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ABSTRACT

Are New Work Practices and New Technologies Biased against Immigrant Workers?*

New technologies and new work practices have been introduced and implemented over a broad range in the production process in most advanced industrialised countries during the last two decades. New work organisation practices like team organisation and job rotation require interpersonal communication to a larger extent compared to the traditional assembly line types of production. In addition to handling the formal language, communication in this respect includes country-specific skills related to understanding social and cultural codes, unwritten rules, implicit communication, norms etc. In this paper we analyse whether these developments – by increasing the importance of communication and informal human capital – have had a negative effect on employment opportunities of immigrants. The results show that firms that use PCs intensively and firms that give their employees broad autonomy employ fewer non-Western immigrants who have not been raised in Norway (i.e. arrived as adults). Furthermore, the negative relationships are especially strong for low-skilled non-Western immigrants. These results may add support to the hypothesis stating that new technologies and (some) new work practices are biased against non-Western immigrant workers, and especially those with low formal skills.

JEL Classification: J61, J71

Keywords: immigrants, employment, new work practices, new technology

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1. Introduction

In this study we investigate whether, and to what extent, changing organizational structures at the work place and use of new technology in the production process aggravate problems facing immigrants in the Norwegian labour market. The main argument is that new technologies, combined with new organisational practice, require interpersonal communication to a greater extent than the traditional assembly line type of production. In addition to handling the formal language, good communication demands the understanding of social and cultural codes, unwritten rules, implicit communication, norms etc. These kinds of skill and ability are clearly country specific. Thus, a communication bias in new technology and new organisational practise may place immigrants at a competitive disadvantage, which could increase over time. In other words, new production methods may be biased against immigrant workers.

Since the beginning of the 1980s, the immigrant proportion of the total population in Norway has increased from 2 per cent to almost 8 per cent. During the same period the composition of the immigrant population has changed from having been dominated by immigrants from Western and Nordic countries to currently being dominated by immigrants from non-Western countries. By 2004, almost 75 per cent of the immigrants in Norway were non-Western immigrants compared to 25 per cent in 1980 (Statistics Norway 2004).

Non-Western immigrants occupy a weak position in the Norwegian labour market. They have low labour force participation rates and high unemployment rates compared to the native. By the third quarter of 2004 the unemployment rate among immigrants in Norway was 11 per cent (Statistics Norway 2004), almost three times as high as that of natives. It is especially high among non-Western immigrants, with immigrants from Africa (20 percent) and Asia (14 per cent) at the upper end of the distribution. Many empirical studies show that similar patterns are found in Sweden and Denmark regarding to the labour market integration of non-Western immigrants (see for example, Pedersen and Smith 2002).

Empirical studies from Scandinavia indicate that the labour market problems of non-Western immigrants have been aggravated during recent decades. Barth et al. (2004) analyse labour market assimilation for different cohorts of immigrants in Norway (from pre-1965 arrivals to 1990–1994). After controlling for time since immigration and a host of human capital and other background variables they conclude that early cohorts have higher earnings than more recent cohorts. This finding suggests that labour market assimilation for

immigrants has become more difficult over time. Rosholm et al. (2006) analyse male immigrant experience in Sweden and Denmark from 1985 to 1995. Their results show that immigrants in both Sweden and Denmark experienced a similar decline in employment prospects during this period, despite diverging business cycles in the two countries. Their interpretation of these results is that changing organisational structures – towards more flexible work organisation – has resulted in a decreased demand for immigrant employees due to their relatively low level of (country specific) communicative skills.

Bratsberg et al. (2003) analyse lifecycle employment profiles of labour immigrants who arrived in Norway during the early 1970s. They find important differences in labour market progress between immigrants from Western and non-Western countries. While employment profiles of Western immigrants converge with those of natives, profiles of non-Western immigrants diverge after age 35. While the employment rate of native men is more or less stable between the age of 35 and 50, the predicted rate of non-Western labour immigrants declined from 92 per cent to 61 per cent. One explanation suggested by the authors to explain these declining employment rates among immigrants is changing structures of labour demand (Bratsberg et al. 2003):

'*Technological change and flatter organizational structures at the workplace may have brought a greater dependency on communication skills and teamwork, and such developments may have hurt employment prospects of non-Western immigrants …*'.

The importance of communicative skills in explaining relative employment and wage developments between natives and immigrants has also received international research attention. Moss and Tilly (1996) analyse changes in skill requirements and the impact of these changes on Black men's access to entry-level jobs by using face-to-face interviews with managers at 56 US firms. Managers in this study report that 'soft' skills – particularly motivation and ability to interact with customers and co-workers – are becoming increasingly important and many managers view Black men as lacking in these soft skills. This may, according to the authors, help to explain Black men's disadvantage in the labour market. Fan et al. (2005) derives a theoretical model that predicts that the more intensively 'soft'/non-cognitive skills are used in an occupation, the greater is the black/white pay differential in that occupation. Using US survey data, they find consistent empirical evidence to support the theoretical prediction.

Introduction of new technologies and of new work practices are two characteristics of 'the new economy' which have emerged in advanced industrialised countries during the past decades. Such organizational changes comprise a move away from traditional assembly line

organisational structures towards multi-tasking, job rotation, teamwork, the use of computers, reductions in management levels and decentralization of responsibility (Lindbeck and Snower 2000). A study by the OECD (1999) shows that these kinds of organizational changes seem to be widespread in Sweden and Denmark (Norway is not included in this OECD study).

