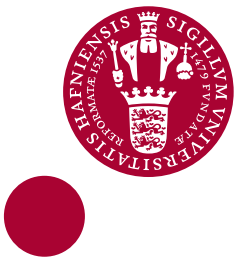
UNIVERSITY OF COPENHAGEN



Human Capital and Wages in Exporting Firms

Munch, Jakob Roland; Skaksen, Jan Rose

Publication date:
2006

Document version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Munch, J. R., & Skaksen, J. R. (2006). *Human Capital and Wages in Exporting Firms*. Cph.: Economic Policy Research Unit. Department of Economics, University of Copenhagen.

Download date: 25. sep.. 2020

EPRU Working Paper Series

Economic Policy Research Unit
Department of Economics
University of Copenhagen
Studiestræde 6
DK-1455 Copenhagen K
DENMARK
Tel: (+45) 3532 4411
Fax: (+45) 3532 4444
Web: http://www.econ.ku.dk/epru/

Human Capital and Wages in Exporting Firms

Jakob Roland Munch
Jan Rose Skaksen

2006-10

ISSN 0908-7745
The activities of EPRU are financed by a grant from
The National Research Foundation

Human Capital and Wages in Exporting Firms*

Jakob Roland Munch†
University of Copenhagen, CEBR and EPRU

Jan Rose Skaksen‡
Copenhagen Business School, CEBR and IZA

October 2006

Abstract

This paper studies the link between a firms education level, export performance and wages of its workers. We argue that firms may escape intense competition in international markets by using high skilled workers to differentiate their products. This story is consistent with our empirical results. Using a very rich matched worker-firm longitudinal dataset we find that firms with high export intensities pay higher wages. However, an interaction term between export intensity and skill intensity has a positive impact on wages and it absorbs the direct effect of the export intensity. That is, we find an export wage premium, but it accrues to workers in firms with high skill intensities.

Keywords: Exports, Wages, Human Capital, Rent Sharing, Matched Worker-Firm Data

JEL Classification: J30, F10, I20

*Financial support from the Danish Social Science Research Council is gratefully acknowledged. The paper has benefittet from comments from participants at The Second Danish International Economics Workshop, Aarhus School of Business and Economic Policy Research Unit (EPRU), University of Copenhagen.

†Address: Department of Economics, University of Copenhagen, Studiestraede 6, DK - 1455 Copenhagen K, Tel.: +45 35323019, Fax: +45 35323000, E-mail: Jakob.Roland.Munch@econ.ku.dk.

‡Address: Department of Economics, Copenhagen Business School, Solbjerg Plads 3C, 5th Floor, DK-2000 Frederiksberg, Tel.: +45 3815 2582, Fax: +45 3815 2576, E-mail: jrs.eco@cbs.dk.

1 Introduction

There is a substantial empirical literature on wages in exporting firms. This literature was initiated by Bernard and Jensen (1995) who found evidence for productivity and wage premia in exporting firms. Since then there has been a large number of studies replicating and extending their analysis, and by now it seems to be a stylized fact that exporting firms are more productive and pay higher wages than non-exporting firms (see Schank, Schnabel and Wagner (2006) for a recent list of existing studies).[1] There are competing theories as to why this is the case, but most support has been found for self-selection of the most productive firms into exporting as the explanation (see e.g. Clerides et al. (1998) and Bernard and Jensen (2004)). Hence, the standard explanation is that the superior performance of exporting firms is due to unobserved heterogeneity.

In this paper, we consider whether the wage premium in exporting firms is linked to the use of human capital in exporting firms. A distinguishing feature of exporting firms is that they use more highly educated labour than non-exporting firms. This is what international trade theory would suggest for countries that are relatively well endowed with educated labour, and this is confirmed by existing studies (see e.g. Bernard and Jensen (1995)). Therefore, one hypothesis is that the export premium in wages is actually an educated labour premium. In recent papers by Barth (2002), Battu, Belfield and Sloane (2003) and Martins (2004) evidence for the existence of human capital externalities at the work place level is found, i.e., the wage level in firms using more educated labour increase beyond the level explained by the individual educational attainment. Thus the exporting variable may pick up such spillover effects of education, if they are not properly accounted for in the wage equation.

An alternative hypothesis we consider is that there is an export premium in wages, but this premium interacts with the education level in firms. That is, the export wage premium is higher in firms using more educated labour. The existence of a link between the skill level, international trade and wages has been suggested by Schott (2004). He documents that firms producing unskilled labour intensive goods are more likely to be in direct competition with firms from low wage countries at international markets. Therefore, a higher skill intensity in exporting firms may mitigate the effect of competition from low income countries, and, if there is firm specific wage bargaining, this lower level of competition may turn into higher wages (see e.g. Dowrick (1989) and Slaughter (2001)).

