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Piero Esposito and Robert Stehrer

The Sector Bias of Skill-biased Technical Change and the Rising Skill Premium in Transition Economies

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The Sector Bias of Skill-biased Technical Change and the Rising Skill Premium in Transition Economies

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Contents

Abstract

In this paper we test the hypothesis that the sector bias of skill-biased technical change is important in explaining the rising relative wage of skilled workers in the manufacturing sector in three Central and Eastern European transition countries. The evidence for Hungary and Poland is consistent with the sector bias being important in explaining the rising wage premium; the hypotheses is however not confirmed for the Czech Republic.

Keywords: *C62, C68, F16, O33*

JEL classification: *skill premium, factor prices, biased technical change, transition*

The sector bias of skill-biased technical change and the rising skill premium in transition economies

1 Introduction

The rising relative demand for skilled labour in the 1990s in many of the advanced but also of the developing and catching-up countries has been debated in a number of contributions over the past decades (for overviews see Acemoglu, 2002; Feenstra and Hanson, 2001, where emphasis is either put on technological explanations or related to increased international integration and outsourcing in particular). The rising relative demand for skilled workers manifested itself either in higher relative wages of the skilled workers or in higher unemployment rates of the unskilled workers. The underlying reasons for that pattern, however, are still debated. For the Central and Eastern European countries, the main focus of the literature in explaining trends of relative demand for skills is on the effects of international integration via trade, foreign direct investment flows and outsourcing patterns. This was also the main focus of the first strand of the literature in the 1990s, which blamed increasing trade integration with less developed countries for the rising relative demand of skilled workers in the advanced economies, notably the USA. Following the Heckscher-Ohlin framework, the latter group of economies should specialize in skill-intensive goods (under the assumption of being the relatively skill abundant) which would result in rising relative wages for skilled workers via Stolper-Samuelson mechanisms. Important contributions in this respect are Wood (1997) and Leamer (1998). However, this view was criticized for various reasons: First, it is unlikely that - in particular for the US - relatively low trade volumes could explain the magnitude of the rise in the skill premium (see Lawrence, 1996). Second, Berman et al. (1994, 1998) have forcefully argued that mainly within- (rather than between-) industry shifts account for the rising relative demand for skilled workers; the between-shifts should, however, be the main reason for the changes in relative demand following the Heckscher-Ohlin-based explanations. A third point of criticism was that - as opposed to the Heckscher-Ohlin model - rising skill premium was also observed in the developing and catching-up economies (in particular Mexico as one of the main trading partners of the US); this was strongly argued by e.g. Feenstra and Hanson (1997). For a general review on such explanations based on international integration see Feenstra and Hanson (2001) already mentioned above. Based on these arguments it was debated whether skill-biased technical progress is important in explaining the rising relative demand for skilled workers. Focusing on technical change, it is important which type of technical change may be responsible for the rising skill premium, i.e. can the factor bias explain this phenomen (see e.g. Krugman, 2000; Acemoglu, 2002) or is it the factor bias of (skill-biased) technical change that is important, as e.g. argued in Kahn and Lim (1998) and Haskel and Slaughter (2002). This debate will be reviewed in the first part of the next section in more detail.

In this paper we address this issue and argue that the sector bias of skill-biased technical change is an important factor in explaining rising relative demand for skills in transition economies. To our knowledge, there exists no study on this topic for the transition economies of Central and Eastern Europe. That group of countries, however, is of special interest from this viewpoint as the countries have undergone rapid technical change absorbing Western technologies and have also experienced fast structural changes with respect to industrial patterns, driven partly by trade integration, foreign direct investment flows and outsourcing. In this paper we study the effects of skill- and sector-biased technical change on the relative wage of skilled workers for the three transition economies Czech Republic, Hungary, and Poland. We focus in particular on the hypothesis that the sector bias of skill-biased technical change is important in explaining the rising skill premium in these countries.

The paper is organized as follows. In the next section we first provide an overview of the literature with respect to the general debate about technology-based explanations of the rising skill premia in the 1980s and 1990s. In the second part of this section we briefly discuss the contributions on rising skill premia in Eastern European countries. In section 3 we first describe the evolution of the skill premium in the manufacturing sector of three Eastern European countries (the Czech Republic, Hungary and Poland) over the period 1995-2003 for which appropriate data are available. We then follow the approach used in Haskel and Slaughter (2002) to test for the effect of the sector bias of skill-biased technical change (SBTC) on the skill premium for the three countries in transition. The last section concludes.

2 Literature review

2.1 Biased technical change and wage premium

The causes underlying rising wages of skilled workers are still debated. However, there is a consensus that technical change is an important factor (Acemoglu, 2002) whereas increased international trade and 'globalization' is no longer considered to be of significance in (directly) explaining the rising relative demand for skilled workers. Other potential explanations - such as deunionization, slowdown of the rate of growth of higher-educated workers, organizational changes - are still under research and no general conclusion can so far be made based on the studies (see European Commission (2005) for a recent overview). On the other hand, the indicators of technology (R&D intensity, computerization, etc.) are strongly linked to within-sector shifts towards more skill-intensive production. In particular, the new information technologies and computerization of the economy are seen as being responsible for the rising skill intensity of employment via capital-skill complementarities (see Krussel et al., 2000, for a recent analysis). However, there are also a number of critical issues including measurement problems of technical change and wage inequality (on this see Card and DiNardo, 2002) and measures of skills (see e.g. Autor et al., 2003, on this) which has to be addressed in future research. Finally, the bulk of the studies focus on the US and the UK while only few studies exist for selected European countries. This last point has also been one motivation for this paper where we focus on three transition economies in Central and Eastern Europe.

