ABSTRACT

LUNDIN, Nannan and **Lihong YUN** (2004). International Trade and Inter-Industry Wage Structure in Swedish Manufacturing: Evidence from Matched Employer-employee Data.

This study examines the inter-industry wage structure in Swedish manufacturing sector by using matched employer-employee data for the period 1996 to 2000. It uses, first, detailed individual and job characteristics to estimate industry-specific and time-varying wage premiums. Second, controlling for effects of domestic competition and technical progress, it examines the impact of international trade on the wage premiums.

Results estimated in the context of the specific factor model of international trade confirm that there are tangible consequences for income distribution from international trade. Further they indicate that industries that export in particular those to high-income countries have higher wage-premiums whereas industries that face import competition from low-income countries have lower wage premiums.

It argues further that technical progress (such as those that are connected with investment in R&D activity) enhances inter-industry wage premiums.

Nannan LUNDIN *and* ***Lihong YUN*** **(2004)**. Trade Union Institute for Economic Research (FIEF), Wallingatan 38, SE-11124 Stockholm, Sweden. Department of Business, Economics, Statistics and Informatics (ESI), University of Örebro, SE-701 82 Örebro, Sweden.

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1. INTRODUCTION

Owing possibly to its relative size and openness, the Swedish manufacturing sector is exposed to stringent competition from foreign markets, the conveyor of which being the imports and exports of the country. Possibly arising from this circumstance, the impact of international trade on the Swedish manufacturing sector has been subject to survey and scrutiny from export as well as import standpoints. According to these studies the firms that are engaged in export activities enjoy enhanced productivity gains whilst those of the import-side have been contributing to 'disciplining' the large manufacturing firms with 'excess market power'.[1]

However, international trade also yields a great deal of impact on labour market outcomes in particular on distribution of the incomes. The impact of openness and trade liberalisation on wage distribution have been subject to detailed investigation where some Less Developed Countries (LDCs) as well as some industrialised economies have been in particular focus.[2]

Sweden has not, at least over the past few decades, been implementing trade reforms that rendered any major consequences for the economy. However, integration of the Swedish economy with the European Internal Market in 1992 and the membership of Sweden in European Union (EU) in 1995 have helped the Swedish manufacturing sector to integrate more closely with the international markets than ever before. Furthermore, the ongoing enlargement processes of the

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[1] See e.g. Hansson and Lundin (2003), Lundin (2003).

[2] See e.g. Lawrence and Slaughter (1993), Roberts and Tybout (1996), Goldberg and Pavcnik (2001), Pavcnik *et al.* (2003) for the US, Mexico, Colombia and Brazil, respectively.

European Union have also expanded the trade between Sweden and the EU-membership candidate countries.

It should be appropriate, therefore, to survey and analyse the particular trends in income distribution of Sweden that takes shape owing to increasing competition that is a result of widening international economic integration.

Whilst investigating income distribution amongst workers in the manufacturing sector, there are some institutional peculiarities about Sweden that too should be borne in mind. According to Country Survey of OECD 2004, the Swedish workers are more inclined to stay longer in the same job than what their counterparts in other OECD countries seem to aspire. This reflects the presence of, amongst other things, relatively more stringent employment protection legislation of the country. Obviously, this practise may yield advantages in advancing firm-specific and industry-specific labour skills and human capital. However, in the context of increased international trade and competition, frictions in labour mobility may also yield consequences in terms of income distribution.

Redistribution of income follows different paths and patterns and inter-industry wage dispersion is just one such.[3] Shift in product prices that are associated with shift in international trade leads to factor price adjustments amongst competitive industries of the export and import sub-sectors. This is true particularly as workers are immobile at least in the short-run. For this purpose, the inter-industry wage structure has been regarded for being of major relevance since it yields implications for industrial as well as trade policies.

Labour mobility due to changes arising from market competition plays an important role in the enhancement of labour productivity. Furthermore, as suggested by Katz *et al.* (1989), policies that encourage

[3] There is a plethora of publications that deal with income inequality related to technological progress with skill-bias. See e.g. Lawrence and Slaughter (1993) and Slaughter and Swagel (1997) for detailed survey.

employment growth in the high-wage sector and reallocation from low wage sector to high wage sectors are likely to transfer labour from low productivity to high productivity uses and thereby making it possible to increase the total output that ultimately yields a positive welfare effect.[4]

The aim of this study is to survey and analyse the effects of international trade on the inter-industry wage structure in the Swedish manufacturing sector. More specifically, by controlling for the individual, firm and industry variables, the study seeks to investigate how international trade impinges on inter-industry wage structure through both export competitiveness and import penetration in the Swedish manufacturing sector. In this attempt the study seeks to make use of a matched employer-employee dataset from the period between 1996 and 2000 that contains detailed information about characteristics of the workers, the firms that employ them, and the industries to which the firms belong.

The matched employer-employee dataset enables the control of individual characteristics and the most important job characteristics. With such an approach, the measures of inter-industry wage premiums may be expected to be of greater accuracy in comparison with those of some earlier studies and which have been on at more aggregate levels. It pertains to state here, therefore, that, in light of the available literature, the present study is the first that attempts at assessing the impact of international trade on inter-industry wage premiums by using micro-level data at individual level for the Swedish manufacturing.

The present study derives itself from two different strands of the literature. The first strand refers to a large body of literature on inter-industry wage premiums whilst the second strand refers to the impact of trade on inter-industry premiums.[5] The present study focuses itself

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[4] However, these policy designs are not unconditional. See Katz *et al.* (1989) for detailed discussions on premises and qualification to achieve overall welfare improvement through such policies.

[5] Dickens and Katz (1986), and Krueger and Summer (1986, 1988) for the US, Gera and Grenier (1994) for Canada, Haisken-DeNew and Schmidt (1999) for a

on the impact of international trade, but with controls for the distinguishing features of Swedish product and labour markets. This is in order to make the analyses relatively more suitable and appropriate for the purpose.

The outline of the remainder of the present paper is as follows. Section Two discusses the pertaining theoretical issues whilst Section Three reviews, albeit briefly, the relevant literature. Section Four introduces the dataset and the empirical investigation strategy. Section Five contains the discussions of the estimation results of the inter-industry wage premiums and assessment of the impact of international trade. Section Six concludes the paper.

2. THEORETICAL BACKGROUND

It obviously is the prerogative of the firms and industries to pay different wages for workers with different levels of human capital and competence as reflected in, for instance, education and experience.[6] But one may ask why some firms/industries should choose to pay more for the some type of worker than others? Some standard labour models seek to explain different wage premiums in the context of employer-characteristics, structure of the industry and the role played by the unions, rather than just in the context of the characteristics of the workers.

The efficiency wage models maintain that there are four possible motivations for the payments of non-competitive wages for the workers in the firms/industries. These are: (1) minimisation of the turnover costs, (2) motivation on workers' efforts, (3) enhancement of workers' loyalty, and (4) selection on workers with high quality. Derived from these motivations and characteristics of the firms/industries (such as

comparison between the US and Germany, and Abowd and Kramarz (2000) for a comparison between the US and France.

[6] Dickens and Katz (1986), Gibbons and Katz (1992) and Krueger and Summer (1988).

firm size, capital intensity, profitability, productivity and concentration) one may observe the opportunity for the employers to implement the efficiency wage.[7]

Then, the bargaining and rent sharing further focus on the structure of the industries and the labour-unions. In the presence of excess market power amongst producers in the product market, higher wages may be paid to workers as a way of rent sharing. Weiss (1966) maintains that in monopoly-wage hypothesis, the workers share the excess profits of firms in concentrated industries. This hypothesis, however, has been rejected empirically.[8] On the other hand, the large producers may exercise monopsonistic powers in wage bargaining. Moreover, the presence of unionisation and the bargaining power of the unions in the labour market affect either the level of the employment or the wages. The union bargaining model in which the workers may exercise their bargaining power predicts that the workers "should" share the rents in the form of higher wages (Grossman 1984).