This paper can be seen as combining the literature on the exporting wage premium

[1] With the exception of the analysis of Schank et al. (2006) this literature is almost solely based on firm level data, so possible selection of high-ability workers into exporting firms is not taken account of.

with insights from the literature on human capital externalities. The evidence on the existence of human capital externalities are mixed. For example Acemoglu and Angrist (2000) find no impact of average skill levels on average wages in US states, while Moretti (2004) reports a significant positive impact of the share of graduates in US cities on individual worker wages. In the present context we are interested in human capital spillovers at the firm level, and these may be particularly important because it is likely that individuals interact more and learn more from each other at this level compared to the city or region level. As mentioned a few papers have recently found evidence of positive externalities at the firm level. Using a Norwegian panel data set of workers, Barth (2002) documents a significant effect of firm average level of education, while using cross sectional data for the UK Battu, Belfield and Sloane (2003) find positive firm level external returns on individual wages. Martins (2004) uses a panel of Portuguese firms to also document substantial social returns to firm level education.

We have access to a unique matched worker-firm panel data set with information about firms' export behaviour. Our empirical approach is to compare otherwise similar individuals working in firms with different export intensities and shares of highly educated workers in the workforce. In contrast to most of the literature on exporting wage premia, our data set allows us to control for observed and unobserved individual characteristics, such as ability, that are correlated with wages and the export status of firms. It is likely that high-quality workers sort into exporting firms. For example exporting firms may reward observed and unobserved ability better than non-exporting firms, causing high-ability workers to select into exporting firms. In this case, the observed exporting wage premium might simply be due to differences in observed and unobserved worker characteristics.

Our empirical analysis starts out by reestablishing results from the two literatures on exporting wage premia and external returns to education. First, we confirm the finding by Bernard and Jensen and others that exporting firms pay higher wages, although it is not whether the firm exports but the export intensity that matters. This result is in line with the only other study that uses matched worker-firm data (Schank el al. (2006)). Second, we find that not only is there a positive effect of individual education on individual wages, but there is also a considerable spillover effect of education on other workers on top of this private return. That is, we find that a higher skill intensity in the firm has a positive impact on wages of all workers in the firm. Third, we find that firms who export more also use more skilled labour, but this does not explain why there is a wage premium in exporting firms. Finally, we show that the size of the export premium is increasing in the skill intensity of the firm, as we find that the inclusion of an interaction term between

the export intensity and the skill intensity enters the wage equation with a significant positive effect. In addition, this interaction term absorbs all of the direct effect of the export intensity and part of the direct effect of the the skill intensity of the firm. In other words, we find that there is an export premium, but it is increasing with the firm level skill intensity.

The rest of the paper is structured as follows. In the following section, we offer some theoretical considerations about the link between wages, education and international trade. In section 3, we describe the data set. In section 4 we specify the empirical model and present the estimation results. Finally, in section 5 we conclude.

2 Two alternative hypotheses

The point of departure of our paper is that wages are higher in exporting firms than in non-exporting firms. The standard hypothesis in the literature is that this is a result of the most productive firms self-selecting into being exporters. This self-selection process may exist if there are fixed costs of exporting, because it is only the most productive firms who find it profitable to "invest" in exporting (see e.g. Clerides et al (1998), Bernard and Jensen (1999) and Melitz (2003)). A competing theory is that firms become more productive when entering foreign markets because of competition and learning in international markets, see e.g. Clerides et al. (1998). However, only a few empirical studies find that this is actually the case (see e.g. Girma, Greenaway and Kneller (2004)).

Irrespective of whether the exporting wage premium is a result of self-selection or learning in export markets, the premium is not necessarily related to the firms' use of human capital. But this possibility is our focus, and we will consider two separate hypotheses in relation to this issue.

2.1 Hypothesis 1

The first hypothesis we propose is that the export premium found in empirical studies reflects a missing variable in the estimations, namely the human capital level in the firms. Human capital intensive countries have a comparative advantage in human capital intensive production, and so exporting firms – i.e., the firms that exploit comparative advantages – employ more educated labour than non-exporting firms.[2] Moreover, as

[2]Even in countries intensive in the supply of unskilled labour, it may be the case that exporting firms use more skilled labour than non-exporting firms but less skilled labour than exporting firms in countries intensive in skilled labour, see e.g. Feenstra and Hanson (1997).

suggested by the results found in Barth (2002), Battu, Belfield and Sloane (2003) and Martins (2004), there are human capital spill-overs inside companies. The idea is that workers interact at the workplace and learn from each other, and this interaction effect is stronger the more high skilled workers there are. Notice that this human capital effect is in addition to the private return to education. Hence, according to this hypothesis, the wage level is higher in exporting firms than in non-exporting firms, but this is a result of exporting firms using more human capital than non-exporting firms.

2.2 Hypothesis 2

The second hypothesis acknowledges the existence of an export premium in wages – for example due to the self-selection of the most productive firms into being exporters – but the size of the premium depends on the skill intensity in the firm. The foreign markets a firm is able to serve may depend on the type of labour employed in the firm. A firm producing clothes may for instance choose to produce a "standard" product. To do this it mostly needs unskilled labour and machines. Alternatively the firm may produce expensive design clothes and by doing so the firm may enter a market with product differentiation and a lower degree of competition. To enter such markets, the firm needs to employ highly skilled labour to develop and brand the product. As documented in Schott (2004), low wage countries mainly produce low priced (low quality) goods. Hence, it seems likely that firms that choose the first strategy and produce unskilled labour intensive "standard" goods are more likely to compete with firms from low wage countries in export markets. In contrast, firms who pick the second strategy and employ high skilled labour may escape intense competition from low wage countries. Lower product market competition, in turn, is likely to spill over into wages if the labour market is unionised and workers and firms bargain over wages (see e.g. Dowrick (1989)). Also there is solid empirical evidence showing that spill-overs from the product market to the labour market exist, see e.g. Blanchflower, Oswald and Sanfey (1996), Hildretch and Oswald (1997), Slaughter (2001) and Arai (2003).