The existing studies on rising wage dispersion in the Central and Eastern European countries mainly look at the effects of trade, foreign direct investment and outsourcing and are summarized in the next section. However, most of them focus on the skill bias of technical change by sector and thus highlight the importance of within-sectoral shifts of relative labour demand. For instance, Acemoglu (2002) uses a one-sector model to explain the effects of skill-biased technical change. Yet the sector bias of this skill-biased technical change may also be an important factor as relative price changes might incude changes in relative demand for goods. From a theoretical point of view Xu (2001) analyses the wage effects of sector- and factor-biased technical change in a model with two sectors and two factors; the effects on the relative wages depend on the specific elasticities of substitution. Similarly, Haskel and Slaughter (2002) argue that the sector bias plays an important role in explaining changes in wage differentials in the 1970s and 1980s. From an economic point of view, skill-biased technical change in a sector which is characterized by low skill intensity (high labour intensity) may induce a shift of demand towards this sector, leading to a fall (rise) in the skill premium. For this to happen the assumption of a high elasticity of substitution in demand (at least larger than one) is necessary. However, this assumption is even more satisfied when taking into account international trade and thus international substitution. That complex relationship of the relative importance of the factor versus sector bias of technical change has been studied in detail in Stehrer (2006) using a model with CES production and demand functions, two factors and a discrete number of sectors and countries integrated via trade flows.

The aim of the present paper is to study in which way the sector bias of skill-biased technical change is important in explaining the rising skill premium in three Central and Eastern European countries. In this analysis we basically follow Haskel and Slaughter (2002). Before going to the empirical sections, let us first review the literature on the rising wage dispersion between skilled and unskilled workers in the Central and Eastern European transition countries.

2.2 The skill premium in CEECs

The empirical literature on the wage premium in CEECs consists of a small, but growing number of articles. For an assessment during the initial phase of transition of the rising wage dispersion and income inequalities in general in the transition countries see e.g. Rutkowski (1996) and for trends over the 1990s see Rutkowski (2001).[1] Most of the previous empirical contributions aim at understanding the contribution of the transfer of technology from abroad mainly via FDI and outsourcing as well as changing patterns of specialization resulting from increased trade integration (see Skuratowicz, 2001; Egger and Stehrer, 2003; Bruno et al., 2004; Geishecker, 2004; Kataria and Trabold, 2004; Lorentowicz et al., 2005; Esposito, 2006). To our knowledge, there is only one study for Hungary which tries to directly estimate the impact of SBTC on the demand for inputs (Tarjáni, 2004). The results, with few exceptions, are in favour of a skill-biased effect of FDI, and there is evidence of a strong effect in the skill-intensive industries.[2] As for international outsourcing the evidence is mixed, depending both on the period and the country under analysis.

Among this strand of literature the first study is that of Egger and Stehrer (2003). They

[1] For an overview for OECD countries see Howell and Huebler (2001).

[2] See Kataria and Trabold (2004) for evidence on the electronics industry in Hungary.

analyse the effect of outsourcing and FDI on the relative wage bill between non-manual and manual workers in the Czech Republic, Hungary and Poland during the period 1993-1999. Outsourcing is proxied by trade in intermediate goods; for foreign direct investment the number of multinational enterprises is used. The authors' main finding is that both imports and exports of intermediate goods have a negative impact on the wage bill ratio; this leads to the conclusion that outsourcing in CEECs indeed uses unskilled workers more intensively and that it consits, to some extent, mainly of the production and export of intermediate goods made from raw materials. Bruno et al. (2004), analysing the same countries, investigate the effect of FDI penetration on the skilled labour share in the total wage bill in manufacturing between 1993 and 2001. Although they cannot find a direct impact of FDI on the labour demand shift, they argue that multinationals' activity contributed to the rise in the skill premium by fostering structural change and by helping to decompress the inherited rigid wage structure. In line with Egger and Stehrer (2003), they find a negative impact of final goods trade.[3] The results of these studies may be affected by the general imbalances of the first years after transition. Esposito (2006) exploits an updated version, up to 2004, of the panel used in the former two studies[4] and analyses the three countries separately. The focus is, as in Egger and Stehrer (2003), on the effect of outsourcing (proxied by trade in intermediate goods), final goods trade and foreign direct investment with the EU on the wage bill ratio of the three countries. The main finding is that the integration of production with the EU influenced the three economies in a different way. In Poland, the wage bill ratio is negatively affected by the exports of intermediates, while it is positively influenced by imports of final goods. At the same time there is a positive, but not significant effect of FDI. The latter variable exerts, by contrast, a significant impact on the other two countries. In the Czech Republic, foreign direct investment favours non-manual workers while the opposite is true for Hungary. In this country the wage bill ratio is also negatively influenced by the import of final goods and positively by the export of final goods. A more detailed skill classification is exploited in the paper of Geishecker (2004) where the impact of foreign direct investment and outsourcing on the demand for low-, medium- and highly skilled workers in seven Central and Eastern European countries is analysed. Foreign direct investment is found to negatively influence the demand for medium-skilled workers, while high- and low-skilled workers are positively

[3] Intermediate goods are not considered in the analysis.

[4] The sample included the period 1997-2003 for the Czech Republic, 1998-2004 for Hungary and 1996-2004 for Poland.

influenced. The effects are, however, not significant and the result is thus not consistent with an unequivocal technology spill-over effect biased towards skilled workers. On the other hand, international outsourcing proxied by trade in intermediate goods is found to have a skill-upgrading effect by raising the share of highly skilled workers and reducing that of medium-skilled ones.

A slightly different approach is taken by Lorentowicz et al. (2005) estimating a version of the Feenstra and Hanson (1997) model. Accordingly, they asses the impact of an increase in foreign capital stock, relative to the domestic one, on the skilled labour share in the total wage bill. After controlling for R&D and the privatization process, the authors find that FDI accounts for 34 per cent of the increase in the relative demand for skills and that the increase was partly due to technological upgrading. Imports, on the other hand, are found to favour manual workers by increasing their wage bill share. In an earlier paper, Skuratowicz (2001) tries to answer the same question by using a panel of regional data for the Polish industry over the period 1993-1998. Her conclusion, similarly to the other studies, is that FDI has a positive and significant impact on the skilled labour share in total industry's wage bill. In her framework, this also means that FDI contributes to the increase in inequality between regions.