The standard labour models such as the efficiency wage models, bargaining and rent-sharing models suggest that the wage premiums may reflect the characteristics of employers, the structure of industry and the role of union. Generally the international trade models support and maintain the view that trade liberalisation and/or increased economic integration endorses redistribution of income among different types of labour with different qualification. One of the key distinctive features amongst these models concerns the degree of factor mobility. In the short and medium run, when, in consequence of trade liberalisation or intensified international competition, the market conditions change, some production factors are assumed to be immobile across industries.

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[7] See e.g. Griliches (1963), Hameresh (1993), Katz *et al* 1989), and Krueger and Summer (1988).

[8] See e.g. Idon and Oi (1999) and Dickens and Katz (1986) for additional empirical examples.

As endorsed by the specific factor model, when workers are assumed to be immobile across industries, the changes in real wages depend on whether the workers are in industries where prices rise or fall. For instance, a general increase in the degree of internationalisation through declining trade barriers and trade cost in all sectors should result in falling prices in import-competing industries and increasing prices in export industries. These price changes lead to increase in wages in the industries with rising prices and decreases in the industries with falling prices. However, when all production factors are mobile across industries in the long-run, the standard Heckscher-Ohlin-Samuelson (HOS) trade models predict that factor prices will be equalised across industries so that industrial wage differences for the same type of workers will disappear. (Suranovic 1997)

It should be apt to note, however, that winners and losers in the short-run and the medium-run models are distinguishable more by industry affiliation of the workers than by factor. These models predict that the factors specific to export industries benefit whilst the factors specific to import-competing industries lose. The industry wage premiums thus are motivated by the fact that in the short and medium run, workers are more likely to be immobile across industries in the presence of industry-specific human capital and skills. Some empirical evidences from labour literature have provided evidences for the labour immobility. Helwege (1992) shows that worker-skills that have been accumulated over time might be firm and industry specific making them less mobile. This is particularly true when concerning the senior and more experienced workers.

The specific factor model assumes of perfect competition in both product and factor markets. Imperfect competition, therefore, opens up additional channels through which international competition may impact on inter-industry wage premiums. A related model that developed by Grossman (1984) states that unions extract rents in form of employment guarantee rather than wages. With rent sharing,

economic integration and/or changing internal competitions may be expected to results in increasing wages in export industries and falling wages in the import competing sector.

Finally, technical progress affects inter-industry wage differentials in three different ways: (1) Hicks-neutral technical progress (shift of A in Y = AF(K,L)), (2) intensive skill-biased technical progress, i.e. the skilled workers can get better paid at jobs that they currently perform, and (3) extensive skill-biased technical progress. This refers to increase in relative demand for skilled workers to unskilled workers. (Johnson and Stafford 1999) The total effects of the all three types of technical progress are related to the proportional changes in output (in other words, Production Possibility Frontier (PPF)) for given factor inputs in that industry.

As predicted in the factor specific model, such shift of PPF derived from technical progress in one industry has similar effects as price changes. For instance, Hicks-neutral technical progress shifts factor-demand in industry, as the change in prices does. Then, it has the same effects as a price increase, i.e. increasing wages for specific factors in industries with high rate of technical progress. This holds for any of the three kinds of technical progress. (Lawrence and Slaughter 1993, Johnson and Stafford 1999, and Suranovic 1997)

The technical progress may be induced by international competition through innovation efforts (such as local R&D expenditure). (Romer 1990 and Grossman and Helpman 1991) There, on the one hand, innovation feeds on knowledge that results from cumulative R&D experience. Then, on the other hand, it contributes to the stock of knowledge. To the extent that R&D activities pass through to industrial sector wages, one may expect the wages to increase in the industries that experience higher R&D gains.

Thus international competition affects inter-industry wage differentials by way of immobility of the industry-specific factor or

industry-rents that are associated with imperfect competition and technical progress.

3. SOME PREVIOUS STUDIES

Edin and Zetterberg (1992) examined the inter-industry wage structure of Sweden by comparing them with individual cross-sectional data for 1984 from the US. Their analysis shows that the magnitude of inter-industry differentials at one-digit level data is much smaller in Sweden than that for the US. They also show that most of the observed industry wage differentials in Sweden are due to differences in labour quality and other non-pecuniary conditions. The findings by Arai (1994), based on micro level data from 1968, 1974 and 1981, indicate that inter-industry wage differentials at two-digit level data are substantial even when unmeasured worker-characteristics and working condition that are controlled.

Most empirical studies that use matched employer-employee data are found within the category of literature for labour economics. However, the empirical evidence of the impact of international trade experienced by combining information at individual with firm level and industry level data is still rather scarce.

Katz *et al.* (1989) address industry wage differentials that are related to strategic trade policy in the US. In this study they use detailed data of individual characteristics and trade data at the industry level and point out that the workers in most of the export intensive sub-sectors to be enjoying comparatively high wage premiums whilst the workers in major import-intensive sub-sectors are paid comparatively low-wage premiums. According to Katz *et al.* (1989) this is particularly true for the industries within the manufacturing sector.

Grey (1993) examines wage premiums and trade performance for Canadian manufacturing industries at the three-digit level for 1985 and argues that Canada too has experienced similar impact of trade on

inter-industry wage premiums as the US according to the study by Katz *et al.*(1989).

Abowd and Kramarz (1999) examined the impacts of international trade and mobility of French workers on wage premiums by using individual information and international trade data for the period between 1986 and 1990. They find the imports at firm-levels to have negative effects on wages. However, they maintain that both imports and exports at four-digit industry level have positive effects on wages.

Salvanes *et al.* (1998) use matched employer-employee data for Norway for the period 1991 to 1995. After controlling for conventional individual human capital variables and job characteristics, they find a higher degree of openness to give, in general, higher wage premiums.

Goldberg and Pavcnik (2001) examine the impact of trade reforms on industry wage structures in Colombia for the 1980s whilst Pavcnik *et al.* (2003) does the same for Brazil of the 1990s. According to the study on Colombia, the relationship between trade protection and wage is negative without industry fixed effects whilst the reverse relationship is true when industry fixed effects are included. However, there is no any significant statistical linkage between changes in industry wage premiums and changes in trade policy that was found in the study on Brazil.

Most part of the hitherto conducted studies that have been conducted by using matched employer-employee data have found evidence supporting the positive effect of exports and the negative effect of imports on inter-industry wage premiums. In the case of Sweden, however, the hitherto conducted studies have been focusing on the labour economics only. It is considered, therefore, that the present study with its approach to examining the impact of international trade on wage premiums in Sweden finds itself due.

4. DATA AND EMPIRICAL STRATEGY

The data used for this study have been obtained from the Bureau of Statistics Sweden. The data are at individual, firm and industry levels have been compiled into a microeconomic database at the Trade Union Institute for Economic Research (FIEF). The individual information has been based on a representative sample of the Swedish economy. For the purpose of the present study, the dataset has been concentrated only on the manufacturing sector of Sweden. Its structure is that of a matched employer-employee dataset, but has been further incorporated with structural characteristics at the industry level.