In addition, case studies of specific markets also offer support for the hypothesis that by using more skilled labour a firm may better serve markets with less competition. One example is Goldberg (1995) who finds that the demand elasticities for luxury and sports cars are lower than those for other types of cars. Another example is Hausman, Leonard and Zona (1994) who find that the demand elasticity for premium beer is lower than that for popular (standard) beer.

To sum up, our hypothesis is that if a firm produces a "standard good", there is in-

tensive competition in international markets from low wage countries. Fierce competition in turn puts downward presure on the profit margin of the firm as well as on wages. By spending ressources on product differentiation – i.e., employing more skilled labour to undertake e.g. innovation, design or branding – a firm may be able to sell goods in international markets where the degree of competition is lower. That is, the firm may sustain a higher profit margin, but workers also gain from a reduced competitive pressure through higher wages. Hence, our second hypothesis is that, if there is a positive export premium in wages, it should mainly be found in firms employing high-skilled labour – i.e., there is a positive interaction effect between exporting and the skill intensity in the firm on wages.

3 Data

We have access to a very rich matched worker-firm longitudinal dataset covering the total Danish population for the years 1999-2002 – the socalled FIDA dataset which is based on administrative registers. Each individual and each firm is associated with a unique identifier, and most importantly all employed individuals are linked with a firm identifier at the end of each year. Detailed information on individual socio economic characteristics is available on an annual basis. These individual level variables are extracted from the integrated database for labour market research (IDA) and the income registers in Statistics Denmark, which have been used in numerous studies. For more details on the IDA dataset see e.g. Abowd and Kramarz (1999).

To this matched worker firm dataset we have merged detailed records on international trade for all firms from The Danish External Trade Statistics. The external trade statistics are compiled in two systems; Intrastat (trade with EU countries) and Extrastat (trade with non-EU countries), and the compilation follows internationally agreed principles for statistics on international trade, see Statistics Denmark (2003) for further details. If a firm exports a specific product to any given country in any given month, this is recorded as one observation in the data. That is, for each combination of firm, month, destination country and product code[3] the total (fob) value of the transaction is known.

In addition to the trade variables there is information about total sales of the firm, thus allowing us to calculate the export ratio of each firm in each year. Furthermore we also construct a measure for the capital labour ratio of each firm as the value of land, buildings, machines, equipment and inventory divided by the number of full-time workers,

[3]The product code is the socalled Combined Nomenclature which encompasses more than 10,000 different products.

and (log of) the size of the firm in terms of the workforce is also included in the analysis as a control variable. From the matched workers we also calculate the proportion of workers with further education at the firm level.

We restrict attention to trade with countries outside the EU countries[4] and Norway for two reasons. First, data on intra-EU trade is censored in a way such that only firms exporting goods with a total annual value exceeding a certain threshold[5] are recorded in the files. No such data limitations exist for trade out of the EU. Second, Denmark is a small and very open economy in which a relatively large proportion of firms export. The formation of the internal market in the EU during the 1990s has abolished most trade impediments, and so the EU can increasingly be regarded as the domestic market for Danish firms, and due to the small size of the Danish market a relatively large part of all medium sized and large firms almost by definition must be exporters. By focussing on trade with countries outside the EU we get more variation across firms, and such trade better resemble that of firms in larger economies like the US.

Throughout the paper we only analyse firms (and their workers) with more than 50 employees, and there are several reasons for this. First, the small firms are much less inclined to export. Second, the link between workers and the small firms is sometimes incorrect or missing. Finally, the number of workers with further education employed in a firm is in practice indivisible, and, therefore, in small firms our measure of skill-intensity becomes very sensitive to the hiring or firing of a single educated worker. This implies that our measure of skill-intensity would be very noisy in small firms. The resulting dataset still covers the majority of workers in the manufacturing sector; almost 3/4 of all workers are employed by firms with more than 50 employees.

A number of studies have documented substantial heterogeneity among firms within industries with respect to their export behaviour, see Tybout (2003) for an overview. Far from all firms export, and this is also true even for Danish manufacturing firms with more than 50 employees, cf. Table 1. Around 85 percent export their products to countries outside EU15 and Norway (88 percent in 2002). There is clearly a positive correlation between firm size and the propensity to export; if all firms with more than 10 employees had been included only approximately 55 percent would be counted as exporters using the same export definition. Danish manufacturing firms sell around 18 percent to countries outside EU15 and Norway. Had we included EU15 and Norway in the export definition more than half of manufacturing production is exported. This, of course, reflects the fact

[4]In our data period (1999-2002), the EU consists of: Germany, UK, France, Italy, Spain, Ireland, Portugal, Belgium, Greece, Austria, The Netherlands, Belgium, Finland, Sweden and Denmark.