Tarjáni (2004), already mentioned above, is the only to aim directly at estimating the effect of SBTC on skilled and unskilled workers in a Central and Eastern European transition economy. The focus is on Hungary between 1980 and 2002. The analysis is carried out, first, by assuming capital-skill complementarities, where capital equipments are complements with skilled labour and perfect substitutes with unskilled labour. The elasticity of substitution between inputs are calculated using a translog production function. The main result is that, both over the whole period and in a sub-sample from 1992, absolute capital-skill complementarity is rejected. Other findings are in favour of a relative capital-skill complementarity. In particular, over time skilled labour became less substitutable with unskilled labour. Furthermore the estimated elasticity between capital and skilled labour is lower than that of capital and unskilled labour. Thus the results confirm the existence of relative capital-skill complementarity and that technological developments in this period increased the demand for, and thus wages of, skilled relative to unskilled labour.

3 Empirical evidence

3.1 Data

The relevant data for this study are basically an update of the data already used in Egger and Stehrer (2003) and have been collected from various sources. The information on employment and wages of manual and non-manual workers has been taken from the Statistical Yearbooks of Hungary and Poland. The National Statistical Institute of the Czech Republic kindly provided us with data for more recent years. To eliminate breaks of employment levels in these series we combined these data with the wiiw Industrial Database[5], which provides smoother time series for the relevant variables. We used the non-manual to manual ratios or shares for a breakdown of employment and wage income as reported in the wiiw Industrial Database into these skill categories. Underlying data for capital stock and gross fixed capital formation of IT and CT assets have been provided by the National Statistical Institutes. These data have been collected and partly harmonized within the EUKLEMS project.[6] Missing data in 1995 have been imputed using trend growth rates. The industrial breakdown for Hungary and Poland is at the NACE 2-digit level (NACE categories 15-37), whereas for the Czech Republic data are available at a higher level of aggregation at the alphanumerical codes DA-DN (see Appendix Table A.1 for a list of these industries). In this paper we also aggregated data for Hungary and Poland to this level to allow for a better comparison over countries.[7] In total, this provides us with a panel of data for fourteen industries, over the period 1995-2003, for three transition economies (the Czech Republic, Hungary and Poland) with all the relevant variables.

3.2 Descriptive statistics

Let us first discuss the most important country and industry differences in skill intensities and relative wages. Figures 3.1 to 3.3 present the mean over 1995-2003 of the skill intensities, the relative wage of non-manual workers and the relative wage bill of non-manual to manual workers.

Seemingly, there are some, if relatively small differences across countries. The skill intensity is on average relatively higher in the Czech Republic, followed by Poland and then Hungary. This

[5]See www.wiiw.ac.at.

[6]See www.euklems.org for further information.

[7]The conclusions from the econometric results do not change when using the more disaggregate level of industries for Hungary and Poland.