In the administrative wage register, every employee posses a personal code as well as an employer code. At the first step of matching the data, the employer code has been used to match to the employee with his/her main employer in the financial accounts of enterprises for all Swedish manufacturing firms with more than 20 employees.[9] The data employed in the present study contain full and part-time manufacturing employees of the age of 16 years and above. Then multiple job-holdings in the dataset are excluded from the analyses.

At the second step of matching, the employee and firm level information have been matched with the industry level data. This has been made possible by matching the classification codes of the industry in both the administrative wage register and the financial accounts of the enterprises.

For this study a panel of data for the period between 1996 and 2000 of the Swedish manufacturing has been employed. For each year, there are between 373,881 to 432,625 employees obtained from between 945 and 1,327 firms. (Appendix 1.1) During the period of 1996-1999, the individual workers were able to be matched with their main employers

[9] The reason that we use 20 employees as cut-off point is that information of both production and export are incomplete for firms that have less than 20 employees in our dataset.

within the private sector only. For 2000, the employer codes were available for both the private and the public sectors, and hence the number of individuals and firms for this year was larger in comparison with the figures for the previous period.

The wages have been measured by taking the logarithms of real monthly wages deflated by the consumer price index for 1990 as its base year. Fulltime equivalent of the figures for part-time employees have been measured by multiplying the number of hours that they have worked with the appropriate figure that represent the number of hours. In the analysis in this paper, first, the standard human capital variables have been used to control for individual characteristics. Then, secondly, information on firm size, capital intensity, technology and profitability measures from the financial accounts of enterprises have been used to construct characteristics of employer. Further yet, imports and exports by year and trading partners and an industry concentration measure at a three-digit level have been constructed by using information from the financial accounts of the enterprises and international trade statistics. Appendix 1.2 provides detailed definitions of these variables.

First the purpose of the empirical strategy applied in this study has to do with the control for demographic background, human capital and job characteristics as well as possible in the estimations of inter-industry wage premiums. Second, the paper seeks to analyse the effect of international trade on the inter-industry wage structure of the Swedish manufacturing by controlling for market imperfection and technical progress. Methodologically, the study seeks to follow the two-stage industry wage premium estimation that has been attempted by Krueger and Summer (1988) and that has been further refined by Haisken-DeNew and Schmidt (1997). In the first instance, the paper seeks to regress individual wages on a set of characteristics of the individual and the firm and a set of industry dummy variables. In this, a baseline industry has been dropped as a reference group by adhering

to assume that the omitted industry has zero wage premiums and estimate a standard ordinary least square (OLS) regression.

Having obtained the estimated coefficients on the industry dummies, i.e. the wage premiums, the study seeks to make, in the second instance, a linear transformation and re-normalise the estimated industry premiums and adjust the standard errors accordingly. This has been attempted by using employment share of each industry as a weight. The normalised wage premium, then, has been interpreted as the proportional difference in wages for an average worker in a given industry relative to an average worker in all manufacturing industries with the similar observable characteristics.[10] As outlined by Haisken-DeNew and Schmidt (1997), the improved procedure of the analysis of the industry wage premium estimation offers the advantage that it makes more meaningful from an economic point to view to interpret coefficients that measure deviations from an overall average rather than from a base category.

Following the Haisken-DeNew and Schmidt (1997) procedure, the study seeks to employ the exact formula to compute both the adjusted and weighted standard deviations of the transformed inter-industry wage premiums and a summary-measure of the overall variability of industry wage premiums.[11]

5. EMPIRICAL SPECIFICATIONS AND RESULTS

The empirical estimations are divided into two parts. The first subsection estimates the inter-industry wage premiums on annual

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10 The study uses the approximation log point as percent throughout this paper.

11 The coefficients on the industry dummies are restricted that their sum, weighted by the industry employment share in the sample, equal zero. Thus, each coefficient indicates approximately the percentage wage difference between an employee in a given industry and the average employee in all industry. The weighted and adjusted standard deviation of the coefficient is calculated as:

$$\hat{s}(\beta) = \sqrt{w'\upsilon'((b^*)b^* + w'\nu'(V(b^*))}.$$

basis for the period between 1996 and 2000. Having obtained the adjusted measures of inter-industry wage premiums, the second subsection estimates the impact of international trade on the wage premiums.

5.1. Estimation of Industry Wage Premiums

With the purpose of investigating the determinants of industry wage premiums, the paper seeks to apply the Haisken-Denew and Schmidt two-stage restricted least-squares-procedure discussed in section 4. [12] Haisken-Denew and Schmidt (1997) In the first instance, the industry-specific wage premiums are obtained by estimating the wage equation E1:

$$\ln(w_{ijK}) = \beta_{Ind} Ind_{ijK} + \beta_{F} Firm_{jK} + Wp_{K}\_Industry_{K} + \varepsilon_{ijK}, \qquad \text{E1}$$

where i is index for the individual, j is index for the firm and K is index for the industry.

$\ln(w_{ijK})$: the log of average monthly wage deflated by the consumer price index.

Ind_{ijK} : a vector of the characteristics of individuals, such as age, gender, educational level and profession.

$Firm_{jK}$: a vector of the characteristics of firms, such as firm size, capital intensity, technology, and profitability.

$Industry_{K}$: a set of three-digit manufacturing industry-dummy variables, which indicates individual *I*'s industry affiliation.

E1 is estimated by OLS and the standard errors are adjusted both for heteroskedasticity and for potential dependency amongst individuals

[12] Goldberg & Pavcnik (2001, 2000) have also applied the same methodology to evaluate the impact of trade reform in several developing countries using micro data.

working in the same industry at the three-digit level. The industry wage premiums thus capture the part of variation in wage that cannot be explained by controlled individual and job characteristics, but can be explained by the individual's specific industry affiliation.

Table 1. Cross-section Estimations of Wage Premiums (wp), 1996-2000.

	Dependent variable: monthly real wage in logarithm				
	1996	1997	1998	1999	2000
Individual control variables					
Gender	0.104 [9.36]	0.107 [15.25]	0.106 [15.12]	0.096 [12.14]	0.090 [12.82]
Age	0.021 [11.93]	0.019 [15.29]	0.019 [12.11]	0.018 [9.41]	0.018 [10.93]
Age x Age	-0.0002 [-11.20]	-0.0002 [-14.03]	-0.0002 [-11.29]	-0.0002 [-9.21]	-0.0002 [-11.00]
Education2	0.052 [6.44]	0.053 [12.71]	0.056 [14.16]	0.045 [7.94]	0.038 [7.38]
Education3	0.073 [7.05]	0.076 [12.59]	0.079 [12.97]	0.067 [8.16]	0.060 [7.57]
Education4	0.100 [8.42]	0.104 [11.07]	0.122 [15.20]	0.113 [10.22]	0.121 [11.10]
Education5	0.232 [16.32]	0.243 [19.41]	0.256 [23.45]	0.242 [16.44]	0.223 [14.36]
Education6	0.427 [20.80]	0.439 [25.26]	0.438 [30.26]	0.428 [28.22]	0.423 [20.92]
Professions	Yes	Yes	Yes	Yes	Yes
Firm-level control variables					
Firm size	0.011 [1.93]	0.012 [2.58]	0.018 [2.84]	0.024 [6.19]	0.019 [5.99]
Capital intensity	0.030 [5.50]	0.027 [3.95]	0.022 [3.55]	0.034 [6.86]	0.025 [5.18]
Relative TFP	0.080 [1.87]	0.051 [2.16]	0.061 [3.95]	0.090 [4.70]	0.172 [5.21]
Profitability	-0.0020 [-0.46]	0.0003 [5.63]	0.0007 [4.60]	-0.0013 [-0.31]	-0.0009 [-0.94]
Industry dummies (3-digit)	Yes	Yes	Yes	Yes	Yes
Adj- R^2	0.53	0.48	0.50	0.54	0.58
F-statistics for Industry dummies	212	166	134	169	148
Observations	317962	316421	299761	329178	347353

Notes: Standard errors are adjusted both for heteroskedasticity and potential dependency among individuals working in the same industry at 3-digit.White's heteroskedasticity-consistent t-statistics are in brackets.

