	2,140E-07 *	-5,730E-08 °	3,020E-07 *
	(9,550E-08)	*(5,170E-08)*	*(5,940E-08)* *	*(3,260E-08)*	*(9,550E-08)*
Δproduction	1,030E-10	-2,980E-11	1,390E-10	-3,910E-11	1,030E-10
	(4,290E-10)	*(2,370E-10)*	*(2,650E-10)*	*(1,450E-10)*	*(4,290E-10)*
Δimport penetra	1,600E-03	1,135E-02 *	-6,677E-03	3,750E-05	1,600E-03
	(8,754E-03)	*(4,734E-03)*	*(5,445E-03)* *	*(2,981E-03)* *	*(8,754E-03)*
Δexport penetra	3,471E-04	-1,231E-03 *	7,383E-04	-1,398E-04	3,471E-04
	(8,703E-04)	*(4,674E-04)*	*(5,383E-04)*	*(2,950E-04)*	*(8,703E-04)*
Vintage Capital	-2,625E-01 *	7,778E-02 *	-1,719E-01 *	3,108E-02 *	-2,625E-01 *
	(1,574E-02)	*(9,202E-03)*	*(1,008E-02)*	*(5,698E-03)*	*(1,574E-02)*
Plant Age	-1,344E-02 *	1,082E-04	-1,038E-02 *	-4,986E-04	-1,344E-02 *
	(9,155E-04)	*(5,298E-04)*	*(5,875E-04)*	*(3,316E-04)*	*(9,155E-04)*
Constant	6,895E-01 *	-5,582E-01 *	7,943E-01 *	-5,817E-02 *	6,895E-01 *
	(4,716E-02)	*(2,768E-02)* °	*(2,999E-02)*	*(1,701E-02)*	*(4,716E-02)*
R-Squared	0,045	0,0159	0,0693	0,042	0,045
Number of Obs	33568	33568	33568	33568	33568

High Educated Workers

	Job Creation	Job Destruction	Hires	Separations	Net Job Creation
Business Cycle	-3,931E-03	-6,589E-03	5,367E-03	6,338E-03	-3,931E-03
	(1,437E-02)	*(6,280E-03)*	*(9,589E-03)*	*(4,246E-03)* *	*(1,437E-02)*
Δwage1	2,660E-06 *	-8,570E-08	1,600E-06 *	-4,560E-08	2,660E-06 *
	(8,480E-07)	*(4,070E-07)*	*(5,740E-07)*	*(2,700E-07)*	*(8,480E-07)*
Δwage2	2,290E-06	-1,100E-06 *	1,410E-06 *	-5,910E-07 *	2,290E-06 *
	(7,840E-07)	*(3,900E-07)*	*(5,300E-07)*	*(2,590E-07)*	*(7,840E-07)*
Δwage3	-6,750E-06 *	7,450E-07 *	-4,380E-06 *	8,950E-07 *	-6,750E-06 *
	(3,420E-07)	*(1,580E-07)*	*(2,220E-07)*	*(1,050E-07)*	*(3,420E-07)*
Δproduction	7,630E-10	-6,460E-12	5,500E-10	-6,110E-11	7,630E-10
	(9,780E-10)	*(4,070E-10)*	*(6,440E-10)*	*(2,590E-10)*	*(9,780E-10)*
Δimport penetra	-1,395E-01 *	2,899E-03	-7,807E-02 °	6,216E-03	-1,395E-01 *
	(6,331E-02)	*(2,868E-02)* *	*(4,191E-02)*	*(1,894E-02)* *	*(6,331E-02)*
Δexport penetra	1,295E-02 *	5,560E-06	7,475E-03 °	-2,723E-04	1,295E-02 *
	(6,035E-03)	*(2,760E-03)*	*(4,002E-03)*	*(1,816E-03)*	*(6,035E-03)*
Vintage Capital	-3,973E-01 *	1,658E-01 *	-2,256E-01 *	6,819E-02 *	-3,973E-01 *
	(7,692E-02)	*(3,754E-02)*	*(5,167E-02)*	*(2,445E-02)*	*(7,692E-02)*
Plant Age	-2,542E-02 *	-4,079E-03 °	-2,258E-02 *	-3,472E-03 *	-2,542E-02 *
	(4,649E-03)	*(2,218E-03)*	*(3,136E-03)*	*(1,466E-03)*	*(4,649E-03)*
Constant	1,122E+00 *	-2,005E+00 *	9,188E-01 *	######### *	1,122E+00 *
	(2,165E-01)	*(1,188E-01)* *	*(1,454E-01)* *	*(7,315E-02)*	*(2,165E-01)*
R-Squared	0,0668	0,0603	0,0666	0,1027	0,0668
Number of Obs	10052	10052	10052	10052	10052