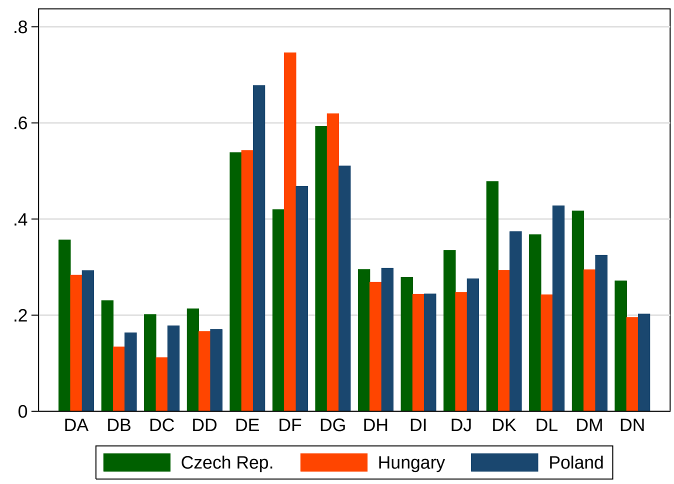

Figure 3.1: Mean of skill intensity

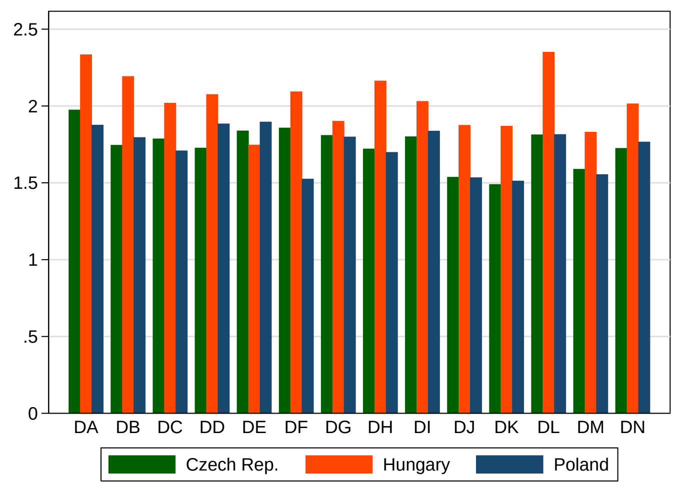

Figure 3.2: Mean of relative wage

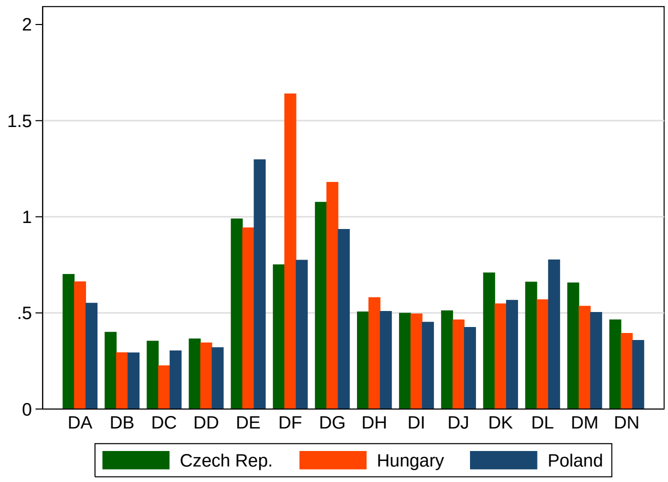

Figure 3.3: Mean of wage bill

is true for all industries with the exceptios of pulp and paper (DE), coke (DF) and chemicals (DG) where Hungary shows the highest skill intensity, and electrical and optical equipment (DL) where Poland ranks first. However, there is a clear industry pattern across countries with pulp and paper (DE), coke (DF) and chemicals (DG) showing the highest skill intensities, and textiles (DB), leather (DC) and wood and wood products (DD) the lowest. This pattern remains relatively stable over time as discussed below. Figure 3.2 presents the mean over the period covered of relative wages; here one can find some differences across countries in the respective levels. The skill premium is higher in Hungary on average and is similar in the Czech Republic and Poland. In all cases the skill premium is 1.5 and 2 for the Czech Republic and Poland, and between 1.75 and 2.4 for Hungary. These two variables together determine the relative wage bill which - as relative wages are similar across industries - follows the pattern of skill intensities (scaled up by relative wages) as can be seen in Figure 3.3.

In this paper we are, however, more interested in the changes over time, which are graphically presented for these three variables in Figures 3.4 to 3.6, showing the difference of the respective variable between 1995 and 2003 (in the case of Poland and Hungary between 1997 and 2003 for the coke and petroleum industry). Strikingly, skill intensities were rising dramatically in the industries pulp and paper (DE), coke, refined petroleum and nuclear fuel (DF), and chemical and chemical products (DG), particularly so in Hungary and even more so in Poland. Skill intensities were also rising in basic metals (DJ), machinery and equipment (DK) and electrical