These work organisation practices involve increased responsibility and more uncertainty for the workers. They also require increased interpersonal cooperation on problem-solving and imply more frequent contacts between individual employees. Thus, the importance of communicative capacity – to 'grease the wheels' of the production process – probably increases as new technologies and new organisational structures are introduced. Low levels of communicative skills will reduce productivity in jobs where communication and interpersonal cooperation is important. Since communicative skills are country specific to a large extent, this development may increase the competence deficit of immigrants. This problem may increase with the geographical and cultural distance between home and host country and may be particularly grave in a small language area like Scandinavia.

Previous research seems to agree that these kinds of changes in the production process have raised the demand for skilled labour, that is to say new technologies and new work practices are skill-biased (see for example.., Berman et al. 1994, 1998, Machin 1996, and Katz and Autor 1999, Caroli and Van Reenen 2001, Caroli 2001). A key point in this literature is that technological innovation and new forms of work organisation have increased the demand for more educated workers.

Evidence of skill-biased technological changes has also been found in the Norwegian labour market (Salvanes and Førre 2003), measured by increased job creation rates for highly qualified workers in firms with new vintages of capital. However, results in Røed and Nordberg (2004) suggest that changes in relative employment opportunities have also arisen between workers at the same skill level. Their results show that relative employment opportunities for workers at the lower end of the wage distribution – *conditional on the level of education and work experience* – have worsened significantly in Norway during the 1990s. This suggests that the weaker parts of *all* skill groups have experienced less favourable labour market opportunities, i.e., this development has also taken place in the highly skilled segment of the labour market.

In this paper we shed some light on this matter by estimating factor demand equations both within and between different skill groups. Our main focus is on the importance of what we call communication-biased technological and organisational change. Specifically, we test the hypothesis that new technology and new work practises are biased against immigrant

workers, and the extent to which this bias arises within or between skill level groups. We employ a matched employer-employee data set from a (panel) survey of firms conducted in Norway. A set of translog cost share functions, modified to take into account the panel aspect of the data and the occurrence of many zeros for the dependent variable, is estimated.

Of course, immigrants are not a homogenous group of workers, and we hypothesize that the increased demand for communicative abilities should be particularly difficult to honour for non-Western immigrants, particularly for those who have not been raised in Norway. To capture these differences in the empirical analyses, we distinguish between different groups of immigrants.[1] Furthermore, as mentioned above, the skill-biased and organisational-biased empirical literature have shown that introduction of new technologies and new work practices are biased in favour of highly skilled workers. Therefore, we also perform analyses distinguishing between workers at different skill levels. In this way we may also shed some light on the result in Røed and Nordberg (2004) reporting a steady detoriation of employment prospects for persons with low abilities in *all* skill groups. Within each skill group (high and low skill) we analyse relative demand for different groups of workers (defined by their country of origin and the length of stay in Norway). Our matched panel employer–employee data material – containing survey information on the use of different forms of new work practices and indicators of new technology, together with individual register information on wages, education and country of origin – allows us to perform a rigorous analysis of these differences.

In Section 2 we propose an econometric framework for estimating the relationship between technology, work organisation practices and the composition of the workforce. In Section 3 the data, the sample, and the variables used in the analysis are described. The results are presented in Section 4, and in section 5 we summarize and conclude.

2. Empirical specification

We analyse the relationship between firm-level indicators of technological adaptation and the firm's workforce structure within a factor demand framework. The estimated equation is derived from a simple quasi-fixed translog cost function (Christensen et al. 1971, 1973; Brown and Christensen 1981). We assume that the firm minimises the cost function given an

[1] Several studies have been conducted analysing the general substitution elasticity between native and immigrant workers. The vast majority of studies report that natives and immigrant workers are far from perfect substitutes in production (Hamermesh 1993, Manacorda et al. 2006).

output constraint. The cost function contains both variable and quasi-fixed inputs. The only variable inputs are related to five types of workers:

(1) Natives
(2) Western immigrants who arrived as children
(3) Western immigrants who arrived as adults
(4) Non-Western immigrants who arrived as children
(5) Non-Western immigrants who arrived as adults.

The definition of Western and non-Western immigrants and the distinction between children and adults are explained in the next section.

Consider the following translog cost function for firm *i* at time *t*:

$$(1)\quad LnC_{it} = \beta_0 + \sum_j \alpha_j \ln W_{ijt} + \sum_{j,k\, j\neq k} \sum \beta_{jk}^{w} \ln W_{ijt} \ln W_{ikt} + \beta_K \ln K_{it} + \sum_j \beta_{jK} \ln W_{ijt} \ln K_{it} + \beta_Y \ln Y_{ji} + \sum_j \beta_{jY} \ln W_{ijt} \ln Y_{it} + \beta_Q \ln Q_{it} + \sum_j \beta_{jQ} \ln W_{ijt} \ln Q_{it}$$

where *j* refers to one of the five different groups of workers and W_{ijt} is the wage rate of group *j* in firm *i* at time *t*. *C* signifies the variable costs. The α parameters reflect own price effects, *K* is physical capital, and *Q* is technological and organizational capital. Firm output, *Y*, is included to capture any non-homotheticity. If costs are independent of the output level, the production technology is homothetic.