[5]This threshold was in all four years of the sample period 2.5 mill. Danish Kroner corresponding to 335.000 Euro.

that the EU countries are very important export destinations for Danish companies. For comparison Bernard and Jensen (1995) report for US manufacturing firms in 1987 that 15 percent export, while for French manufacturing firms in 1986 Eaton, Kortum and Kramarz (2004) report that 17 percent export.[6] These are much lower numbers and indicates the inevitable negative correlation between domestic market size and export orientation. The percentages exported for these two countries are 10 percent and 22 percent respectively. This shows that by focussing on exports to countries outside EU and Norway the export behaviour of firms is more comparable to that of firms in larger economies.

Insert Table 1 here

Table 2 displays sample means for nonexporters, exporters and exporters with an export intensity exceeding 10 percent. Danish exporters are indeed larger, older and use a higher share of workers with further education. Interestingly, firms that export a relatively large proportion of their sales also have an even higher share of workers with further education. In the empirical analysis in the following section, we use this share of workers in the firm having a further education as our measure of the skill intensity in the firm.

With respect to average wages, exporting firms in fact pay somewhat lower wages to workers with a vocational education, but they pay more to workers with further education. Thus the raw data suggests the existence of a link between exporting, wages and skill intensity.

Insert table 2 here

Among the individual level variables the hourly wage rate is obviously the most important one in the analysis, and this wage rate is calculated as total labor income divided by the total number of hours worked in any given year. A long list of individual socio economic characteristics are used as control variables in the analysis. There are self explanatory dummies for gender, the presence of children, the presence of two adults in the household, immigrant status and city size. We also include standard human capital variables, i.e., dummies for educational attainment, labour market experience, experience squared and job tenure. In addition, there are dummies for membership of unemployment insurance funds and trade unions. We also include dummies for the occupation and industry of the individual. Occupational dummies are based on the Danish version of the ISCO-88 definition, and we operate with the nine main categories. The industry

[6] Bernard and Jensen (1995) exclude small US firms, while Eaton et al. (2004) include all French firms. They both include exports to all foreign destinations.

dummies are based on the three digit NACE level, which leaves us with 36 manufacturing industries.

We restrict the sample to include only full-time manufacturing workers in the age group of 18-65 years. In the final data set used for wage regressions there are 302,309 persons yielding 958,884 person-years. Descriptive statistics for selected individual level variables are displayed in Table 3.

Insert table 3 here

4 Empirical Analysis

In this section we consider whether exporters are paying higher wages when worker characteristics are taken account of? If so may this effect be explained by a lack of control for the skill intensity of the firm (our first alternative hypothesis)? And is it robust to the inclusion of an interaction term between export and skill intensity (our second alternative hypothesis)?

4.1 Skills, exports and individual wages

The empirical strategy is to compare wages of otherwise similar workers who work in firms with different skill intensities and export behaviour. Suppose that the hourly wage rate of worker i in firm j at time t is determined by a simple Mincer human capital wage equation of the form

$$\log w_{ijt} = \beta' x_{it} + \gamma' z_{jt} + \alpha_i + \epsilon_{ijt}, \tag{1}$$

Individual covariates such as experience, experience squared and tenure are included in x_{it}, and firm specific variables – notably variables for whether firms are exporting and the share of workers in the firm having further education (the skill intensity) – are contained in z_{jt}. This model is an individual fixed effects specification, i.e., α_i is a time-invariant unobservable component of human capital such as intelligence or motivation. Thus, in contrast to the vast literature on exporting and wages that rely on firm level data alone, we are able to control for the fact that workers in exporting firms may have better observed and unobserved characteristics than workers in nonexporting firms.

One important source of bias in the coefficients of interest (γ) may be unobserved firm characteristics that are correlated with export variables or the skill intensity and individual wages. To alleviate this problem one strategy would be to include fixed effects for pairs of workers and firms. However, such a strategy is not straightforward in the

present case because we only have four years of data. If we included worker-firm fixed effects, identification would only be based on stayers and thus come from changes in export and skill intensity in a firm over time. Over only four years such variation is minimal – there is in particular very little within-firm variation in the skill intensity – so we need to rely also on movers to identify the effects of skill intensity.[7] Instead we are careful to control for as much observed firm heterogeneity as possible. In the regressions below we include information on capital per worker, firm size measured by the number of employees, the share of women, the share of union members, the share of part time workers and the share of the workforce with age above 40 years.

In section 2 we outlined different hypotheses concerning the export premium in wages, and Table 4 displays estimation results related to these hypotheses. The three models in the table are the results of running different specifications of the wage equation in (1), and in all cases we include year dummies, industry dummies and individual covariates as reported in table 3 (coefficients not reported).

Insert table 4 here

In the first model we do not control for the skill intensity in the firm, and we do not allow for any interactions between skill intensity and exporting. This model, therefore, corresponds to the traditional approach in the literature on wage premia in exporting firms. However, in contrast to this literature we control for observed and unobserved worker heterogeneity. We find that the decision to export or not has no impact on wages, while the export intensity has a significant positive impact on wages. The coefficient implies that a ten percentage point increase in the export intensity corresponds to 3.3 percent higher wages. This result is very similar to the findings by Schank et al. (2006) who study a German matched worker-firm dataset. They also find no impact of the export dummy but a positive impact of the export intensity, and in their corresponding specification wages rise by 2.8 percent for blue collar workers and 1.5 percent for white collar workers when the export intensity rises by ten percentage points.