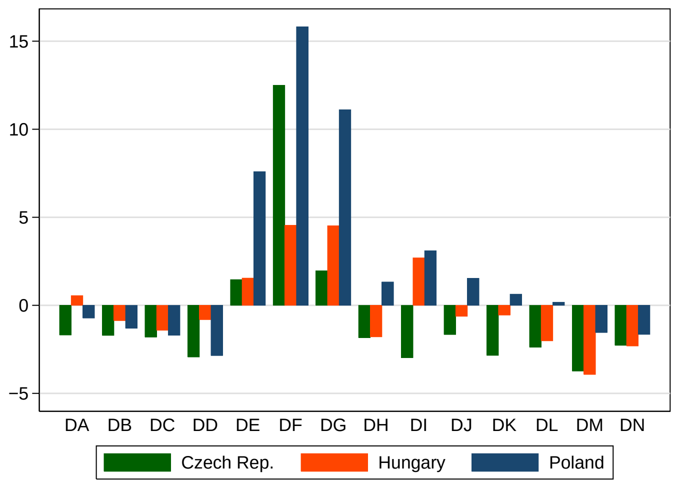

Figure 3.4: Change in skill intensity

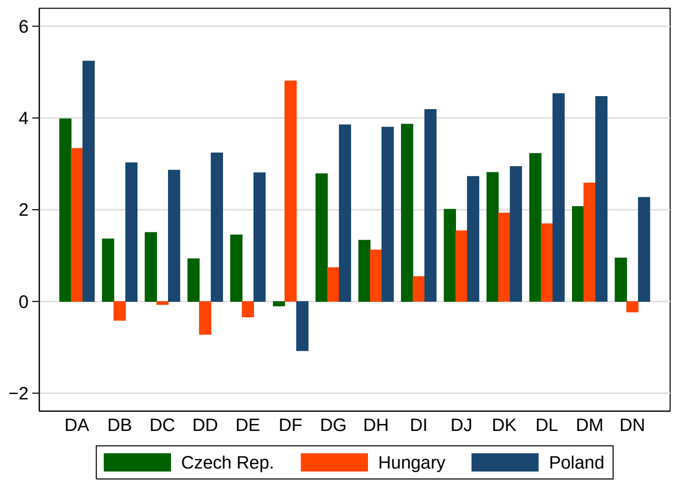

Figure 3.5: Change of relative wage

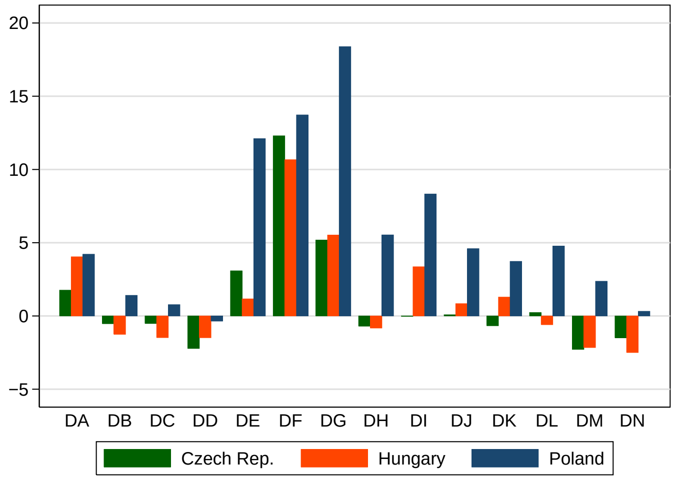

Figure 3.6: Change in relative wage bill

and optical equipment (DL) in Poland, and in food products, beverages and tobacco (DA) and other non-metallic mineral products (DI) in Hungary; in all other cases the skill intensity was declining. In general, skill intensities have been rising in the most skill-intensiv sectors, have been falling most strongly in the industries with intermediate skill intensities, and show the smallest change in industries with the lowest skill intensities. Relative wages were rising in general, in Poland between 2 and 4 per cent per year (the only exception is coke and petrolem, DF, where the skill premium was falling). Similarly, the relative wage was also rising in the Czech Republic, albeit to a lesser extent, between 1 and 4 per cent. Hungary shows the smallest changes in the skill premium (the only exception is the coke and petroleum industry, DF). In interpreting the movements of these variables in Central and Eastern European countries, there is an important point to be stressed. The restructuring process was not completed in 1995. In particular, the skill intensities at the beginning at the 1990s were relatively high, which induced labour shedding of former administrative personnel. Especially in the Czech Republic this restructuring process seems to have started later compared to the other countries.

Skill intensities may change either due to factor-biased technical change or because of changes in the relative wage (a shift along the isoquant). Using the definition of the relative wage bill, $b = \frac{w_s}{w_u}\frac{l_s}{l_u}$, we can express it in terms of logarithmic changes, $\hat{b} = \hat{\omega} + \hat{l}$. Here, $\hat{b} > 0$ indicates skill-biased technical change. A proxy for this is shown in Figure 3.6 where we calculated the percentage change of the wage bill for the period 1995-2003. The evidence for skill-biased technical change is mixed. In Poland we find strong evidence for skill-biased technical change with the only exception of wood and wood products (DD); the skill-biased nature of technical change is also more pronounced in the high- and medium-skill-intensive sectors. The Czech Republic and Hungary show more similar patterns with the skill bias less important in general. This is particularly true for the Czech Republic, where the relative wage bill was strongly increasing only in coke and petroleum (DF) and chemicals (DG), but less so in food and food products (DA) and pulp and paper (DE); in the other industries the change was almost zero or even negative. In Hungary the relative wage bill is more often increasing, but also falling in some industries, in particular again in textiles (DB), leather (DC) and wood and wood products (DD). From this we can conclude that, first, skill-biased technical change was not a general pattern although it is the prominent one; second, skill-biased technical change is more pronounced in the industries characterized above as skill-intensive. This latter point underlines the importance of the sector bias of (skill-biased) technical change and shall be addressed econometrically in the next subsection.

Finally, let us present the relative importance of these sectors. We do this in terms of employment as this variable is used later on to estimate the model by weighted least squares. Figure 3.7 shows the mean of employment shares over time. The most skill-intensive sectors

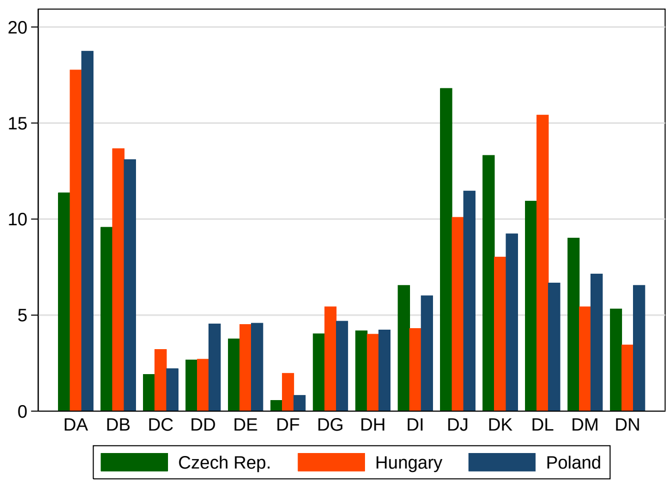

Figure 3.7: Mean of employment shares

- pulp and paper (DE), coke and petroleum (DF) and chemicals (DG) - make up only a low proportion whereas the medium-skill-intensive industries dominate. Only industry DA, which can be characterized as low-skill-intensive, shows a relatively high proportion with up to nearly 20 per cent in Hungary and Poland.

3.3 Measuring skill-biased technical change

3.3.1 Econometric model

Following Haskel and Slaughter (2002) we estimate the equation

$$\Delta\omega_j = a_0 + a_1 \Delta \ln \frac{w_{js}}{w_{ju}} + a_2 \Delta \ln \frac{K_j}{Y_j} + \varepsilon_j \tag{3.1}$$

where $\Delta\omega_j$ denotes the level change in the non-manual labour share of the total wage bill; K denotes capital and Y is industrial production at constant prices as described above. ε_k denotes an additive error term. This specification assumes that capital is a quasi-fixed factor in each sector and that the industry minimizes the cost of skilled and unskilled labour according to a translog production function with constant returns to scale. This equation was introduced in Binswanger (1974) and Berndt and Wood (1982) and is commonly used in the literature.

In a first step we pool all sectors and estimate equation (3.1). A variation in ω_j not explained by $\Delta \ln \frac{w_{js}}{w_{ju}}$ and $\Delta \ln \frac{K_j}{Y_j}$ is usually attributed to skill-biased technical change. The coefficient a_1 is either positive or negative, depending on σ_i being below or above one. Further, a positive coefficient a_2 indicates capital-skill complementarity. a_0 then measures the cross-sector average of SBTC whereas $(a_0 + \varepsilon_j)$ is the sector-specific SBTC and consequently the vector $(a_0 + \varepsilon_j)$. A larger value indicates a higher degree of SBTC.