By assuming that costs are homogenous of degree one in prices, we can impose the standard restrictions, and using Shepard's lemma we can generate a series of *j* variable wage cost share equations of the familiar form:

$$(2)\quad S_{ijt} = \frac{\partial \ln C}{\partial \ln W_j} = \alpha_j + \sum_{k=2,3,4,5} \beta_{jk}^{w} \ln\left(\frac{W_{ikt}}{W_{i1t}}\right) + \beta_{jK} \ln K_{it} + \beta_{jY} \ln Y_{it} + \beta_{jQ} Q_{it}$$

where S_{ijt} is the wage cost share of worker group *j (j = 1, 2, 3, 4, 5)* in firm *i* at time *t*. W_{ikt}/W_{i1t} are average wages for group *k (k = 2, 3, 4, 5)* divided by the average wage for group *1* (natives). Including a vector with firm-specific control variables (*X*), specifying the firm's technological capital and new work organisation practices and adding an error term, we get the following econometric specification of (2):

$$(3)\ S_{ijt} = \alpha_j + \sum_{k=2,3,4,5} \beta^w_{jk} \ln(\frac{W_{ikt}}{W_{i1t}}) + \beta_{jK} \ln K_{it} + \beta_{jY} \ln Y_{it} + \beta_{jQ} PC_{it} + \beta_{jO} ORG_{it} + \beta_{jX} X_{it} + u_{ijt}$$

where u_{ijt} is a stochastic error term. The measure of technological capital (*PC*) is the share of workers using personal computer, and *ORG* is a set of binary variables measuring new work organisation practices. Restrictions are imposed upon the model from the structural equations. *Symmetry* implies the following restrictions:

$$\text{i)}\ \beta^w_{jk} = \beta^w_{kj},$$

and *homogeneity* implies two cross equation restrictions:

$$\text{ii)} \sum_{j=1}^{5} \alpha_j = 1,\ \ \sum_{j=1}^{5} \beta_{jm} = 0$$

and one within equation restriction:

$$\text{iii)} \sum_{m \in M} \beta_{jm} = 0$$

.

where *m* refers to each independent variable in equation (3) and *M* is the total number of variables.

If new technology and new forms of work practices are biased against immigrant workers we would expect a negative relationship between the indicators of technology, new work practices and the share of immigrants wage costs in total wage costs. We have assumed that the main mechanism generating this bias is that the use of PC technology and organizational practises increase the return to communicative capacity. Thus, we expect the negative relationships to be reinforced with the geographical and cultural distance between Norway and the home country of the immigrants and to be weakened by the time the immigrants have lived in Norway. The implications of these expectations in the formal context of equation (3) are that the *PC* variable and *ORG* variables have a more negative influence on the wage cost share for non-Western – compared to Western – immigrants., i.e., $\beta_{2Q} > \beta_{4Q}$, and $\beta_{3Q} > \beta_{5Q}$ (and the same ranking with regard to the β_{jO}). Furthermore, the negative communication-bias is stronger towards those immigrants who are not raised in Norway, i.e., $\beta_{2Q} > \beta_{3Q}$, and $\beta_{4Q} > \beta_{5Q}$ (and the same ranking with respect to the β_{jO}).

There are some problems related to estimating equation (3). Firstly, the dependent variables are censored. Secondly, introducing the relative wage measure at the firm level as

one of the explanatory variables would reduce the number of observations considerably, since a large share of the firms do not employ immigrant workers. Thirdly, there is the issue of endogeneity. To make a causal statement regarding the effect of organisational and technological changes on labour demand we must discuss the possibility of reverse causality. In the rest of this section we discuss how these problems may be handled in an orderly fashion.

First, we tackle the problem of censoring. A large proportion of firms do not have any (or some) of the groups of immigrants in their labour force. For example, approximately 50 per cent of the firms do not have any non-Western immigrants who arrived as adults in their employment. The same is true for 53 per cent of the firms with regard to non-Western immigrants who arrived as children. The corresponding percentages for Western immigrants are 47 per cent and 25 per cent, respectively. Standard ordinary least square (OLS) will produce inconsistent results in such cases. Estimation techniques should be applied that take account of this censoring. Thus, we estimate the factor demand equations by a simultaneous Tobit maximum likelihood procedure. Furthermore, since the data material is organised as a panel, we estimate random effect Tobit models. One advantage related to this approach is that we can take into account all restrictions implied by the structural cost equations. Another advantage is that exploitation of the panel structure improves the efficiency of the estimator, and in a non-linear model it also restores consistency.[2] A disadvantage related to this approach, as shown below, is that the restrictions implied by the structural cost equations become quite complex in this non-linear setup, and hence, recovery of the omitted parameters of the model becomes cumbersome.

We assume in the following that the cost shares reflect an underlying tendency, Y_{ijt}, to employ immigrants belonging to each of the four types of immigrant workers. The relationship between this underlying latent tendency and the cost shares is described in (4):

$$(4)\quad Y_{ijt} = \alpha_j + \sum_{k=2,3,4,5} b^{w}_{jk} \ln\left(\frac{W_{ikt}}{W_{i1t}}\right) + b_{jK} \ln K_{it} + b_{jY} Y_{it} + b_{jQ} PC_{it} + b_{jO} ORG_{it} + b_{jX} X_{it} + e_{ijt}$$

$$S_{ijt} = \begin{cases} Y_{ijt} & \text{if } Y_{ijt} > 0 \\ 0 & \text{otherwise} \end{cases}$$

Where the error term is specified as an error component model, i.e., we assume that : $e_{ijt} = \varepsilon_{ijt} + \eta_{ij}$, $\varepsilon_{ijt} \sim N(0, \sigma^2_{ijt})$ and the random effect follows a discrete distribution. In each

[2] In a non-linear setup, neglect of the panel structure in the data leads to inconsistent estimates.

equation we allow for up to three different support points, and the correlation of the random effect between equations is completely flexible.

We believe that (4) reflects a plausible assumption. When employing the Tobit approach we estimate the parameters of the latent index. For these parameters, the restrictions imposed by the assumptions of *homogeneity* and symmetry are quite complicated: What we estimate are the *b*'s, but the restrictions are in terms of the β's, which are also the parameters of interest.