Sources: Industrial Statistics and Register Data for Norway, 87-94.

Notes: Tobit estimator is used. * Refers to a significant coefficient at the 95% confidence level, ° refers to a significant coefficient at the 90% confidence level.

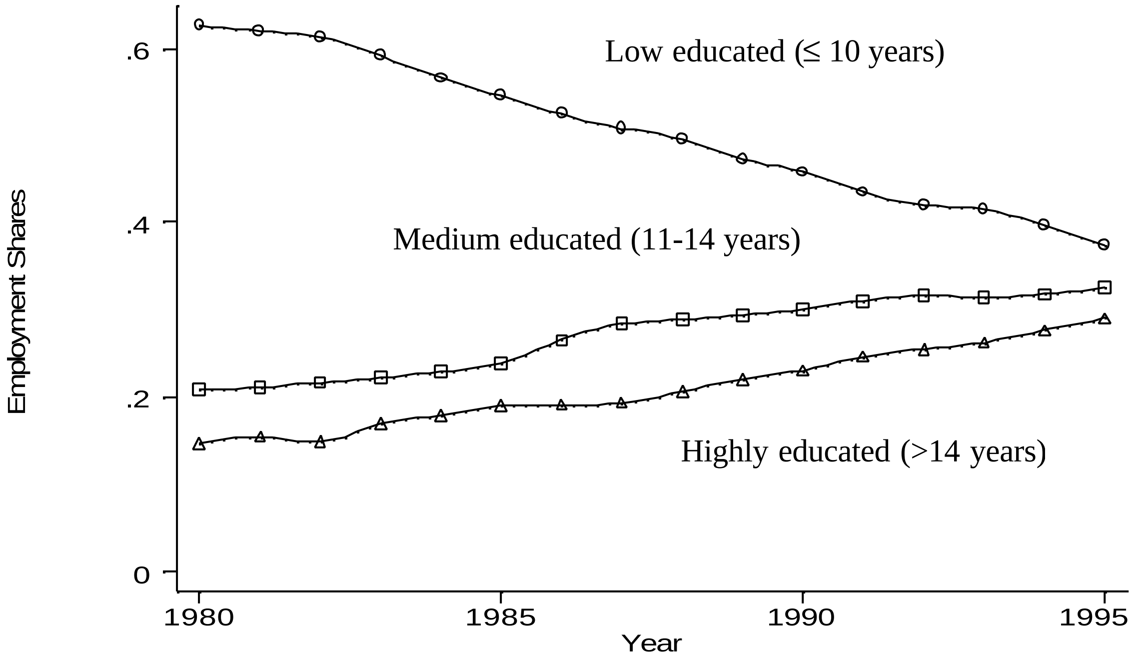

Figure 1: The share of different education categories as percentages of the labour force.