Table 1 reports the results of the cross-sectional estimations of E1. The standard demographic and human capital variables yield similar results as in most labour studies. Male workers receive, on average, 10% higher wages than the female workers as indicated by the positive and significant coefficient. Using age as proxy, experience gives also higher wages, but at a decreasing rate. The education variables at different levels have also positive and significant effects on wages.

The size of the coefficients is increasing with the education level, indicating that each successive increase in education gives a positive return. The study controls also for professional category by using standard classification at one-digit level. Due to multicollinearity between education and profession, it is only some of the coefficients on profession that are individually significant.

In the wage equation E1, the study controls for the characteristics of the worker-affiliated firms such as firm size, capital intensity, relative total factor productivity (TFP) and profitability. Both firm size and capital intensity provide clear evidence to larger firms and firms with higher capital intensity which pay higher wages. The coefficients on these two variables are highly significant and positive for the whole period. The coefficient on firm size is at the range of 1.1%-2.4% whilst the coefficient on capital intensity is at the range of 2.2%- 3.4%. As opposed to what the case has been with labour studies from before, the present study introduces also an explicit measure of technology, namely the relative TFP. The coefficient on the relative TFP is at the range of 5%-17%, which is positive and significant. It is assumed that the relative TFP captures the unobservable technology, superior management-skills and other organisational characteristics of the firms. The study further includes profitability of the firms as a control variable.[13] But, the coefficient on profitability is less stable and its

[13] In order to avoid the instability in the profit measures, the paper uses an average profit over three-year interval. For year 1996, the profit measure is computed as the average profit for year 1994, 1995 and 1996. Similarly for year 1997, the paper uses the average for year 1995, 1996 and 1997, etc. The endogeniety between

positive effect on wage is not very clear as in other labour studies. (see Heyman 2002 and Arai 2003)

In the labour literature, particularly using firm level data, the choices of control variables and various measures of the same variable are often open empirical issues. To check the robustness of the given specifications, the paper seeks to experiment with including the market share and using an alternative profitability measure. The results of these alternative specifications are reported in Appendix 2.1 and Appendix 2.2. In some previous studies (see e.g. Salvanes 1998), market share is included to control for firm's market power or efficiency. As shown in Appendix 2.1, the positive effect of market share on wage is not clear-cut. Another effect is that the coefficient on the relative TFP becomes smaller and less significant in comparison to the original specification in E1. When the paper includes firm size, and then, the coefficient on market share becomes no longer significant.[14] These results indicate that there is strong muliticollinearity among firm size, market share and relative TFP, and paper has selected, therefore, the most parsimonious specification that excludes the market share.

The other experiment is to use an alternative profitability measure defined as the logarithm of profit per employee, which is the most conventional measure of profitability in labour literature. Here the TFP is excluded from the model. As shown in Appendix 2.2, the coefficient on profitability is not significant. The difference in the results compared with other studies on Sweden (see Heyman 2002 and Arai 2003) may be explained by: (1) when the technology variable is included in the models, the effect of profitability becomes less clear, and (2) second, instead of including both manufacturing and some service sectors, the present study includes solely the manufacturing industries. It also

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wage and profit is often addressed in rent-sharing literature. Since the paper does not explicitly model the rent-sharing mechanism, but uses profitability as a control variable, this potential endogeniety problem is not explicitly addressed here.

[14] For brevity, the result that includes firm size is not reported here, but available at request from authors.

should be noted here that the present study does not limit the sample only to the firms with positive profits.

Another possible determinant of wage premiums refers to the ownership structure. As robustness check, the paper includes foreign versus domestic and private versus public ownership dummy variables in the model. The estimation results show that coefficients on ownership are not statistically significant and the coefficients on other control variables remain unaffected when additional ownership structures are controlled. Therefore, the paper excludes ownership controls from specifications.[15]

Taken together, paper controls for both the human capital and relevant job characteristics in the estimation of the industry-specific wage premiums and find that the estimates are robust to the modified specification. The wage equations for the whole period are well behaved. Nevertheless, there are two empirical issues that need to be discussed before one hastens to discussing the estimates of industry-wage premiums, namely the unmeasured labour quality and compensation differentials in the inter-industry wage premium estimation.

It is often argued that labour quality cannot be adequately controlled, since non-measurable labour quality differences (such as motivation and innate ability) may vary systematically with industry, and can be picked up by industry-variables instead of human capital controls. This methodological issue has been addressed in several previous studies by using fixed-effect estimates in the context of panel data instead of cross-sectional estimation. However, this solution is not without potential problems. First, from a methodological point of view it can only be applied to the individuals who switch industries. The most obvious methodological drawback that one may encounter refers to that individuals do not switch across industries randomly, and that it

[15] The results with ownership controls are available at request from authors.

causes endogeneity bias in the estimation.[16] Moreover, selection bias and measurement errors emerge immediately with such approaches. Theoretically, the expected number of industry-switchers may not be large, since in short-run, the labour is perceptibly immobile. Furthermore, a number of recent studies have shown that the mobility of labour takes more commonly place across firms within the same industry instead of across industries.

The compensating differential argument is that agreeable and disagreeable firms' characteristics vary systematically with one's own industry, and therefore the wage differentials are paid to compensate employees for non-wage aspect of industries.

More generally speaking, the compensation differentials may be due to the omitted controls such as differences on working condition. Evidence from previous studies such as Murphy and Topel (1986) and Summer and Krueger (1986) show that industry wage differentials in the US are robust after controlling for various working conditions. The dataset used for the present study does not offer the possibility to control for various working conditions. However, in the earlier study on inter-industry wage structure of Sweden (Arai 1994), the substantial industry premiums were robust after controlling for working condition variables and individual fixed effects.

The dataset used for the present study includes 76-85 manufacturing firms depending on the year of calculation. It is generally difficult to perceive of the general picture of the wage structure when the number of the firms is large and the classification of industry is fragmented. In order to give a more direct impression of the magnitude of estimated wage premiums, the present study seeks to estimate the same model (E1) by including first two-digit level instead of three-digit level industry dummy variables. This information has been summed up in Table 2.

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[16] See Gibbons & Katz (1992) for more detailed discussion on it.

Table 2. Wage Premium (two-digit level) for 1996-2000.