However, the parameters of the actual cost shares, the β's, can be expressed as a *function* of the parameters of the latent index. The relations between the two sets of parameters (illustrated for the capital variable) are the following:

$$(5) \quad \beta_{jK} = \frac{1}{n}\sum_i \partial S_{ijt} / \partial \ln K_{it} = b_{jK} \cdot \frac{1}{n}\sum P(Y_{ijt} > 0) \,, \\ = b_{jK} \cdot \overline{P(Y_{ijt} > 0)}$$

or at least this is the case if we think of β as the average influence of a variable on the outcome, which is what the parameter captures in the linear case. The parameter restrictions, which in the translog cost function model were just parameter restrictions are now slightly more complex in the sense that they also depend on the fractions of uncensored observations.

However, the cross equation restriction in ii) on the α's and β's (and the singularity of the error covariance matrix) can be ignored by leaving out the first equation from the estimations, while the within equation restriction in iii) is circumvented by the division with one of the price variables (here, the wages of natives), in each equation.

The only restriction left is thus the symmetry restriction in i). It is now important to note that the symmetry restriction does not imply that $b_{jk}=b_{kj}$, but rather, that

$$(6) \quad b^w_{jk}\overline{P(Y_{ijt} > 0)} = b^w_{kj}\overline{P(Y_{ikt} > 0)}$$

so, that $$b^w_{jk} = b^w_{kj}\frac{\overline{P(Y_{ikt} > 0)}}{\overline{P(Y_{ijt})}}$$

These restrictions are incorporated directly in the estimation process. We then turn to the problem of missing relative wage observations. To measure the relative wages at the firm level would reduce the number of observations considerably. The reason is that a large proportion of the firms have no immigrant workers in their workforce. The employment of immigrants is probably driven by a non-random selection process. Thus, it is likely this

procedure would cause a severe selection bias problem as well. We deal with this problem by including relative wage measures at the regional (county) level. The regional group specific wage measures are calculated from information on individual wages, place of residence, country of birth and duration of residence in Norway. Combined with information about the same individuals' working hours we construct individual hourly wages, which in turn are aggregated up to county level. Still, it is likely that identification of the wage effect may be difficult because differences in wages not only reflect exogenous movements in the price of labour, but also unobserved differences in skills and abilities among workers.

Finally, to what extent will we be able to make causal statements about how the use of new technology and work practises affect the demand for immigrant workers? That is, can we rule out the case of reverse causality, i.e., that firms which hire many immigrant workers change their technology and form of work practices in response to workers and skills available. Lewis (2006) present empirical evidence for US manufacturing firms that support his hypothesis that the combination of skilled and unskilled labour in a plant's metropolitan area affects its use of technology. These results support models in which producers adapt techniques to factor mix, i.e., a reverse direction of causation compared to our story. However, the issue of endogeneity is not easily addressed as it is difficult to find good instrument variables for the *PC* and *ORG* variables, that is, variables which affect the use of this technology and these organisational practises, but at the same time do not affect the wage costs shares. However, observing that the proportion of immigrants from non-Western countries is on average 5 per cent, and that in only 1/16 of all firms does it exceed 20 per cent, it seems unlikely that the firm would adapt its production technology to this part of the work force. Rather, we would expect the firm to do the opposite; namely, to adapt its work force to its production technology, which is what we study in this paper. However to shed some light on the potential problem we do two things. First; we employ a crude estimation strategy, estimating a fixed effect (first differenced) model of wages cost shares regressed on all time-varying variables. This procedure yield results that are qualitatively the same as those we find here, although the sizes of the parameters are not readily comparable.[3] Secondly; we estimate the model using lagged values of the explanatory variables. This means that we estimate wage cost shares from 2003 on explanatory variables from 1997. Although this is not a completely satisfactory test for endogeneity, it should reduce the problem because the use of lagged explanatory variables reduces the simultaneity of the firm's decision-making regarding the

[3] These results are available upon request.

choice of technology, new work practices and the composition of the work force. The results from this approach are presented in Section 4.

3. Data and variables

The data comes from an employer–employee panel data set consisting of both survey and register information. The starting point is an establishment-level survey of a representative sample of Norwegian establishments conducted by the Institute for Social Research and Statistics Norway in 1997. The sample of establishments is representative for private and public establishments in Norway with more than 10 employees. In 2003, the survey was repeated. All firms participating in 1997 were asked to participate again.

In this paper we limit the analyses to private sector firms present in both 1997 and 2003, that is, we have a balanced sample of private sector firms. The net sample used in the empirical analyses consists of 1088 observations, or 544 firms.

To the survey of establishments Statistics Norway has linked register information from several public administrative registers, including both employee and employer level information. We have employee level information on country of origin, level of education, and wages, all taken from public registers. The rest of the variables are from the employer level.

Information on wages is based on individual register information from the tax authorities. Each individual's wage information is linked to an employer. This enables us to aggregate wage information at the firm level for each type of worker. All analyses are restricted to workers 20–60 years of age.

The dependent variable is the *share of wage costs in total wage costs* at the firm for each of the five categories of workers: Natives, Western immigrant who arrived as children, Western immigrants who arrived as adults, non-Western immigrant who arrived as children, and non-Western immigrants who arrived as adults. Western countries include the Nordic countries, countries in Western Europe, USA, Canada, New Zealand and Australia. Non-western countries are those in Asia (including Turkey), Africa, Southern and Central America and Eastern Europe.

To distinguish between immigrants who are raised in Norway (i.e. who arrived as children) and those who are not (who arrived as adults) we exploit information on age when

arriving to Norway (Age_N) and number of years of education after mandatory education (Education). We define:

$$\text{Child immigrant if : } Age_N \leq 16 + \text{Education}$$
$$\text{Adult immigrant if : } Age_N > 16 + \text{Education}$$

where the right hand side is intended to proxy the age of entry into the labour market.