In the second model, we include the share of the workers in the firm with further education as our measure of the firm level skill intensity. First, we see that the skill intensity variable has a substantial and highly significant impact on wages (a ten percentage points higher skill intensity corresponds to 11 percent higher wages). Second, we see that inclusion of the skill intensity variable only slightly reduces the coefficient to the export

[7] Schank et al. (2005) find almost no impact on the coefficient to the export intensity variables from taking firm fixed effects into account. This is confirmed in the Danish data but only for the export intensity – the impact of skill intensity is washed away by the firm fixed effects.

intensity variable. Thus, although exporting companies do have a much higher share of further educated workers, and a higher share of further educated workers leads to higher wages, the wage premium in exporting firms is not a result of a higher skill intensity in exporting firms. That is, we can reject the first alternative hypothesis.

In the third model, we include the interaction term between skill intensity and export intensity. Firms may hire more high skilled workers to differentiate their products to escape competition in world markets, and this benefit from the skill intensity is more pronounced the more involved the firms are in export markets. Thus the inclusion of the interaction term allows us to better distinguish between the competing explanations behind the export and human capital premia. If firms learn from exporting and this is the reason behind the positive exporting wage premium, this effect should stand irrespective of the inclusion of the interaction term. Likewise if there are important social returns to education, the direct effect of skill intensity should be unaffected by the interaction term. We find that the interaction term indeed enters the wage equation with a large and positive effect. Furthermore this effect absorbs the entire effect of the export intensity while the skill intensity still has a direct positive impact on wages, but its magnitude has been reduced somewhat. Thus, we find clear evidence in support of our second hypothesis.

An interesting extension is to allow for heterogeneity in the effects across educational subgroups of the workers. In the following we have split the sample in three groups; unskilled workers, workers with vocational education and workers with further education, and Table 5 shows the results.

Insert table 5 here

Qualitatively there is not much difference between the subgroups, but the effects seem to be strongest for workers with vocational education. In model 1 these workers is the only group to experience a significantly positive effect of export intensity. They also have the highest coefficient to the skill intensity in model 2, but unskilled workers and workers with further education also gain from having co-workers with further education. In model 3 the interaction term has a significant positive impact for all three subgroups (only at the 10 percent level for workers with further education), and again the effect is strongest for workers with vocational education. Interestingly the direct effect of skill intensity is no longer significant for any subgroup and the coefficients are all smaller than for the full sample. This questions the robustness of the notion of human capital spill-overs at the firm level. Further, workers with vocational education even have a weak *negative* direct effect of export intensity, so perhaps the direct effect of exporting may actually for

some workers signal more competition and thus lower wages. To sum up, we find that the evidence we found for our second hypothesis for the full sample is not qualitatively sensitive to heterogeneity across educational subgroups.

4.2 Endogeneity

An important question is wether we can attach any causal interpretation to the relationship between exports, skill intensity and wages. Exporting may increase wages if firms learn and become more competitive by serving foreign markets, but as argued in the introduction support has been found for reverse causality in the sense that productive high paying firms self-select into exporting. Another source of endogeneity bias is if firms face increasing demand for their products in export markets and as a result pays higher wages through rent sharing. At the same time the higher demand likely leads to a higher export intensity. In this case exporting is not causing higher wages. Likewise, with respect to the relationship between skill intensity and wages, increased demand may induce firms to hire younger and more educated workers which would imply a higher skill intensity, but it would be wrong to interpret this as a causal relationship from skill intensity to wages.

In this sub-section we address this issue by instrumenting the export and skill intensities and the interaction term between the two variables. Of course, implementation of instrumental variables methods calls for acceptable instruments in the sense that they are relevant, i.e., they explain a significant amount of variation in the endogenous regressors, and they are valid, i.e., they are uncorrelated with the error term in the wage equation. As instruments for the export intensity we use the age of the firm, the export ratio of the firm's industry[8] and the 10 year lagged export ratio. We argue that the age of the firm potentially affects the export intensity as firms grow over time and increasingly enter export markets. At the same time we do not expect age to play a direct role in wage determination. The average export ratio of the industry is likely to be correlated with the firms export intensity but it appears not to be significantly related with wages in the Danish labour market, see Munch and Skaksen (2005). As instruments for the skill intensity we try with the average skill intensity of the industry and the average skill intensity of the local labour market.[9] Skill intensities at more aggregated levels should be exogenous to and correlated with the firm level skill intensity and it is not immediately

[8] The export ratio is defined as the industry's total export divided by industry output. The industry definition is based on a Danish code from the National Accounts with 55 manufacturing industries.

[9] The local labour markets are socalled communting areas, which are defined by groups of geographically connected municipalities where the internal commuting is 50 percent higher than the external commuting.

clear that they should be important for wage determination given that we also include industry fixed effects and regional control variables. For the interaction term we use as instruments the six combinations of interacted instruments.