Sector	1996	1997	1998	1999	2000
15: Food & Beverage	-0.074 (0.008)	-0.052 (0.006)	-0.040 (0.005)	-0.059 (0.007)	-0.047 (0.004)
16: Tobacco	-	-	-	-	-
17: Textiles	0.002 (0.025)	-0.048 (0.008)	-0.044 (0.009)	-0.029 (0.007)	-0.047 (0.005)
18: Wearing apparels	-0.135 (0.010)	-0.104 (0.011)	-0.097 (0.012)	-0.030 (0.013)	-0.066 (0.011)
19: Leather, footwear	-	0.036 (0.015)	-0.018 (0.012)	-0.010 (0.011)	-0.034 (0.009)
20: Wood products	-0.029 (0.016)	-0.019 (0.013)	-0.012 (0.013)	-0.027 (0.009)	-0.016 (0.007)
21: Pulp and paper	**0.026** **(0.012)**	**0.059** **(0.010)**	**0.036** **(0.011)**	**0.013** **(0.010)**	**0.003** **(0.008)**
22: Publishing, print	**0.008** **(0.010)**	**0.046** **(0.007)**	-0.001 (0.009)	**0.040** **(0.007)**	**0.046** **(0.006)**
23: Refined petroleum products	**0.007** **(0.011)**	**0.041** **(0.009)**	**0.029** **(0.006)**	-0.005 (0.009)	**0.032** **(0.006)**
24: Chemicals & chemical products	-0.035 (0.009)	-0.004 (0.008)	-0.003 (0.006)	-0.020 (0.012)	-0.008 (0.007)
25: Rubber and plastic products	-0.057 (0.010)	-0.016 (0.006)	-0.029 (0.008)	-0.009 (0.008)	-0.027 (0.005)
26: Other non-metallic mineral products	-0.030 (0.006)	-0.004 (0.004)	-0.001 (0.005)	-0.018 (0.005)	-0.017 (0.004)
27: Basic metals	-0.012 (0.007)	**0.048** **(0.011)**	**0.042** **(0.010)**	0.011 (0.011)	-0.005 (0.009)
28: Fabricated metal products	-0.093 (0.029)	**0.007** **(0.005)**	-0.036 (0.004)	-0.022 (0.009)	-0.025 (0.005)
29: Machinery	-0.012 (0.007)	**0.007** **(0.003)**	-0.014 (0.003)	-0.022 (0.003)	-0.019 (0.002)
30: Office machinery & computers	**0.131** **(0.014)**	-	-	**0.062** **(0.013)**	**0.009** **(0.005)**
31: Electrical machinery & apparatus	-0.033 (0.007)	-0.005 (0.007)	**0.005** **(0.006)**	**0.011** **(0.006)**	-0.023 (0.005)
32: Radio, television, communication equipment	-0.009 (0.016)	**0.031** **(0.011)**	**0.031** **(0.012)**	**0.051** **(0.011)**	**0.055** **(0.008)**
33: Medical, precision instrument	**0.002** **(0.008)**	**0.029** **(0.008)**	-0.000 (0.007)	**0.033** **(0.004)**	**0.058** **(0.005)**
34: Motor vehicles, trailers	**0.024** **(0.015)**	**0.011** **(0.009)**	**0.019** **(0.011)**	-0.015 (0.013)	**0.003** **(0.008)**
35: Other transport equipment	-0.043 (0.008)	-0.022 (0.004)	-0.030 (0.005)	-0.027 (0.008)	-0.015 (0.004)
36: Furniture, manufacturing n. e. c.	-0.047 (0.008)	-	-0.022 (0.007)	-0.025 (0.009)	-0.047 (0.004)
Overall average	8.889 (0.082)	9.183 (0.250)	9.284 (0.180)	8.954 (0.104)	8.991 (0.056)
Overall variability of industry wage coefs. (two-digit)	0.013	0.007	0.007	0.009	0.005
Overall variability of industry wage coefs. (three-digit)	0.010	0.009	0.009	0.007	0.006
No. of Observation	317962	316421	299761	329178	347353
Adj. R^2	0.52	0.48	0.49	0.53	0.57
F statistics for no industry effect (two-digit industry)	552.27	425.78	234.85	303.55	306.27

Note: control variables at individual and firm levels are the same as in the 3-digit industry specification.

First, the overall variability of the industry wage premiums at both the two-digit level and the three-digit level show a decreasing pattern. This pattern is relatively clearer at the three-digit level, i.e. the convergence of wage premiums which is indicated by a declining standard deviation 0.010, 0.009, 0.009, 0.007 and 0.006 for the period 1996 to 2000.

Further, some industries, such as pulp and paper (SNI21), office and computers (SNI30), radio, television and communication equipment (SNI32), medical and precision instrument (SNI33) and motor vehicles (SNI34) generally have higher wage premiums. For instance, an average worker in the pulp and paper industry has 2.6% higher wage than an average worker in the whole manufacturing in 1996. Then in other industries such as wearing apparels (SNI18), chemicals and chemical products (SNI 24), rubber and plastic products (SNI25) and other non-metallic mineral product (SNI26) have, in general, lower wage premiums. An average worker in rubber and plastic products industry has, for example, 3.5% lower wage than an average worker in the whole manufacturing in 1996.

Table 3. Correlation of Inter-industry Wage Premiums (Wp) Over Time.

	wp1996	**wp1997**	**wp1998**	**wp1999**	**wp2000**
wp1996	1.0000	-	-	-	-
wp1997	0.7902	1.0000	-	-	-
wp1998	0.7278	0.859	1.0000	-	-
wp1999	0.6338	0.7298	-	1.0000	-
wp2000	0.551	0.6265	0.7210	0.8021	1.0000

Notes: The table presents the adjusted wage premiums. The correlations are statistically significant at 1% level.

Table 3 uses year-to-year correlations between wage premiums over the whole period to check the stability of the wage structure. As shown

in Table 3, the year-to-year correlations range from 0.86 to 0.73.[17] In Arai (1994), the correlations between wage premiums are 0.91 for 1968 and 1974, 0.63 for 1968 and 1981 and 0.62 for 1974 and 1981 for a sample of non-agricultural workers. Krueger and Summer (1988) report that industry wage premiums have a correlation up to 0.91 in the period 1974 to1984 in the US.

Then, Roberson (1999) reports a correlation of 0.92 for 1987-1997. One is not able to compare the correlations in various studies since different measures of wages for different samples have been used. The correlation may also be sensitive to the time period and the sectors that are investigated. In the present study, the correlation between the yearly inter-industry wages for the manufacturing sector appear to be relatively low and which may be due to the fact that the observed time-period is relative short. The relatively low correlation of the inter-industry wage premiums over time suggest that industry wage structure reflects some transitory effects of the short-run demand shocks in combination with immobility of labour. Hence, the next step of the present analyses, relates the inter-industry wage premiums further to international trade, as a potential source of such demand shocks.

5.2. Wage Premiums and International Trade

The aim of this section is to assess the impact of international trade on industry wage premiums, after controlling for domestic competition and technology progress. In here the transformed inter-industry wage premiums, Wp_K from section 5.1 over time have been pooled as a dependent variable. Since the dependent variable in this stage is the estimate from E1, the inverses of the adjusted and weighted variances of the wage premium coefficients are used as weights to deal with the potential measurement errors have been used in here.

[17] Similar results have been obtained for unadjusted wage premiums as well.

This procedure puts more weights on industries with smaller variances in industry premiums. In the other words, model has been estimated by applying the weighted least square estimator (WLS). (see e.g. Goldberg and Pavcnik 2001)

The model is specified as the following:[18]

$$Wp_{Kt} = \beta_{im} \operatorname{Im} port_{K,t-1} + \beta_{ex} Export_{K,t-1} + \beta_{R\&D} R\&D_{K,t-1} + \beta_H H_{Kt} + \beta_{H^2} H_{Kt}^2 \quad \text{E2}$$
$$\sum \delta_t Yeardummy + \sum \delta_{ind} Industrydummy_{Kt} + \nu_{Kt},$$

where

$Import_{K,t-1}$: Lagged import penetration at three-digit level.

$Export_{K,t-1}$: Lagged export to production ratio at three-digit level.

$R\&D_{K,t-1}$: Lagged average R&D intensity at three-digit level as proxy for technical progress.

H_{Kt}: Herfindahl index at three-digit level as proxy for domestic competition.