In a next step we regress SBTC on the initial skill intensity $(S/U)_j$:

$$SBTC_j = \alpha + \beta_{BIAS} \frac{S_j}{U_j} + u_j \tag{3.2}$$

and compare the coefficient β_{BIAS} with the actual change in the skill premium. If the sector-bias hypothesis is the relevant one, then one expects a positive parameter, $\beta_{BIAS} > 0$, with rising skill premium, and a negative parameter, $\beta_{BIAS} < 0$, with falling skill premium. This pattern would be consistent with the hypothesis that the sector bias of SBTC explains the changes in wage patterns.

We have estimated various models for robustness checks, basically following the specifications in Haskel and Slaughter (2002) which we shortly describe here; the results are discussed in the next section. In the first specification we estimated equation (3.1) and use the variation not explained by $\Delta \ln(w_s/w_u)$ and $\Delta \ln(K/Y)$ as a measure of SBTC, i.e. $(a_0 + \varepsilon_j)$; a_0 measures the average of SBTC and ε_j the sector-specific part. In the second specification we excluded $\Delta \ln \frac{w_{js}}{w_{ju}}$ from equation (3.1) as this might reflect unobserved skill-mix differences rather than exogenous wage differences. In this case SBTC is measured as ε_j only as a_0 accounts for wage changes which are common to all sectors. Next we again exlcuded $\Delta \ln(w_s/w_u)$ from equation (3.1) but include dummies for two groups of industries (dividing the sample into the less skill-intensive industries DB, DC, DD and DN, on the one hand, and the remaining more skill-intensive industries, on the other). This allows for greater cross-section variation in production techniques across sectors. The measure of SBTC is again ε_j. In specification (4) we add the IT&CT investment (i.e. gross fixed capital formation) to output ratio to equation (3.1) where we used the average of the ratio of gross fixed capital formation in IT and CT assets to output over the period 1995-2003. This assumes that investment in IT and CT causes SBTC. For Poland these asset types are not available; in this case we used the stock of 'Machinery' relative to output.[8] The measure of SBTC is then the IT&CT regressor times the estimated coefficient. Finally, we directly use $\Delta(w_s/w_u)$ as a measure of the skill bias; thus results appear only when reporting estimation of equation (3.2). In the Appendix we further present results using yearly changes and including time dummies in specifications (1), (2) and (4).

Each of these specifications have been estimated applying weighted least squares using sector employment averaged over the period as weights. In all cases we applied robust estimation procedure, i.e. the statistics are based on White's heteroskedasticity robust standard errors. We also calculated corrected standard errors following the methodology in Feenstra and Hanson (1999)[9] for β_{BIAS} in cases where the regressand in equation (3.2) was calculated using regression coefficients from equation (3.1) as in these cases the errors are correlated across observations. However, in these cases the coefficients became insignificant or the correction procedure resulted in singular matrices due to the low number of observations. As the results in all specifications are quite homogenous, we report the estimation results without applying this correction procedure. We also tested a number of other specifications confirming the results presented here.

[8] We also tried to use Machinery for the Czech Republic and Hungary. In the case of the Czech Republic the cofficient is insignificant as it is for IT & CT investment; for Hungary the coefficient is positive and significant at the 10 per cent level. The results for the bias in equation (3.2) are only slightly different. Thus we conclude that Machinery may not be a good proxy for IT & CT investments.

[9] We would like to thank Robert C. Feenstra and G.H. Hanson for providing us with the details of this procedure.

3.3.2 Results

The results of these estimations are presented in Tables 3.1 for equation (3.1) and Table 3.2 for equation (3.2), respectively. Tables A.2 and A.3 in the Appendix show the same specifications based on annual data including time dummies. A change in the relative wage is in all cases

	(1)	(2)	(3)	(4)
Czech Republic				
Δ Relative wage	0.162 *			0.125
	(0.078)			(0.235)
Δ Capital-output ratio	0.032	0.026	0.042	0.046 *
	(0.144)	(0.277)	(0.103)	(0.090)
IT&CT-output ratio				6.717
				(0.123)
Constant	-0.023	0.005	0.014	-0.044 **
	(0.202)	(0.592)	(0.221)	(0.039)
F	2.819	1.296	4.721	1.970
R^2	0.175	0.065	0.233	0.280
Obs.	14	14	14	14
Hungary				
Δ Relative wage	0.238 ***			0.402 ***
	(0.006)			(0.000)
Δ Capital-output ratio	0.040 ***	0.030	0.055 **	0.096 ***
	(0.010)	(0.119)	(0.011)	(0.000)
IT&CT-output ratio				21.108 ***
				(0.000)
Constant	0.042 *	0.053	0.102 ***	0.025 **
	(0.083)	(0.152)	(0.004)	(0.022)
F	14.682	2.861	13.483	87.877
R^2	0.454	0.142	0.659	0.829
Obs.	13	13	13	13
Poland				
Δ Relative wage	0.256			0.203
	(0.356)			(0.475)
Δ Capital-output ratio	-0.027	0.007	0.025	-0.032
	(0.604)	(0.725)	(0.508)	(0.569)
IT&CT-output ratio				0.979
				(0.180)
Constant	0.000	0.064 ***	0.083 ***	-0.030
	(0.997)	(0.000)	(0.000)	(0.670)
F	0.890	0.130	10.582	1.853
R^2	0.062	0.001	0.420	0.162
Obs.	13	13	13	13

Notes: p-values in brackets; ***, **, * denote significance at the 1, 5, and 10 % level.

Table 3.1: Regression results of (3.1) using weighted least squares over period 1995-2003

positively related to the change in the relative wage bill suggesting an elasticity of substitution smaller than one. This is significant for the Czech Republic for the first specification only, for

Hungary for all specifications. For Poland the estimates are positive but not significant.