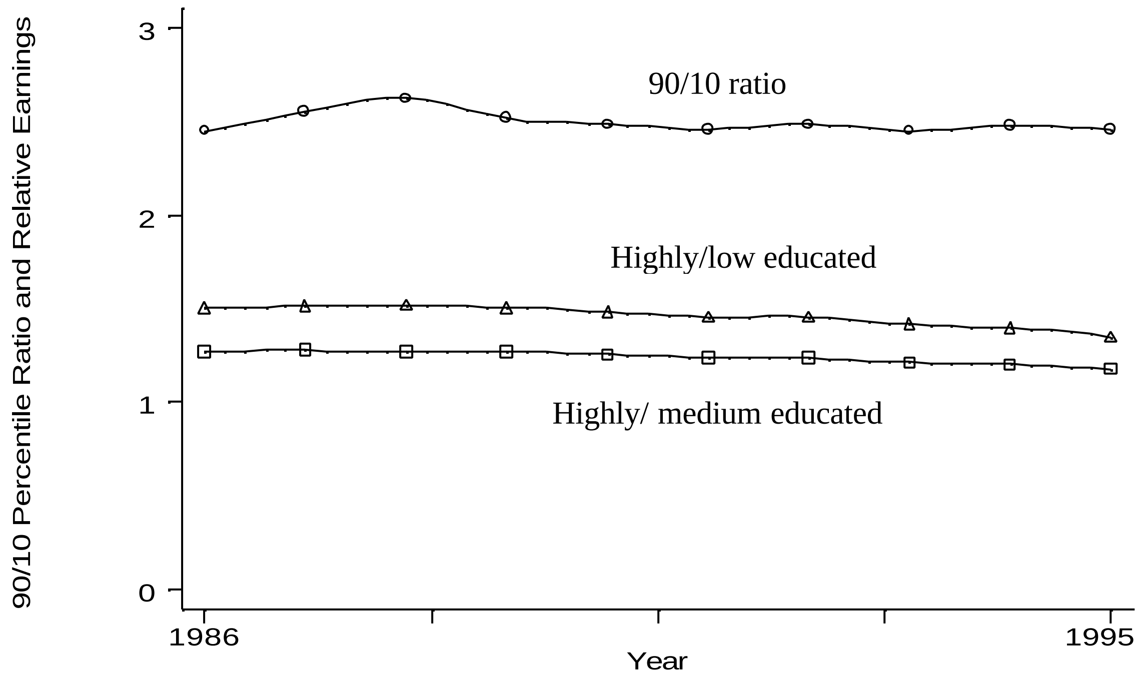

Figure 2: The 90/10 earnings ratio and the relative earnings of education groups.

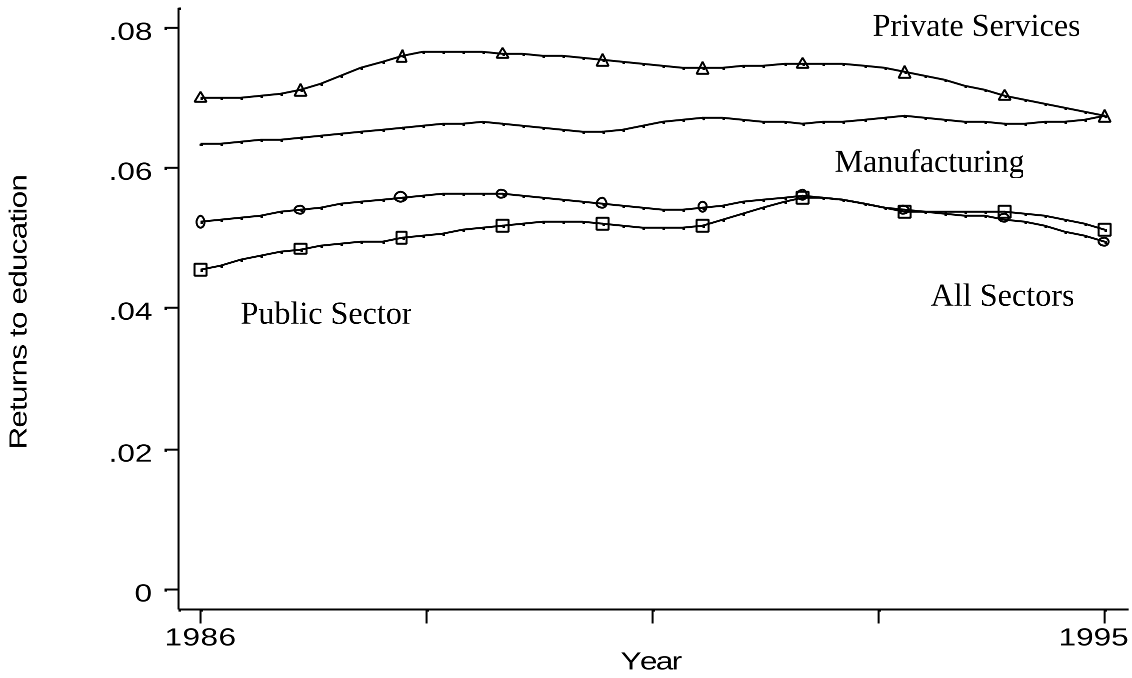

Figure 3: Returns to education in Norway by sectors.