To measure the impact of *technology* we use a measure of the percentage of workers using *personal computers*, based on answers to the following question: 'How large a share of the employees use PC or other computer in their daily work?' (named PC). The percentage of workers using PC is, of course, a crude measure of the level of technology at the firm. PCs are used to accomplish a vide variety of tasks, which differ greatly in complexity. On the other hand, this measure has the advantage of being widely used in different studies across countries. This facilitates the possibility of comparing results of different studies.

To measure the impact of *new work practices* we use four dummy variables measuring job rotation, use of teamwork, multitasking, and the degree of autonomy given to the workers. Information on *Job rotation* is taken from replies to the following question: 'Are any of the employees involved in job rotation?' yes/no. Information on *teams* is taken from the following question: 'Are any of the employees organised in work teams?' yes/no. Information on *multitasking* is taken from the following question: 'Are employees given training so that they can cover (be responsible for) several work areas?' yes/no. Finally, the degree of *autonomy* at the workplace is taken from answers to the following question: 'What opportunities do employees have for making their own choices so as to finding the best way to accomplish their assignments?' The alternatives were: Full opportunities; Quite good opportunities; Some good opportunities; and None. From this we construct a binary indicator of autonomy at the workplace, taking the value one if the firm answers 'Full opportunities', and zero otherwise.

We use level of education to distinguish between workers at different skill levels. Two skill levels are used: Low skill (compulsory school and secondary school) and high skill (university or college degree).

Control variables include information on relative wages, output, capital, region, industry, recruitment problems and downsizing. 'Relative wages' measures the relative difference in mean hourly wages between the different worker types relative to native workers. 'Hourly wages' is constructed from individual information on total wages, duration of the working relationship, and working time. The 'mean hourly wages' is measured at a

regional level (county).[4] 'Output' is measured by firm sales. 'Capital' is measured by the sum of equity and debt. The 'firm's location' is measured by 19 regional dummy variables (counties), 'industry' is measured by 18 dummy variables based on two digit NACE codes. Information on recruitment problems is based on how difficult it is to recruit qualified personnel. If the firm answers very difficult, the variable is given value one, zero otherwise. Information on downsizing is based on a question whether any major organisational changes have taken place during the last five years. If yes, the firm is asked whether this led to a reduction in the number of employees. If the firm answers yes, the variable is given the value one; zero otherwise. Information on recruitment problems and downsizing is included to control for the possibility that the employment structure at the firm is the result of factors other than changes in technology or new work practices.

4. Results

Table 4.1 presents descriptive statistics for the dependent and some of the independent variables. The first row shows that, in the average firm, approximately 90 per cent of the firm's total wage costs go to natives. The largest immigrant group in this sample is Western immigrants who arrived as children (3.9 per cent) followed by non-Western immigrants who arrived as adults (2.9 per cent).

[Table 4.1 about here]

The next two rows show mean share of total wage costs for low-skilled and highly skilled workers.[5] Approximately 70 per cent of the firms' wage costs go to low-skilled natives. Approximately 20 per cent go to highly skilled natives. The immigrant groups with the largest wage share are low-skilled non-Western immigrants who arrived as adults, and low-skilled Western immigrants who arrived as children, both with 2.6 per cent..

The average share of PC users (in their daily job) in a firm in this sample is 46 per cent. Six out of ten firms use teams, while four of ten firms use job rotation. One in four firms give their workers much autonomy, while more than four out of five firms give training to their workers so that they can cover several work areas (multitasking).

[4] There are 19 counties in Norway.
[5] The wage shares sum to unity for all workers and for low- and highly skilled workers together.

Table 4.2 presents estimates of the relationship between the wage cost structure of the workforce, and technology and new work practices.[6] All models are estimated using the simultaneous dependent Tobit system of equations presented in section 2. The omitted equation is the natives' equation.

[Table 4.2 about here]

Increasing the proportion of workers in the firm using a PC by 1 percentage point decreases the share of total wage costs by 2.9 percentage points for non-Western immigrants arriving to Norway as adults.[7] For non-Western immigrants who arrived as children, the coefficient is close to zero. The proportion of workers in the firm using a PC is positively related to the share of Western immigrants who arrived as children, while the impact is close to zero for Western immigrants who came as adults. These results may add support to hypothesis saying that new technologies – by increasing the need for interpersonal communication in a broad sense – are biased against non-Western immigrants who arrived as adults.

Regarding the indicators of new work practices, we do not find any significant relations between use of *teams* and the share of any of the immigrant groups in total wage costs. Firms that give their employees lot of *autonomy* employ fewer non-Western immigrants, although the result is only statistically significant for those who arrived as children. The results for immigrants from Western countries are not statistically significant. This result for the autonomy variable agrees with a hypothesis saying that new work practices – by increasing the importance of communication and informal human capital – may harm non-Western immigrant workers, the group which is perceived to possess low levels of these human capital components.

In firms where *multi-tasking* is an important feature in daily work, non-Western immigrants who arrived as children have a *higher* share of total wages. This result is at some odds with the hypothesis of new work practices being biased against non-Western immigrants, but may be explained by some firms' need for upgrading the skills of their workforce, for instance due to requirements from the production technology side, –, i.e. it

[6] The dependent variable in all the models is the employee groups' share of wages in the firm's total wage costs. We have run regressions using employment shares as the dependent variable instead. The results are not sensitive to the choice of the dependent variable.

[7] The estimated coefficients in table 4.2 measure the (intra-marginal) impact on the underlying and unobserved dependent variable. In order to get an approximate measure of the *average* effect on the observed variable, we must multiply the estimated coefficient with the share of non-censored observations in the material.

may measure training rather than multi-tasking. The coefficient is not statistically significant for any of the other groups. Finally, in firms involved in job-rotation schemes, the fraction of immigrant wage costs in total wage costs is not significantly different from that in firms not involved in such schemes.