Alternatively, we divide international trade into high respectively low income country groups to assess the differential effects of trade on wage premiums depending on the different origins and destinations of trade.[19]

$$Wp_{Kt} = \sum_{c=H,L} \beta_{im} \operatorname{Im} port_{K,t-1} + \sum_{c=H,L} \beta_{ex} Export_{K,t-1} + \beta_{R\&D} R\&D_{K,t-1} + \beta_H H_{Kt} + \quad \text{E3}$$
$$\beta_{H^2} H_{Kt}^2 + \sum \delta_t Yeardummy + \sum \delta_{ind} Industrydummy + \nu_{Kt} \ .$$

The export and import flows are potentially endogenous, since they depend on factor prices. Furthermore, there might also be simultaneity problem between wages and technical progress. In the absence of valid external instruments, the paper uses one-year lagged trade variables and lagged industrial R&D intensity in the estimation to avoid the potential endogeneity problem. One may alternatively employ a two-

[18] More detailed variable definitions are presented in data Appendices: description of variables 1.2.

[19] See Lundin (2003) for detailed information on the country group classification.

stage least squares (2SLS) method and use the lagged values of variables as instruments to address their current levels.[20]

However, the current values and the lagged values of the variable often reveal to be serially correlated and relatively persistent over time. The potential endogeniety problem might still yield biased result, in particular in the specifications with relatively small number of observations. (Shea 1997)

Table 4 report the results from estimations of E2 and E3. There it is attempted at estimating the regressions with and without fixed effects alternately. The specifications have been regarded without the industry fixed effect as preferred specifications since what has been desired are the inter-industry differences in wage premiums, but not within-industry variations of wage premiums over time. [21]

Methodologically, there are a relatively large numbers of industry dummy variables included in the model (above 70 industries) and the time period of the study is relative short (4 year after lagging the trade variables). Both of these factors prevent the procurement of efficient and consistent estimates of impact of trade and technology when a large number of industry dummies are included.

Furthermore, the paper seeks to experiment also with estimating the model by using between and first-difference estimators as robustness checks. Between estimators that use the cross-sectional information in data yields similar results as the WLS estimator.[22]

The first-difference estimator is an alternative way to controlling for unobserved time-invariant industry-specific effects. For the similar

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[20] We experiment with the 2SLS estimations, which yield similar results as shown in Table 4. The Durbin-Wu-Hausman test indicates there is not much concern on endogeneity, and the Hausman test suggests that the 2SLS estimators are not consistency. The results are available with request.

[21] When industry-dummies are included in regressions (which are equivalent to fixed effects (FE), the effects of the explanatory variables on inter-industry wage premiums disappear. This alternative estimation results are available with request.

[22] Since we use the inverses of the adjusted and weighted variances of the wage premium coefficients as weights to deal with potential measurement error in the weighted least square (WLS) estimation, we regard the WLS as a preferred estimator. The between estimator yields similar results, but the measurement errors cannot be handled properly as in the WLS.

reasons, this estimator turns out to be inefficient as the industry-fixed effect.[23] Discussions in subsequent parts focus on the results obtained by the WLS instead of the industry fixed-effect estimation.

Ramsey's RESET test shows that a model is appropriately specified if its p-value is insignificant. VIF stands for variance inflation factor. As a rule of thumb, a variable whose VIF- values are greater than 10 may be needed for further investigation of collinearity.

Table 4. International Trade and Inter-industry Wage Premium

Dependent variable: adjusted industry wage premium (wp)						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Lagged Import penetration (total) LpeneT	-0.035 [-1.62]	-	-	-0.023 [-1.18]	-	-
Lagged Export orientation (total) LexT	0.034 [1.88]	0.010 [0.55]	-	0.016 [0.91]	-0.0004 [-0.02]	-
Lagged high- income import LpeneDep	-	0.005 [0.29]	-0.003 [-0.15]	-	0.013 [0.76]	0.013 [0.59]
Lagged low-income import LpeneLess	-	-0.273 [-5.43]	-0.282 [-6.94]	-	-0.244 [-4.98]	-0.236 [-5.73]
Lagged high-income export LexDep	-	-	0.028 [2.59]	-	-	0.018 [1.65]
Lagged low-income export LexLess	-	-	-0.081 [-1.86]	-	-	-0.097 [-2.18]
Lagged R&D intensity *LRnD*	-	-	-	0.238 [3.12]	0.143 [2.03]	0.146 [2.17]
Herfindahl index H	-	-	-	-0.031 [-2.76]	-0.027 [-2.48]	-0.030 [-2.57]
Herfindahl x Herfindahl index H^2	-	-	-	-	-	-
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies (3-digit)	No	No	No	No	No	No
VIF	1.79	1.74	1.84	1.71	1.69	1.83
Ramsey RESET (p-value)	0.100	0.860	0.046	0.002	0.470	0.136
Adj. R^2	0.04	0.14	0.18	0.08	0.17	0.21
No. of Observations	370	370	370	370	370	370

cont…

[23] The results of between-effect and first-difference estimators are available on request from the authors.

…cont.

Dependent variable: adjusted industry wage premium (wp)			
	(7)	**(8)**	**(9)**
Lagged Import penetration (total) LpeneT	-0.020 [-1.11]	-	-
Lagged Export orientation (total) LexT	0.022 [1.33]	0.006 [0.35]	-
Lagged high- income import LpeneDep	-	0.011 [0.66]	0.004 [0.18]
Lagged low-income import LpeneLess	-	-0.218 [-5.01]	-0.224 [-5.84]
Lagged high- income export LexDep	-	-	0.025 [2.47]
Lagged low-income export LexLess	-	-	-0.083 [-1.96]
Lagged R&D intensity *LRnD*	0.321 [3.91]	0.217 [2.86]	0.206 [2.97]
Herfindahl index H	-0.165[a] [-3.11]	-0.132 [a] [-2.54]	-0.130 [a] [-2.61]
Herfindahl x Herfindahl index H^2	0.137 [a] [2.82]	0.106 [a] [2.25]	0.104 [a] [2.25]
Year dummies	Yes	Yes	Yes
Industry dummies (3-digit)	No	No	No
VIF	4.38	4.20	4.03
Ramsey RESET	0.000	0.046	0.008
Adj. R^2	0.13	0.19	0.23
No. of Observations	370	370	370

Notes: White's heteroskedasticity-consistent t-statistics are in brackets.
VIF stands for variance inflation factor. As a rule of thumb, a variable whose VIF values are greater than 10 may need further investigation on collinearity.
a: Their individual VIF-values are approximated 13-15.

The models with only trade variables (Column 1 and 2), and the models with the trade variables as well as other industrial characteristics (such as R&D intensity and concentration) (Column 5 and 6) appear to be appropriately specified at the same time as there is not severe multicollinearity problem.

As shown in Column 1, the coefficient on the lagged total import-penetration is not significant. But the coefficient on the lagged total

export ratio is positive and significant at 10% level. The lagged total import penetration is grouped into low and high-income subgroups in Column 2, the lagged import penetration from low-income countries shows a negative and significant effect on the inter-industry wage premiums. However, the coefficient on total export becomes insignificant.

Furthermore, as it has been pointed out in the section for Theoretical Background, both imperfect competition and technical progress may also have effects on inter-industry wage structure. Thus, the model in Column 2 is further extended to include the indicators for industrial technical progress (R&D intensity) and market concentration (Herfindahl index), which is shown in Column 5. Similarly with the indications for Column 2, the negative effect of the lagged import penetration from low-income countries on the inter-industry wage premiums remains significant. Then**,** there are some evidences on the positive effects of industrial R&D intensity (as a proxy for technical progress) as well as the negative effects of market concentration (Herfindahl index).