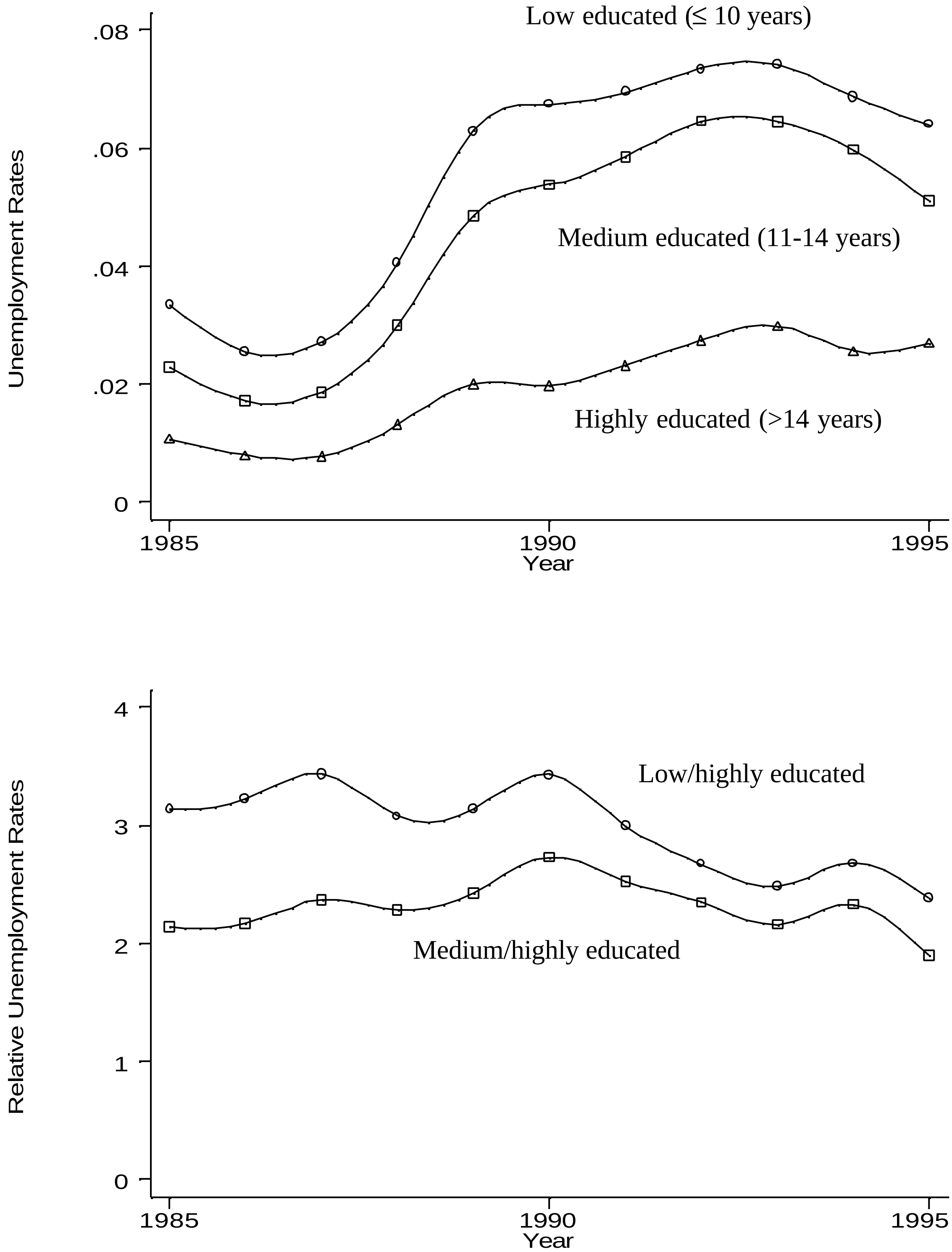

Figure 4a-b: Absolute and relative unemployment rates for education categories of workers.