Regarding the output variable, this is significant for natives and Western immigrants arrived as adults. This is evidence of non-homothetic production technology. Finally, for the downsizing variable, firms that have reduced the number of workers during the last five years have a lower share of immigrants, but the effect is only significant for Western immigrants who arrived as children. These results, thus, do not suggest that the burdens of downsizing are borne disproportionally by non-Western immigrants.

Communication bias across skill groups

As mentioned earlier, evidence in the empirical literature suggests that new technologies and new work practices are biased in favour of workers in higher skill groups. A natural follow-up from table 4.2 is to check whether the relationship between new technologies, new work practices and the share of immigrants in total wage costs are uniform across skill groups. Are highly skilled non-Western immigrants protected against negative effects from the increasing importance of communication and informal human capital (for instance, by having more communicative skills than low-skilled non-Western immigrants)? table 4.3 presents estimates for wage bill shares for the five different groups by level of skills. We distinguish between low-skilled workers and highly skilled workers. The model is once again estimated with a nine-equation simultaneous panel Tobit model similar to that specified in section 2 (highly skilled natives are the left- out equation).

[table 4.3 about here]

Estimates for low-skilled workers are shown in the upper half of the table, while estimates for highly skilled workers are shown in the lower half. The results for the intensity of *PC* use show that the negative relationship for non-Western adult immigrants reported in table 4.2 to a large extent is explained by a strong negative effect on the low-skilled workers in this group. If the share of workers using PC increases with 1 percentage point, the share of adult low-skilled non-Western immigrants decreases by approximately 3.6 percentage points (again, the impact is found by multiplying the coefficient in table 4.3 with the fraction of uncensored observations). For all groups of workers, the relationship between PC and the wage cost share

is more positive for highly skilled workers than for low-skilled workers, and it is statistically significant for all low-skilled groups. At first glance it might appear that the intensity of PC use has an adverse effect on low-skilled natives that is larger than the negative impact on the group of low-skilled non-Western immigrants who arrived as adults (approximately 16 percentage points versus 3.6 percentage points). However, note that the effects are measured in percentage *points*. Measured as relative changes from the group's average percentage of the firm's total wage costs, reported in table 4.1 (70.2 per cent for low-skilled natives and 2.6 percent for low-skilled non-Western immigrants arrived as adults) we see that the relative negative effect of increasing the PC share is much larger for low-skilled non-Western immigrants arrived as adults than for low-skilled natives. Overall, the results for the PC variable are in line with hypotheses and results from the 'skill biased technological change' literature (e.g., Berman *et al.* 1994, Machin 1996).

Regarding the negative relationship between *autonomy* and the demand for immigrants who arrived as children, reported in table 4.2, this result is not statistically significant when splitting into skill groups. The opposite is true for non-Western immigrants who arrived as adults. The autonomy coefficient for this group was not significant in table 4.2. When splitting the groups we find a negative relationship between autonomy and demand for low-skilled non-Western immigrants who arrived as adults, and a non-significant relationship between autonomy and the demand for non-Western immigrants who arrived as children. This finding is in line with a hypothesis that some new features of the new work practices reduce the demand for non-Western immigrants not raised in Norway. Finally, *multitasking*, *work teams* or *job rotation* do not appear to strongly affect the wage cost shares across skill groups.

Summing up, we find that firms where new technologies are used more intensively, and firms that employ new work practices more frequently, tend to have lower wage cost shares of immigrants in general. This trend is particularly strong with regard to low-skilled immigrants from non-Western countries who did not follow any basic schooling in Norway, that is, those who arrived as adults. These results would suggest that new technology and new work practices are biased against immigrant workers. However, as mentioned in section 2 we cannot completely rule out the possibility of problems related to endogeneity. To indicate the severity of this problem we estimate a SURE Tobit model (including cross-equation restrictions) with lagged explanatory variables, i.e., we use dependent variables from 2003 and explanatory variables from 1997. Although this is not a waterproof test of endogeneity bias, then if simultaneous choice of technology and demand for natives and immigrant workers are part of the problem, regressing on lagged explanatory variables should reduce the

problem. This procedure reduces, of course, the number of observations by 50 per cent; the number of observation is now equal to 544. Table 4.4 present results from this estimation.

[table 4.4 about here]

For the PC-coefficients the previous results still stand. We find significant and negative effects of PC on the demand for low-skilled non-western immigrants, especially those arriving as adults. We also still find a negative effect of PCs on the demand for low-skilled natives, but considering the large differences in wage cost shares between natives and non-western immigrants, the negative effect is larger for non-western immigrants. Regarding the autonomy variable, it is no longer significant for non-western immigrants arriving as adults. However, this is due to larger standard errors, and not smaller coefficient. It is reasonable to assume that it is the smaller sample that increases the uncertainty of the estimates. In addition, to control directly for the possibility that the mix of highly skilled and low-skilled immigrants and natives in the firm's geographical area affects its use of technology, as found in Lewis (2006), we also estimate factor demand equation like in table 4.4 controlling for the share of high and low-skilled natives and immigrants in the county where the firm operates. These variables proxy the local labour supply facing the firm. The inclusion of these variables does not alter the previous results (results available from authors upon request).

All in all, based on the results in table 4.4 we still argue that that endogeneity is not critical in our study. We therefore have confidence that what we measure is indeed the causal effect of new technologies – admittedly, crudely measured –and new work practices on the tendency for firms to employ different groups of workers. And we have thus argued that these new technologies and new work practices are biased against immigrant workers, especially those from non-Western countries without formal and informal skills.