Moreover, the export ratios are grouped into low and high-income subgroups and which are shown in Column 6. The sign of the coefficients on the lagged import penetration, R&D intensity and Herfindahl index are similar to those in Column 5 and which are significant. Then**,** there are indications to that there is a positive effect of export to high-income countries whilst a negative effect of export to low-income countries.

These results of trade impacts on the inter-industry wage premiums can be explained by the specific factor model. At first, the paper seeks to examine the effects on import penetration from the low-income countries (Column 2, 5 and 6). When import competition from the low-income countries intensifies in the domestic market, it imposes a downward pressure on the prices that the domestic industries have to face. The lower prices (and also the lower relative prices) of import goods

lower the revenues of domestic firms in the import competing industries. Thus the profits may be forced downwards and even in a negative direction. In this situation the firms have to either contract by laying-off workers or lowering the wages in order to eliminate their losses. Given that workers are assumed to be immobile in the short-run across industries due, amongst other things, to industry specific skills and it is not easy to find a new job in another industry, the lower wages become the final outcome. Alternatively, the workers concerned may try to shift over to another firm in the same industry. This is mainly due to the fact that it is difficult to shift across the industries. In this case, the worker still has to accept a lower wage as he/she is still in the same industry that encounters import penetration.

In the present study, it is difficult to observe such negative effects on wages that are imposed by imports from high-income countries. Evidence can be found only in the case of imports from low-income countries. These may be due to imports from low-income countries are often homogenous, standard goods and which compete on the basis of their prices. In the meanwhile the imports from high-income country are often highly differentiated and which may compete on the basis of their quality rather than their price.

With reference to the export side: when the relative prices of export goods rise or the domestic industries achieve a competitive position in exporting markets, the firms in the export sector receive increased revenues from sales in the international markets. Thus, initially profits amongst these firms rise. The increase in profits stimulates the expansion of production. Since production cannot be expanded by attracting workers from the other industries in the short-run, the firms in the export industry have to compete, initially, for workers who are already present in the industry. However, the most attractive way to attract the workers from the same industry, or to induce the incumbent workers to stay, is to offer them higher wages. The higher wages are, therefore, offered in the export-competitive industries (Column 1 and 6).

However, the exports to low-income countries do not generate such a positive effect on wage premiums. On the contrary, the effect is negative (Column 6). This might be because the exports to these low-income countries are homogenous and standard goods and which face more intensive price competition in those low-income markets, and there is a downward pressure on the prices of these export goods in those markets.

Such positive effect of the total exports as well as the exports to high-income countries and negative effect of imports from low-income countries are consistent with the results of the studies by Katz *et al.* (1989) for the US and Grey (1993) for Canada.

The impact of trade explained by the specific factor model is under the assumption of perfect competition. As it has been discussed in the section for Theoretical Background, both imperfect competition and technical progress may have effects on the inter-industry structure.

In order to control for the effect of domestic competition, the paper specifies a non-linear relationship between industry wage premiums and domestic concentration by including Herfindahl index, and the square of this term (Column 7-9). As opposed to most of the earlier empirical studies,[24] these indicate of a negative relationship between concentration and wages in this study. This can be interpreted with reference to the fact that the large employers may exercise monoposonistic powers. Further, if the concentrated sectors are affected under import competition,[25] then the loss of excess profit may also lead to decreases in wages. Moreover, it has been experimented in the paper by including a square of Herfindahl index (Column 7-9) which yield similar results as those in Column 5 and 6. However, the negative effects of market concentration appear to be decreasing and which has

[24] Belman (1988) gives a detailed survey on agreement and disagreement on the effect of market concentration on wages.

[25] This hypothesis has been tested in a previous study (Lundin 2003) in Swedish manufacturing for period 1990-1999.

been indicated by the coefficient on the squared Herfindahl index that is positive and significant. This reveals a U-shaped curve relationship between concentration and wages. Within a certain interval of concentration level, however, when the concentration ratio reaches a higher level and passes a certain threshold, a positive relationship emerges. It is in line with the monopoly-wage hypothesis that workers share the excess profits of firms in concentrated industries. Nevertheless, as Ramsey RESET test suggests the specifications in Column 7-9 are not appropriately specified and which may be due to multicollinearity between the Herfindahl index and its square term.

As shown in Column 5 and 6, the positive effects of average R&D intensity (as a proxy for technical progress [26]) reflect that technical progress has the same effects as price changes, i.e. increasing wage for specific factor (such as labour) in industries with high rate of technical progress.

The wage structure may be influenced by the market forces and the institutional factors as well. For the Swedish labour market, the high rates of union participation and collective bargaining are important institutional features. First, the union participation ratios in Sweden are uniformly high across industries and persistent over time. The variation in the union-participation variable is profoundly limited. Second, the Swedish labour market is indeed characterised by a high degree of centralisation in the wage setting but permits the industries and firms to have substantial degree of local influence on wage determinations (Arai 1994 and 2003). This indicates that the influence of the wage bargaining system takes place through local wage negotiations within industries where coordination is difficult. This may explain why the union effect cannot be identified at such aggregate

[26] We use also average labour productivity as robustness measure for technology and the results using this measure are very similar to the R&D intensity. We use therefore R&D intensity as a more direct measure for technology progress.

levels as in this study.[27] Furthermore, the unions in Sweden are organised not only on firm and industry level but also on the basis of education or professional levels. It requires, therefore, more detailed information on union participation at both firm and industry levels in order to capture the bargaining effect, and the distribution of union-participation at various education and professional levels. However, data and information on these two aspects of the matter are incomplete for the present study.

Finally, an additional number of alternative robustness checks have been used for the model specifications.[28] The paper includes, for instance, the growth rate of industry-employment in order to control for the effect of the demand for labour. However the coefficient on employment growth is not statistically significant. The macroeconomic demand effects probably are picked up in the year dummy variables in the original specifications of E2 and E3. The paper includes also the average skill-intensity as an additional control for the aggregate effect of skill and which is often emphasized in the labour literature. However, this effect is not significant. It is assumed that the aggregate skill-effect has been captured by the R&D intensities and which can be regarded as a more direct measure of skill and technical requirements.

6. CONCLUSIONS

In its attempt to investigate trade-wage link in the Swedish manufacturing, this paper sought, first, to measure inter-industry wage dispersion and then analyse how international trade affects the inter-industry wage structure.

In stark similarity with previously conducted studies of the wage structure in Sweden, the first part of the empirical analyses of this

[27] Although we experimented with inclusion of union participation rates at the two-digit industry level, it was difficult to find any significant union premiums. See Heyman (2002) page 59 for more detailed discussion on this point.

[28] Results from these alternative specifications are available at request from authors.

paper finds substantial dispersion of inter-industry wage premiums after controlling for important human capital and the characteristics of the employer. These results provide indications to both imperfect labour-mobility in short-run and transitory demand shocks that have impact on the wage structure in the Swedish manufacturing sector. Further, the overall variability of wage premiums has decreased during the period between 1996 and 2000.

In the second part, the paper seeks to relate the inter-industry wage premiums to international and domestic competitions and technical progress. Consistent with most of the wage-technology literature, the paper finds clear evidence to indicate that industries with higher technical standard, measured by R&D intensities enjoy higher wage premiums. Regarding international competition, the paper observes a pattern of higher wages in export competitive industries whilst lower wages in import competing industries. Nevertheless, the effect of producer concentration shows a negative effect on wage premiums and which has been interpreted as the large employers may exercise monopsonistic power.