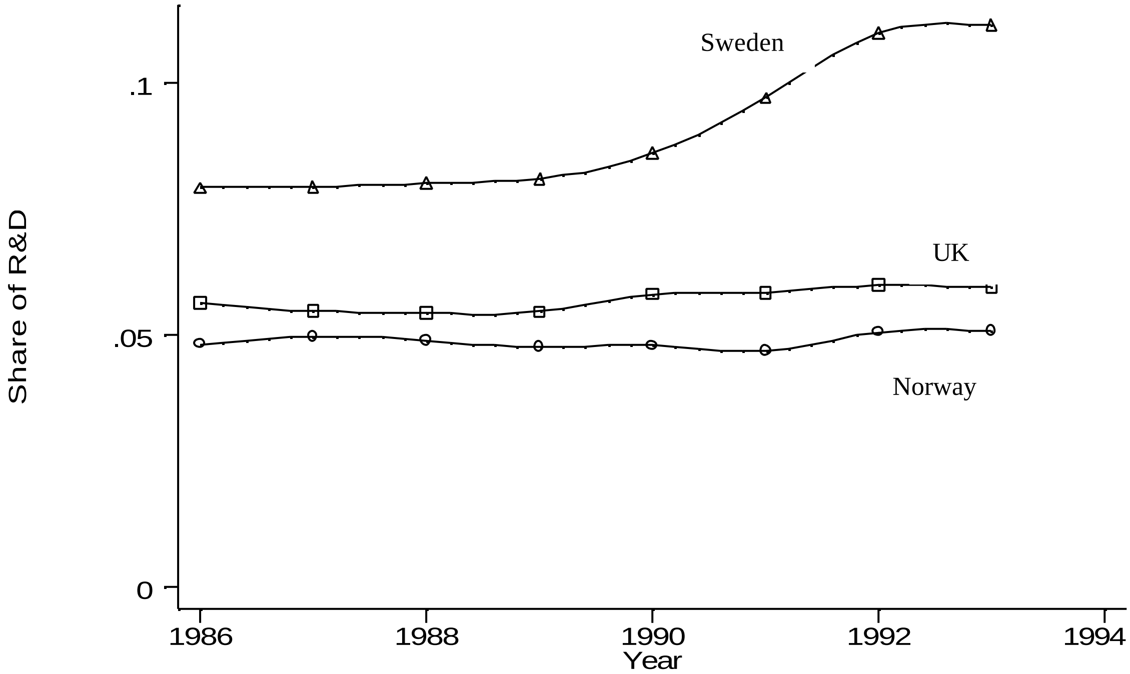

Figure 5: R&D intensity in the manufacturing sectors of Norway, Sweden and the UK.