5. Conclusions

As described in the introduction, Non-Western immigrants have a weak position in the Norwegian labour market. Studies also indicate that their labour market position have weakened during the last decades. In this paper we have analysed whether there are any features of the 'new economy' that may help to explain these trends, which are also clearly visible in other western economies. Introduction of new technologies and introduction of new

work practices are two characteristics of the new economy. We have analysed whether these developments – by increasing the importance of interpersonal communication and informal human capital – have had a negative effect on employment opportunities of immigrants. We distinguished between four groups of immigrants: Western immigrants who arrived as children, Western immigrants who arrived as adults, non-Western immigrants who arrived as children, and non-Western immigrants who arrived as adults.

To analyse the relationship between indicators of new technology, new work practices and the demand for immigrant workers we used representative firm level panel data containing both employer and employee level information. We estimated factor demand equations where the dependent variable is the immigrant wage cost share of total wage costs in the firm.

The results show that firms that use PCs intensively and firms giving their employees much autonomy employ fewer non-Western immigrants. These relationships are especially prevalent for non-Western immigrants who are not raised in Norway. These results add support to the hypothesis that new technologies and some new work practices are biased against immigrant workers.

The literature on skill-biased technological and organisational change has presented results suggesting that both new technologies and new organisation practices are skill-biased by increasing the demand for highly skilled workers. In the paper, we checked whether the relationship between new technologies, new work practices and the share of immigrants in total wage costs are uniform across skill groups. The results show that the negative relationship between autonomy and the demand for non-Western immigrants not raised in Norway only is valid with regard to the low-skilled workers. With regard to the highly skilled workers we find no significant relationship between autonomy and the share of non-Western immigrants in total wage costs. The same pattern applies to a large extent with regard to the relationship between the technology indicator (PC) and the wage cost share of non-Western immigrants. These results indicate that education increases communicative skills among non-Western adults and, thus, protects them against the negative effects of new work practices on the demand for immigrant labour. In summary, our results indicate that new work practices and new technologies are biased against immigrant workers: However, this is mainly against low skilled immigrant workers who are not raised in Norway. Our result seem to be in line with findings in Rosholm et al. (2005). They report negative employment developments among immigrants in Sweden and Denmark from 1985 to 1995, and interpret this as effect of increased importance of interpersonal communication due to changes in work practices.

Future work is desired to confirm the results obtained in this study. Access to data with reliable instrument variables for technology and new work practices would be especially helpful.

Still, a preliminary discussion of policy implications of these findings may be warranted. Our results tend to favour integration policies which provide immigrants with language training combined with general information about the receiving country intensively and on a early stage after arrival. Once a certain basic communicative level is achieved, we would suggest intense use of temporary employment subsidies combined with on-the-job language training courses sponsored by the public sector in order to neutralise the negative impacts of lacking communicative abilities.

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Table 4.1. Descriptive statistics. Mean values and standard errors

	Natives		Non-western immigrants				Western immigrants			
			Adults		Children		Adults		Children	
	Mean	Std.dev	Mean	Std.dev	Mean	Std.dev	Mean	Std.dev	Mean	Std.dev
Wage shares										
-All workers	0.896	0.116	0.029	0.073	0.014	0.031	0.019	0.033	0.039	0.040
-Low-skilled	0.702	0.218	0.026	0.068	0.007	0.018	0.018	0.034	0.026	0.032
-Highly skilled	0.195	0.187	0.004	0.012	0.004	0.001	0.004	0.012	0.013	0.026

	All	
	Mean	Std.dev
PC	0.461	0.361
Teams	0.616	0.486
Autonomy	0.267	0.443
Multitasking	0.812	0.387
Job rotation	0.439	0.496

Note: For definitions of non-western and western immigrants, as well as definitions of adult and children immigrants, see section 3.

Table 4.2. Demand for immigrant workers. Dependent variable: Wage bill shares. Simultaneous panel Tobit model

	Non-Western immigrants				Western immigrants			
	Adults		Children		Adults		Children	
	Coeff.	Std.err	Coeff.	Std.err	Coeff.	Std.err	Coeff.	Std.err
PC	-0.058***	0.008	-0.007	0.005	0.003	0.006	0.018***	0.005
Teams	-0.003	0.005	-0.003	0.003	-0.001	0.004	-0.002	0.003
Autonomy	-0.008	0.006	-0.012***	0.004	0.007*	0.004	-0.006*	0.003
Multitasking	-0.007	0.007	0.009**	0.005	0.005	0.005	-0.003	0.004
Job rotation	0.001	0.005	0.002	0.003	-0.004	0.004	-0.001	0.003
Log output	0.014***	0.003	0.002	0.002	0.012***	0.002	0.001	0.002
Log Capital	-0.001	0.002	0.004***	0.001	-0.002	0.001	0.001	0.001
Downsizing	-0.005	0.007	0.002	0.004	-0.003	0.004	-0.012***	0.004
Censored observations	546		507		580		817	
N	1088		1088		1088		1088	

Note: Additional control variables include a year dummy, a regional relative wage measure, 18 industry dummies, 19 county dummies, a dummy variable measuring recruitment problems, and a variable measuring the main occupational group's share of the total number of workers. Level of significance: *** 1 per cent, ** 5 per cent, * 10 per cent. One equation has been omitted: the equation for natives.