In a situation with multiple potential instruments for each potentially endogenous variable we may test for relevance and validity of the instruments. Our strategy is as a first step to include all instruments implementing two-stage least squares, since this may generate more efficient estimates.[10] Next we evaluate the relevance of instruments in two ways. First, we implement the test of redundancy suggested by Hall and Peixe (2003) for each instrument[11], but we never found any signs of redundancy of any of our instruments in any model below. Second, for the final set of instruments we calculate the cluster-robust F-test for excluded instruments corresponding to the "partial R-squared" measure of instrument relevance proposed by Bound, Jaeger and Baker (1995). The F-statistic rejects the null that the instruments are jointly equal to zero in all first-stage regressions although sometimes only at the 10 percent level in the regression for the export intensity. Finally, with respect to the validity requirement we first test each instrument individually using the C-statistic by choosing a conservative significance level of 20 percent. For the skill intensity in the local labour market we rejected the null hypothesis that this instrument is valid, so we dropped it along with its interaction terms. For all the remaining valid instruments we also evaluate their overall validity using the cluster-robust version of Sargan's statistic for over-identification (the Hansen J-statistic) and it was never rejected.

Table 6 presents the estimation results for the full sample corresponding to the previous results of Table 4. In model 1 the coefficient to the export intensity almost triples, but it is no longer significant. In model 2 the skill intensity is added and its coefficient is slightly higher than the corresponding OLS coefficient. Again it is no longer significant, but it is well known that 2SLS standard errors have a tendency to be large. In model 3 we add the interaction term and the coefficient to this variable more than doubles and it is significant at the 10 percent level. Interestingly in this case the interaction term absorbs both direct effects, such that there no longer seems to be any spillover effect of education at the firm level. We also calculate and report the cluster-robust version of the Hausman test of endogeneity of the potentially endogenous variables in the models, and in no case can we reject the null that the variables under consideration are exogenous. Thus, overall

[10] It should be noted that our potentially endogenous regressors take values in the interval $[0, 1]$, so in principle the first stage equation is a non-linear tobit. However, Angrist and Krueger (2001) argue that two-stage least squares is a robust estimation method and that consistency of the second-stage estimates does not depend on getting the first-stage functional form right.

[11] Instruments are redundant if the asymptotic efficiency of the estimation is not improved by using them.

the IV results do not indicate endogeneity, and, if anything, they only reinforce the OLS results.

Insert table 6 here

5 Conclusion

In this paper we have explored the relationship between a firm's education level, export performance and wages of its workers. We have offered a brief discussion of the possible theoretical connection. We argue that firms may escape intense competition in international markets by using high skilled workers to undertake or improve innovation, design or branding and thereby differentiate their products. Lower product market competition, in turn, is likely to spill over into wages if the labour market is unionised and workers and firms bargain over rents created in the firm. That is, we should find a positive association between a firm's share of educated labour and wages of the workers.

Using a very rich matched worker firm longitudinal dataset we first reestablish two separate results from the existing literature. First, controlling for observed and unobserved worker heterogeneity, we find that firms with high export intensities pay higher wages. The existing literature uses firm level data and is therefore unable to control for worker heterogeneity. We show that even after controlling for possible selection of high quality workers into exporting firms the exporting wage premium still stands. Second, in line with a small literature on firm-level human capital externalities, we find that the firm level skill intensity increases wages of all workers in the firm. This indicates that interaction with high skilled workers at the workplace may lead to learning and higher productivity and wages for all.

Our main result is that inclusion of an interaction term between the export intensity and the proportion of educated workers at the firm level enters the wage equation with a significant positive effect. In addition, this interaction term absorbs the direct effect of exporting and much of the effect of firm level education. These results are consistent with the findings of Schott (2004) in the sense that firms may increase their use of highly educated labour to differentiate their products and thereby escape intense competition at international markets. By doing so wages may increase as workers are in a better bargaining position if there is less intensive competition at the goods market. That is, in line with our theoretical considerations, the export wage premium accrues disproportionately to workers in firms with high skill intensities.

References

[1] Abowd, J. and F. Kramarz (1999), The Analysis of Labor Markets using Matched Employer-Employee Data, in: Orley Ashenfelter and David Card (eds.), *Handbook of Labor Economics,* vol. 3B, Amsterdam: Elsevier Science, 2629-2710.

[2] Acemoglu, D. and J. Angrist (2000), How Large Are Human Capital Externalities? Evidence from Compulsory Schooling Laws, *NBER Macroeconomics Annual*, 9-59.

[3] Angrist, J. D., and A. B. Krueger (2001), Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments, *Journal of Economic Perspectives* 15, 69-85.

[4] Arai, M. (2003), Wages, Profits, and Capital Intensity: Evidence from Matched Worker-Firm Data, *Journal of Labor Economics* 21, 593-618.

[5] Barth, E. (2002), Spillover Effects of Education on Co-Worker Productivity. Evidence from the Wage Structure, mimeo.

[6] Battu, H., C. R. Belfield, and P. J. Sloane (2003), Human Capital Spillovers within the Workplace: Evidence for Great Britain, *Oxford Bulletin of Economics and Statistics* 65, 575-594.

[7] Bernard, A. and J.B. Jensen (1995), Exporters, Jobs and Wages in US Manufacturing: 1976-1987, *Brookings Papers on Economic Activity, Microeconomics*, 67-119.