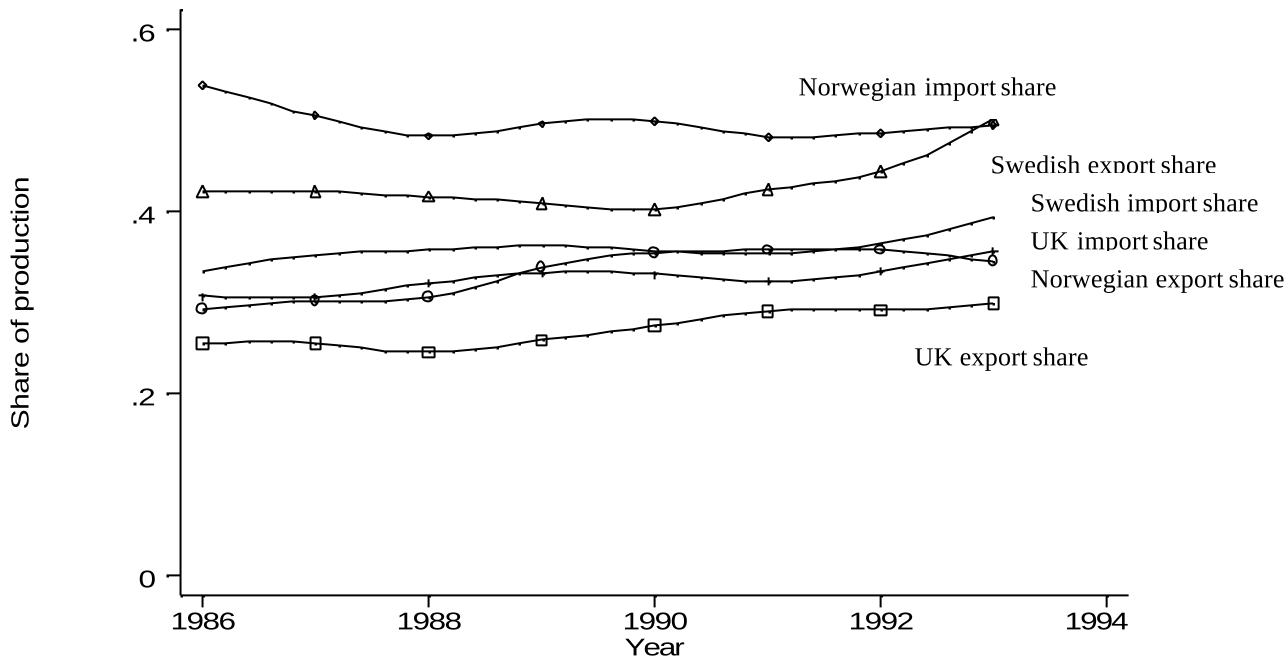

Figure 6: Import and export shares of manufacturing production for Norway, Sweden and the UK.

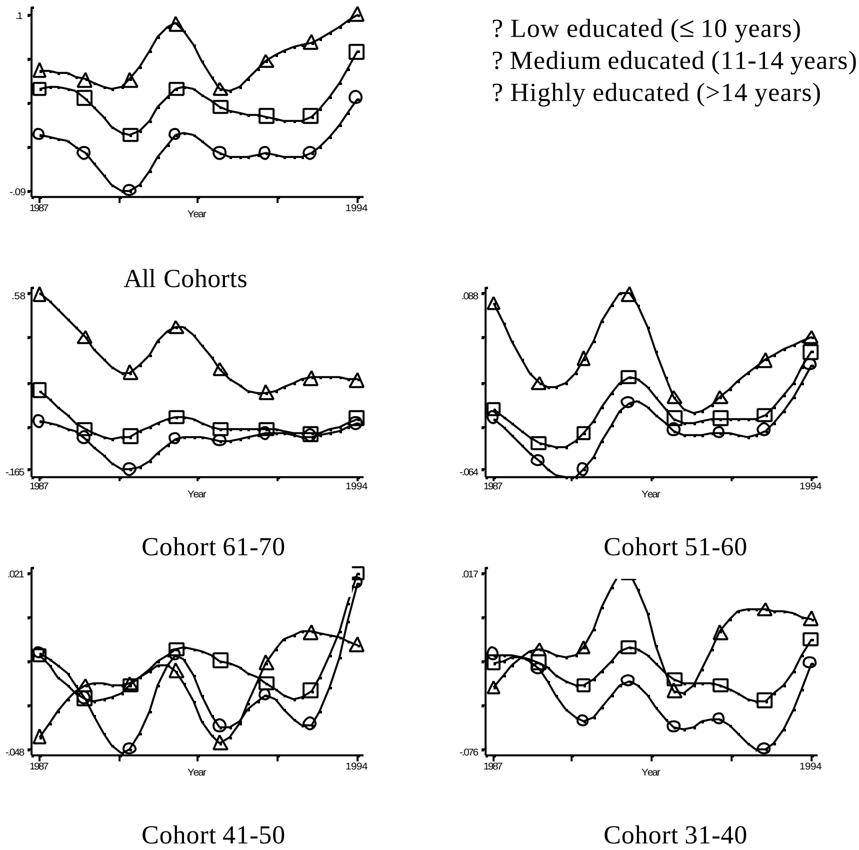

Figure 7a-e: Net job creation by cohort.

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