Table 4.3. Demand for native and immigrant workers. Low-skilled and highly skilled workers. Dependent variable: Wage bill shares. Simultaneous panel Tobit model

	Low-skilled									
	Natives		Non-western immigrants				Western immigrants			
			Adults		Children		Adults		Children	
	Coeff.	Std.err	Coeff.	Std.err	Coeff.	Std.err	Coeff.	Std.err	Coeff.	Std.err
PC	-0.160***	0.015	-0.079***	0.012	-0.009*	0.005	-0.014**	0.007	-0.009*	0.005
Teams	-0.029***	0.012	0.012	0.008	-0.002	0.004	-0.003	0.005	-0.001	0.003
Autonomy	-0.025**	0.013	-0.015*	0.009	0.002	0.004	-0.005	0.005	-0.007*	0.004
Multi Tasking	-0.002	0.018	-0.014	0.010	0.005	0.006	-0.005	0.007	-0.005	0.005
Job rotation	0.013	0.012	0.004	0.009	-0.002	0.004	0.003	0.005	-0.002	0.004
Log output	-0.027***	0.005	0.012***	0.004	0.006***	0.002	0.008***	0.002	0.003	0.002
Log Capital	-0.001	0.003	0.001	0.003	0.001	0.001	0.001	0.001	-0.000	0.001
Down Sizing	0.010	0.015	-0.008	0.011	0.001	0.005	-0.007	0.007	-0.002	0.005
Censored at 0	2		594		704		507		352	
Censored at 1	35		0		0		0		0	
N	1088		1088		1088		1088		1088	
	Highly skilled									
	Natives		Non-western immigrants				Western immigrants			
			Adults		Children		Adults		Children	
			Coeff.	Std.err	Coeff.	Std.err	Coeff.	Std.err	Coeff.	Std.err
PC			-0.011*	0.006	0.011**	0.005	0.007	0.006	0.032***	0.006
Teams			0.006	0.004	0.004	0.004	0.009*	0.005	0.002	0.004
Autonomy			-0.001	0.005	-0.008	0.005	0.003	0.005	-0.005	0.004
Multi Tasking			-0.005	0.006	0.002	0.005	0.002	0.007	-0.006	0.004
Job rotation			-0.004	0.005	0.002	0.004	-0.004	0.005	0.002	0.004
Log output			0.011***	0.003	0.004**	0.002	0.014***	0.003	0.009***	0.003
Log Capital			0.000	0.001	0.001	0.001	-0.003	0.002	0.001	0.002
Down Sizing			-0.004	0.005	0.006	0.005	0.002	0.005	-0.009	0.007
Censored at 0			857		848		859		624	
Censored at 1			0		0		0		0	
N			1088		1088		1088		1088	

Note: Additional control variables include a year dummy, a regional relative wage measure, a dummy variable measuring recruitment problems, and a variable measuring the main occupational group's share of the total number of workers. Level of significance: *** 1 per cent, ** 5 per cent, * 10 per cent. One equation has been omitted: the equation for high-skilled natives

Table 4.4. Demand for native and immigrant workers. Low-skilled and highly skilled workers. Lagged explanatory variables. Dependent variable: Wage bill shares. SURE Tobit model

	Low-skilled									
	Natives		Non-western immigrants				Western immigrants			
			Adults		Children		Adults		Children	
	Coeff.	Std.err	Coeff.	Std.err	Coeff.	Std.err	Coeff.	Std.err	Coeff.	Std.err
PC	-0.190***	0.038	-0.092***	0.030	-0.020***	0.009	-0.010	0.013	-0.007	0.008
Teams	-0.021	0.028	0.004	0.018	-0.005	0.006	-0.004	0.009	0.005	0.005
Autonomy	-0.029	0.027	-0.018	0.019	0.0001	0.006	0.003	0.009	-0.006	0.005
Multi Tasking	-0.036	0.044	-0.012	0.022	0.001	0.008	-0.011	0.011	0.002	0.008
Job rotation	0.037	0.029	-0.013	0.019	-0.004	0.006	0.002	0.009	-0.007	0.006
Log output	-0.131	0.139	0.041	0.102	0.044	0.034	0.055	0.047	0.015	0.030
Log Capital	-0.037	0.098	0.026	0.064	0.013	0.020	0.001	0.027	0.010	0.019
Down Sizing	0.016	0.034	-0.012	0.025	-0.002	0.008	-0.002	0.011	-0.002	0.008
Censored at 0	1		269		341		246		181	
Censored at 1	0		0		0		0		0	
N	544		544		544		544		544	
	Highly skilled									
	Natives		Non-western immigrants				Western immigrants			
			Adults		Children		Adults		Children	
			Coeff.	Std.err	Coeff.	Std.err	Coeff.	Std.err	Coeff.	Std.err
PC			-0.013*	0.009	0.013*	0.009	0.016**	0.008	0.028***	0.010
Teams			0.005	0.007	0.0001	0.007	0.005	0.007	0.009	0.007
Autonomy			0.0001	0.006	-0.009	0.007	0.001	0.007	-0.002	0.007
Multi Tasking			-0.001	0.008	0.001	0.008	0.004	0.009	0.006	0.009
Job rotation			-0.007	0.006	0.0001	0.007	-0.010	0.007	-0.010	0.008
Log output			0.085**	0.040	0.033	0.038	0.135***	0.036	0.067**	0.040
Log Capital			-0.002	0.023	0.019	0.022	-0.023	0.024	0.034**	0.023
Down Sizing			-0.004	0.008	-0.010	0.009	-0.006	0.008	-0.018*	0.011
Censored at 0			416		407		405		309	
Censored at 1			0		0		0		0	
N			544		544		544		544	

Note: Additional control variables include a regional relative wage measure, a dummy variable measuring recruitment problems, and a variable measuring the main occupational group's share of the total number of workers. Level of significance: *** 1 per cent, ** 5 per cent, * 10 per cent. One equation has been omitted: the equation for high-skilled natives.