[8] Bernard, A. and J.B. Jensen (1995), Exceptional Exporter Performance: Cause, Effect, or Both?, *Journal of International Economics* 47, 1-25.

[9] Bernard, A. and J.B. Jensen (2004), Why Some Firms Export, *Review of Economics and Statistics* 86, 561-569.

[10] Blanchflower, D. G., A. J. Oswald and P. Sanfey (1996), Wages, Profits, and Rent Sharing, *Quarterly Journal of Economic*s 111, pp. 227-251.

[11] Bound, J., Jaeger, D. A. and Baker, R. (1995), Problems with instrumental variables estimation when the correlation between the instruments and the endogeneous explanatory variable is weak, *Journal of the American Statistical Association* 90, 443–450.

[12] Clerides, S., S. Lach, and J. Tybout (1998), Is Learning by Exporting Important? Microdynamic Evidence from Columbia, Mexico, and Morocco, *Quarterly Journal of Economics* 113, 903-48.

[13] Dowrick, S. (1989), Union-Oligopoly Bargaining, *The Economic Journal*, 99, 1123-1142.

[14] Eaton, J., S. Kortum, and F. Kramarz (2004), Dissecting Trade: Firms, Industries, and Export Destinations, *American Economic Review, Papers and Proceedings*, 94, 150-154.

[15] Feenstra, R.C. and G. Hanson (1997), Foreign Direct Investment and Relative Wages: Evidence from Mexico's Maquiladoras, *Journal of International Economics*, 42, 371-394.

[16] Girma, S., D. Greenaway and R. Kneller (2004), Does Exporting Increase Productivity? A Microeconometric Analysis of Matched Firms, *Review of International Economics* 12, 855–866.

[17] Goldberg, P.K., 1995, Product Differentiation and Oligopoly in International Markets: The Case of the U.S. Automobile Industry, *Econometrica* 63, 891-951.

[18] Hall, A. R. and Peixe, F. P. M. (2003), A consistent method for the selection of relevant instruments, *Econometrics Reviews* 22, 269–287.

[19] Hausman, J., G. Leonard and J.D. Zona, 1994, Competitive Analysis with Differentiated Products, *Annales d'Economie et de Statistique* 34, 159-180.

[20] Hildretch, A.K.G. and A.J. Oswald (1997), Rent-Sharing and Wages: Evidence from Company and Establishment Panels, *Journal of Labor Economics* 15, 318-337.

[21] Martins, P. S. (2004), Firm-Level Social Returns to Education, IZA Discussion Paper No. 1382.

[22] Moretti, E. (2004), Estimating the Social Return to Higher Education: Evidence from Longitudinal and Repeated Cross-Sectional Data, *Journal of Econometrics* 121, 175-212.

[23] Munch, J. R. and J. R. Skaksen (2005), Specialization, Outsourcing and Wages, IZA Discussion paper No. 1907.

[24] Schank, T., C. Schnabel and J. Wagner (2006), Do exporters really pay higher wages? First evidence from linked employer-employee data, *Journal of International Economics,* forthcomming.

[25] Schott, P. K. (2004), Across-Product Versus Within-Product Specialization in International Trade, *Quarterly Journal of Economics* 119, 647-78.

[26] Slaughter, M.J., 2001, International Trade and Labor-demand elasticities, *Journal of International Economics* 54, 27-56.

[27] Statistics Denmark (2003), Danish External Trade Statistics, Copenhagen, available at http://www.dst.dk/Vejviser/Portal/Udenrigshandel/METODE/omudenrigshandelsstatistik.asp

[28] Tybout, J. (2003), Plant- and Firm-Level Evidence on the 'New' Trade Theories, in *Handbook of International Trade*, Oxford: Basil-Blackwell

A Appendix: Tables and figures

Table 1. Manufacturing firms and exports

Year	Proportion that export	Proportion exported
1999	0.84	0.17
2000	0.85	0.18
2001	0.85	0.19
2002	0.88	0.18

Notes: Firms are classified as exporters if they export to countries outside EU-15 and Norway. Proportion exported is total exports out of EU15 and Norway as a percentage of exporting producers' sales. Only manufacturing firms with more than 50 employees are included.

TABLE 2. SAMPLE MEANS, FIRMS 2002

	Nonexporters	Exporters	Exporters Intensity > 0.1
Average size (employees)	124	247	327
Sales (1,000,000 DKK)	141	384	505
Firm age (years)	17.7	24.7	25.8
Capital per worker (1,000 DKK)	355	358	356
Share of workers unskilled	0.41	0.40	0.37
Share of workers with vocational edu.	0.45	0.44	0.42
Share of workers with further edu.	0.14	0.16	0.21
Share of workers above 40 years	0.44	0.48	0.48
Share of workers female	0.26	0.30	0.32
Share of workers member of union	0.81	0.83	0.82
Share working part-time	0.09	0.04	0.03
Average wage rate, unskilled (DKK)	158	157	159
Average wage rate, vocational (DKK)	192	183	182
Average wage rate, further (DKK)	226	242	249
Average export intensity (exports/sales)		0.13	0.30
Number of firms	164	1,085	426

Notes: Firms are classified as exporters if they export to countries outside EU-15 and Norway. Only manufacturing firms with more than 50 employees are included.