When estimating the panel over years (see Table A.2 in the Appendix) the coefficients become insignificant for Hungary, but are highly significant for the Czech Republic and in this case also for Poland in all specifications. The change in the capital-output ratio controls for capital-skill complementarity and is positively significant in the case of Hungary in all specifications apart from (2), and significant at the 10 per cent level for the Czech Republic when simultanously including the IT&CT-output ratio. In Poland the coefficients are again insignificant in all cases, but become significant when using yearly data. Finally, the IT&CT-output ratio is significant only for Hungary. Summarizing, the results suggest that technical change has a skill-biased nature in all countries (when also taking into account the results from using yearly data). Capital-skill complementarity was found to be significant only in Hungary.

Using these results we construct a measure for skill-biased technical change as outlined above. The resulting measures of SBTC are in all cases highly correlated. Except for the fourth measure, the correlation is in nearly all cases in between 0.80 and 0.99 for all countries, whereas in specification 4 it ranges from 0.2 to 0.6. This suggests that the latter measure of SBTC is not a good proxy as a direct measure of SBTC in the transition economies as compared to other ones. Thus we consider the results from this measure less reliable. Considering the sectoral distribution of SBTC, it is high and positive in the more skill-intensive industries. In Hungary and Poland also the medium-skill industries experienced a positive, although low, SBTC, while in the Czech Republic, and in the low-tech branches in all countries, SBTC is zero or even slightly negative.

The most important results with respect to the sector-bias hypothesis are presented in Table 3.2 and Appendix Table A.3 based on yearly data. These tables report the results of estimating equation (3.2) where the skill bias variables were constructed as described above. There is strong evidence that the sector bias of skill-biased technical change is important in explaining the increase in the skill premium in Hungary and Poland. The positive sign of the parameter indicates that the skill-biased technical change is concentrated in the skill-intensive sectors, which thus confirms the hypothesis of the importance of the sector bias. In Hungary the skill bias parameter is significantly positive in all specifications apart from (3). This, together with the results from the first equation, suggests that capital-skill complementarity was important in the high-skill sectors. For Poland the results are somewhat surprising given the poor performance of the estimations of equation (3.1). Nonetheless, the resulting measure for the skill bias are

	(1)	(2)	(3)	(4)	(5)
Czech Republic					
Bias	0.114	0.143	0.059	0.073 **	0.131
	(0.254)	(0.135)	(0.560)	(0.016)	(0.177)
Constant	-0.064 **	-0.052 *	-0.021	0.004	-0.047
	(0.045)	(0.078)	(0.498)	(0.662)	(0.119)
F	1.433	2.563	0.359	7.903	2.060
R^2	0.145	0.203	0.042	0.368	0.159
Obs.	14	14	14	14	14
Hungary					
Bias	0.159 ***	0.191 ***	0.036	0.202 ***	0.194 ***
	(0.000)	(0.003)	(0.432)	(0.004)	(0.002)
Constant	-0.001	-0.051 ***	-0.010	0.022	-0.039 **
	(0.952)	(0.009)	(0.467)	(0.372)	(0.023)
F	33.255	13.835	0.665	12.903	16.223
R^2	0.416	0.382	0.035	0.372	0.340
Obs.	13	13	13	14	13
Poland					
Bias	0.316 ***	0.340 ***	0.169 *	0.022	0.339 ***
	(0.001)	(0.001)	(0.095)	(0.388)	(0.001)
Constant	-0.096 ***	-0.103 ***	-0.051 *	0.038 ***	-0.038 *
	(0.000)	(0.000)	(0.091)	(0.003)	(0.094)
F	18.523	19.339	3.334	0.801	19.322
R^2	0.595	0.649	0.275	0.025	0.642
Obs.	13	13	13	14	13

Notes: p-values in brackets; ***, **, * denote significance at the 1, 5, and 10 % level.

Table 3.2: Regression results of (3.2) using weighted least squares over period 1995-2003

significantly positively related to sectoral skill intensity. This is also the case for specification (5) where we used the direct measure $\Delta(w_s/w_u)$ as a measure of the skill bias. The sector-bias hypothesis is also confirmed when using yearly data as shown in the Appendix tables. For the Czech Republic a significant result is only found for specification (4) which uses the IT&CT-output ratio in constructing the skill bias measure. This suggests that IT&CT seems to be concentrated in skill-intensive sectors, explaining the rising skill premium. Again the results are highly significant when using yearly data as shown in Appendix Table A.3. In summary, the results confirm the hypothesis that the sector bias of skill-biased technical change is an important factor in explaining the rising relative wage of skilled workers in the transition countries.

4 Concluding remarks

This paper addressed the issues, first, whether technical change was skill-biased and, second, whether the sector bias of skill-biased technical change (SBTC) - i.e., the concentration of technical change in the skill-intensive sectors - is important in explaining the rising relative wages of skilled workers in transition countries over the period 1995-2003. To our knowledge, this hypothesis has so far not been tested for Central and Eastern European transition economies. Based on data collected from national statistical sources, we tested the sector-bias hypothesis for the Czech Republic, Hungary and Poland. First, we find evidence that technical change was skill-biased in most cases. Capital-skill complementarity in explaining the increase in the wage bill share of skilled workers was mainly important in the case of Hungary only. The sector-bias plays an important part in explaining the rising skill premium in Hungary and Poland, however, the sector-bias hypothesis is not confirmed in the case of the Czech Republic. Thus, for Hungary and Poland skill-biased technical change was concentrated in skill-intensive industries, which helps to explain the rising skill premium in these countries. There is less evidence for this in the case of the Czech Republic.