The inter-industry wage premiums appear to be closely related with international competition, technology and market imperfection based on the obtained results. In the context of increased international competition, labour mobility plays an important role both in reduction of short-run adjustment costs and in enhancement of productivity. Hence, the results of this study may have some ramifications for implementing a new labour policy. The legislation on labour market faces a challenge, on the one hand, from the need to provide job security, and, on the other, to facilitate the labour mobility and ensure that the workers may move in search of jobs where they can be more productive and earn a higher return for their skills. The result of this study suggests, further, that trade with low-income countries and with high-income have varying ramifications on the inter-industry wage structure. This is probably due to the different technical standards and

skill endowments in the trade with these two subgroups, which elucidate that there might be some skill bias related to the effect of trade on wages. For instance, both high-skilled labour and the low-skilled labour may be affected in different ways, although they both are in exporting industries.

This interaction between trade and skills calls for more detailed investigation in the future research.

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Appendix 1.1. Panel description.

Year	Number of Individual	Number of firms	Number of Industries (3 digit)
1996	373,681	945	76
1997	400,271	960	81
1998	381,262	958	80
1999	390,187	989	78
2000	432,625	1327	85

Total number of observation: individual – year: 1,978,026.

Appendix 1.2. Descriptions on variables.

Variables	Descriptions
	Individual Characteristics
Gender	gender=1, Man; gender=0, Woman.
Age	Age = Current year minus birth Year .
Education1 – Education 6	Edu1: Education before-secondary school, less than 9 year. Edu2: Education before-secondary school, 9 years. Edu3: Secondary education. Edu4: Post-secondary education, less than 2 years. Edu5: Post-secondary education, 2 years and more. Edu6: Post-graduate education.
Profession 1- 9	Profession 0: Armed forces. Profession 1: Legislators, senior officials and managers. Profession 2: Professionals. Profession 3: Technicians and associate professionals. Profession 4: Clerks. Profession 5: Service workers and shop sales workers. Profession 6: Skilled agricultural and fishery workers. Profession 7: Craft and related trades workers. Profession 8: Plant and machine operators and assemblers. Profession 9: Elementary occupations.
Monthly wage(real)	Log(nominal monthly wage*100/ consumer price index),1990 as base year.
	Firm Characteristics
Firm Size	log (average employment).
Capital Intensity	Ratio of book-value capital stock (based on 1990's price) to employment.
Market Share	Ratio of firm's sales to industry's sales at 3-digit.
Profitability	Profitability1 = (Return to capital $_{t-2}$ + Return to capital$_{t-1}$ + Return to capital$_t$)/3. Profitability2 = [log (real accounting profit / employment)$_{t-2}$+ log (real accounting profit / employment)$_{t-1}$+ log (real accounting profit / employment)$_t$]/3
Relative TFP[29]	Relative TFP$_t$ = TFP for firm i / average TFP in industry k
	Industry Characteristics
Import penetration	Ratio of import to consumption.
Export Orientation	Ratio of export to total turnover.
Herfindahl index (H)	Sum of squared of market share at 3-digit level.
R&D intensity	Ratio of R&D investment to total turnover.

[29] Calculation of total factor productivity is present in Hansson and Lundin(2003), Appendix 2.2.

Appendix 2.1. Robustness specification1: market share.

	Dependent variable: monthly real wage in logarithm				
	1996	**1997**	**1998**	**1999**	**2000**
Individual control variables					
Gender	0.104 [9.31]	0.107 [15.18]	0.106 [15.20]	0.096 [12.00]	0.090 [12.92]
Age	0.021 [11.95]	0.019 [15.17]	0.019 [12.01]	0.018 [9.53]	0.018 [11.01]
Age x Age	-0.0002 [-11.21]	-0.0002 [-13.94]	-0.0002 [-11.15]	-0.0002 [-9.28]	-0.0002 [-11.02]
Edu2	0.052 [6.42]	0.053 [12.71]	0.056 [14.29]	0.045 [7.89]	0.038 [7.47]
Edu3	0.073 [7.07]	0.076 [12.63]	0.079 [13.08]	0.067 [8.08]	0.060 [7.65]
Edu4	0.100 [8.36]	0.104 [11.04]	0.122 [15.34]	0.114 [10.05]	0.121 [11.14]
Edu5	0.233 [16.34]	0.244 [19.65]	0.257 [23.82]	0.244 [16.45]	0.224 [14.59]
Edu6	0.427 [20.62]	0.440 [25.35]	0.440 [30.58]	0.430 [28.58]	0.424 [21.36]
Professions	Yes	Yes	Yes	Yes	Yes
Firm-level control variables					
Market Share	0.048 [1.67]	0.036 [1.70]	0.039 [0.90]	0.090 [3.25]	0.101 [4.41]
Capital intensity	0.028 [5.20]	0.027 [3.84]	0.023 [3.66]	0.029 [4.73]	0.020 [4.51]
Relative TFP	0.053 [1.40]	0.040 [1.61]	0.051 [2.44]	0.069 [3.01]	0.144 [4.77]
Profitability	-0.002 [-0.35]	0.0003 [5.19]	0.0007 [3.85]	-0.0020 [-0.46]	-0.0008 [-0.80]
Industry dummies	Yes	Yes	Yes	Yes	Yes
R^2	0.53	0.48	0.50	0.54	0.57
Observations	317962	316421	299761	329178	347353

Notes: Standard errors are adjusted both for heteroskedasticity and potential dependency among individuals working in the same industry at 3-digit. White's heteroskedasticity-consistent t-statistics are in brackets.

Appendix 2.2. Robustness specification 2: ln (profit/employee).

Dependent variable: monthly real wage in logarithm					
	1996	1997	1998	1999	2000
Individual control variables					
Gender	0.107 [9.05]	0.110 [20.16]	0.106 [14.15]	0.102 [14.23]	0.095 [13.62]
Age	0.021 [10.21]	0.020 [13.81]	0.019 [11.75]	0.019 [9.16]	0.019 [10.43]
Age x Age	-0.0002 [-9.42]	-0.0002 [-12.96]	-0.0002 [-11.02]	-0.0002 [-8.93]	-0.0002 [-10.83]
Edu2	0.052 [5.41]	0.054 [11.18]	0.056 [12.04]	0.050 [8.57]	0.039 [7.23]
Edu3	0.074 [6.03]	0.077 [11.63]	0.080 [11.96]	0.076 [9.03]	0.061 [7.81]
Edu4	0.102 [7.78]	0.106 [11.75]	0.121 [13.57]	0.120 [9.78]	0.121 [10.36]
Edu5	0.237 [15.15]	0.247 [23.36]	0.255 [22.13]	0.254 [16.89]	0.229 [15.03]
Edu6	0.430 [20.44]	0.447 [27.95]	0.436 [26.52]	0.437 [27.90]	0.426 [22.45]
Professions	Yes	Yes	Yes	Yes	Yes
Firm-level control variables					
Firmsize	0.005 [0.80]	0.013 [2.23]	0.019 [2.43]	0.024 [4.88]	0.017 [4.70]
Capital intensity	0.024 [3.23]	0.021 [3.35]	0.018 [2.39]	0.029 [4.34]	0.010 [1.71]
Profitability	0.003 [0.71]	0.001 [0.39]	0.001 [0.21]	0.009 [2.53]	0.019 [2.88]
Industry dummies	Yes	Yes	Yes	Yes	Yes
R^2	0.54	0.48	0.50	0.53	0.58
Observations	264172	253668	242492	256433	281968

Notes: Standard errors are adjusted both for heteroskedasticity and potential dependency among individuals working in the same industry at 3-digit. White's heteroskedasticity-consistent t-statistics are in brackets.