TABLE 3. SUMMARY STATISTICS, WORKERS

	Mean	Min.	Max.
Log wage rate (DKK)	5.17	3.74	6.73
Age 18-24	0.06	0	1
Age 25-29	0.10	0	1
Age 30-39	0.33	0	1
Age 40-49	0.27	0	1
Age 50-59	0.22	0	1
Age 60-65	0.02	0	1
Female	0.31	0	1
Married	0.59	0	1
Two adults	0.75	0	1
Kids 0-6 years	0.23	0	1
Immigrant	0.04	0	1
Copenhagen	0.11	0	1
Big city	0.13	0	1
Small city	0.76	0	1
Unskilled	0.38	0	1
Vocational education	0.44	0	1
Further education	0.18	0	1
Experience (years)	18.11	0	39
Experience squared	418.83	0	1521
Tenure (years)	5.92	0	22
Union membership	0.89	0	1
UI fund membership	0.94	0	1
Number of observations		958,884	

TABLE 4. EFFECTS OF EXPORT AND SKILL INTENSITIES ON WAGES

	Model 1		Model 2		Model 3	
	coeff.	std.err.	coeff.	std.err.	coeff.	std.err.
Export dummy	-0.0009	0.0035	-0.0014	0.0034	-0.0004	0.0035
Export intensity	**0.0327**	0.0102	**0.0274**	0.0101	-0.0171	0.0153
Skill intensity			**0.1080**	0.0191	**0.0711**	0.0205
Exp. int. × skill int.					**0.2146**	0.0562
Number of observations	958,884		958,884		958,884	
R^2	0.8813		0.8814		0.8814	

Notes: Standard errors are corrected for clustering at the firm level. Bold numbers indicate a significant effect at the 5 percent level. Only workers in firms with more than 50 employees are included. Individual level variables (see Table 3), individual fixed effects, industry effects, year effects and firm level variables (capital per worker, log of firm size, the share of women, the share of union members, the share of part time workers and the share of the workforce with age above 40 years) are included in all models.

TABLE 5. ESTIMATION RESULTS FOR EDUCATIONAL SUBGROUPS

	Model 1		Model 2		Model 3	
	coeff.	std.err.	coeff.	std.err.	coeff.	std.err.
Unskilled workers:						
Export dummy	-0.0001	0.0039	-0.0008	0.0038	-0.0002	0.0039
Export intensity	0.0252	0.0155	0.0221	0.0154	-0.0116	0.0218
Skill intensity			*0.0588*	0.0326	0.0229	0.0342
Exp. int. × skill int.					**0.2037**	0.0811
Number of observations	365,097		365,097		365,097	
R^2	0.8902		0.8902		0.8902	
Workers with vocational education:						
Export dummy	-0.0023	0.0041	-0.0026	0.0040	-0.0014	0.0041
Export intensity	**0.0386**	0.0132	**0.0356**	0.0131	*-0.0309*	0.0172
Skill intensity			**0.0709**	0.0217	0.0125	0.0257
Exp. int. × skill int.					**0.3433**	0.0903
Number of observations	420,475		420,475		420,475	
R^2	0.8686		0.8687		0.8688	
Workers with further education:						
Export dummy	0.0025	0.0048	0.0026	0.0049	0.0031	0.0049
Export intensity	0.0162	0.0103	0.0144	0.0104	-0.0223	0.0202
Skill intensity			**0.0532**	0.0227	0.0309	0.0268
Exp. int. × skill int.					*0.1258*	0.0658
Number of observations	173,312		173,312		173,312	
R^2	0.9280		0.9280		0.9281	

Notes: Standard errors are corrected for clustering at the firm level. Bold numbers indicate a significant effect at the 5 percent level, and numbers in italics indicate a significant effect at the 10 percent level. Only workers in firms with more than 50 employees are included. Individual level variables (see Table 3), individual fixed effects, industry effects, year effects and firm level variables (capital per worker, log of firm size, the share of women, the share of union members, the share of part time workers and the share of the workforce with age above 40 years) are included in all models.

Table 6. Effects of export and skill intensities on wages, 2SLS

	Model 1		Model 2		Model 3	
	coeff.	std.err.	coeff.	std.err.	coeff.	std.err.
Export dummy	-0.0025	0.0043	-0.0025	0.0042	0.0005	0.0048
Export intensity	0.0937	0.1297	0.0676	0.1311	-0.0506	0.1604
Skill intensity			0.1197	0.0801	-0.0017	0.1022
Exp. int. × skill int.					*0.5023*	0.3279
p-value of endog. test	0.8210		0.9575		0.4247	
Number of observations	958,884		958,884		958,884	
R^2 (within)	0.1885		0.1899		0.1899	

Notes: Standard errors are corrected for clustering at the firm level. Numbers in italics indicate a significant effect at the 10 percent level. Only workers in firms with more than 50 employees are included. Individual level variables (see Table 3), individual fixed effects, industry effects, year effects and firm level variables (capital per worker, log of firm size, the share of women, the share of union members, the share of part time workers and the share of the workforce with age above 40 years) are included in all models.