A Tables

NACE 2-digit	Code	Industry	
15,16	DA	Food products, beverages and tobacco	Medium
17,18	DB	Textiles and textile products	Low
19	DC	Leather and leather products	Low
20	DD	Wood and wood products	Low
21,22	DE	Pulp, paper, paper products; printing and publishing	High
23	DF	Coke, refined petroleum products and nucelar fuel	High
24	DG	Chemicals, chemical products and man-made fibres	High
25	DH	Rubber and plastic products	Medium
26	DI	Other non-metallic mineral products	Medium
27,28	DJ	Basic metals and fabricated metal products	Medium
29	DK	Machinery and equipment n.e.c	Medium
30,31,32,33	DL	Electrical and optical equipment	Medium
34,35	DM	Transport equipment	Medium
36,37	DN	Manufacturing n.e.c.	Low

Table A.1: List of industries

	(1)	(2)	(1a)	(2a)	(3)	(4)	(4a)
Czech Republic							
Δ Relative wage	-0.076		-0.031			-0.076	-0.032
	(0.215)		(0.639)			(0.219)	(0.637)
Δ Capital-output ratio	0.011	0.013	0.012	0.014	0.017	0.011	0.012
	(0.334)	(0.269)	(0.527)	(0.474)	(0.415)	(0.360)	(0.541)
IT&CT-output ratio						-0.141	-0.069
						(0.836)	(0.923)
Constant	0.002	0.000	0.013 ***	0.013 ***	0.009 *	0.002	0.013 ***
	(0.396)	(0.942)	(0.000)	(0.000)	(0.070)	(0.465)	(0.001)
F	1.176	1.233	3.537	3.741	3.316	0.788	3.256
R^2	0.045	0.014	0.164	0.159	0.170	0.046	0.164
Obs.	112	112	112	112	112	112	112
Hungary							
Δ Relative wage	0.203 ***		0.203 ***			0.203 ***	0.203 ***
	(0.000)		(0.000)			(0.000)	(0.000)
Δ Capital-output ratio	0.021 ***	0.023 ***	0.031 ***	0.039 ***	0.045 ***	0.022 ***	0.034 ***
	(0.000)	(0.006)	(0.001)	(0.006)	(0.002)	(0.000)	(0.000)
IT&CT-output ratio						0.303	0.470
						(0.604)	(0.400)
Constant	0.003 ***	0.006 ***	0.005	0.012 **	0.016 ***	0.002	0.004
	(0.008)	(0.004)	(0.251)	(0.044)	(0.004)	(0.364)	(0.366)
F	31.478	7.859	10.086	4.884	7.638	21.960	9.522
R^2	0.417	0.101	0.490	0.219	0.285	0.419	0.495
Obs.	110	110	110	110	110	110	110
Poland							
Δ Relative wage	0.243 ***		0.220 ***			0.239 ***	0.217 ***
	(0.000)		(0.000)			(0.000)	(0.000)
Δ Capital-output ratio	0.001	0.015	-0.004	0.001	0.005	0.000	-0.007
	(0.958)	(0.569)	(0.809)	(0.961)	(0.840)	(0.990)	(0.714)
IT&CT-output ratio						0.078 *	0.062
						(0.075)	(0.163)
Constant	0.000	0.008 ***	0.001	0.006 **	-0.001	-0.003	-0.001
	(0.794)	(0.000)	(0.660)	(0.032)	(0.727)	(0.228)	(0.532)
F	20.485	0.326	12.484	2.905	4.206	15.356	10.618
R^2	0.354	0.009	0.452	0.221	0.306	0.367	0.460
Obs.	110	110	110	110	110	110	110

Notes: p-values in brackets; ***, **, * denote significance at the 1, 5, and 10 % level respectively.

Table A.2: Regression results of (3.1) using weighted least squares for yearly changes

	(1)	(2)	(1a)	(2a)	(3)	(4)	(4a)	(5)
Czech Republic								
Bias	0.037 ***	0.038 ***	0.036 ***	0.036 ***	0.025 *	-0.001 ***	-0.001 ***	0.036 ***
	(0.004)	(0.004)	(0.007)	(0.007)	(0.054)	(0.000)	(0.000)	(0.007)
Constant	-0.011 **	-0.014 ***	0.001	-0.012 **	-0.009	0.000	0.000	0.001
	(0.022)	(0.008)	(0.907)	(0.029)	(0.131)	(0.517)	(0.517)	(0.852)
F	8.470	8.659	0.993	0.994	0.486	7.923	7.923	4.093
R^2	0.057	0.058	0.056	0.057	0.029	0.319	0.319	0.200
Obs.	112	112	112	112	112	112	112	112
Hungary								
Bias	0.020 *	0.026 **	0.019 **	0.025 **	0.011	0.003 ***	0.004 ***	0.026 **
	(0.058)	(0.027)	(0.044)	(0.018)	(0.299)	(0.000)	(0.000)	(0.014)
Constant	-0.002	-0.007 **	-0.001	-0.007	-0.003	0.000	0.000	-0.008 *
	(0.381)	(0.029)	(0.843)	(0.135)	(0.483)	(0.300)	(0.300)	(0.076)
F	3.664	5.045	0.567	0.770	0.144	6.403	6.403	4.782
R^2	0.065	0.072	0.071	0.079	0.017	0.310	0.310	0.196
Obs.	110	110	110	110	110	112	112	110
Poland								
Bias	0.040 ***	0.040 ***	0.039 ***	0.040 ***	0.020 **	0.001 *	0.001 *	0.040 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.026)	(0.081)	(0.081)	(0.000)
Constant	-0.012 ***	-0.012 ***	-0.012 ***	-0.013 ***	-0.006 *	0.003 ***	0.002 ***	-0.007 *
	(0.000)	(0.001)	(0.001)	(0.001)	(0.095)	(0.000)	(0.000)	(0.071)
F	21.985	17.618	2.910	2.560	0.681	1.796	1.796	5.139
R^2	0.196	0.129	0.222	0.161	0.045	0.093	0.093	0.346
Obs.	110	110	110	110	110	112	112	110

Notes: p-values in brackets; ***, **, * denote significance at the 1, 5, and 10 % level respectively.

Table A.3: Regression results of (3.2) using weighted least squares for yearly changes

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