MAGYAR TUDOMÁNYOS AKADÉMIA
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INSTITUTE OF ECONOMICS
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ESTIMATING SOME LABOUR MARKET IMPLICATIONS OF SKILL BIASED TECHNOLOGY CHANGE AND IMPORTS IN HUNGARY

HAJNALKA TARJÁNI

Magyar Tudományos Akadémia
Közgazdaságtudományi Intézet

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Author: Hajnalka TARJÁNI, MTA Közgazdaságtudományi Intézet, 1112 Budapest, Budaörsi u. 45., E-mail: htarjani@econ.core.hu

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ESTIMATING SOME LABOUR MARKET IMPLICATIONS OF SKILL BIASED TECHNOLOGY CHANGE AND IMPORTS IN HUNGARY

BY

HAJNALKA TARJÁNI

Abstract

This paper examines the influence of capital accumulation and imports on the relative demand for skilled and unskilled labour in Hungary between 1980 and 2002. Historical data shows that both relative employment and wages of skilled labour were favourably influenced by the changes of the past decades, when the transformation of the Hungarian economy from a centrally planned to a market led regime took place. The paper studies whether these effects were similar to those observed in the international literature in the context of developed and less developed economies. Besides facilitating international comparisons, examination of factor demand functions also aims to complement existing results from the Hungarian literature.

JEL classification: F16, J31
Keywords: Trade and Labor Market Interactions, Wage Differentials by Skill

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TARJÁNI HAJNALKA

A SZAKKÉPZETTSÉG-INTENZÍV TECHNOLÓGIAI VÁLTOZÁS ÉS AZ IMPORT HATÁSA A MAGYAR MUNKAERŐPIACRA

Összefoglaló

A tanulmány azt vizsgálja, hogy milyen hatással volt a tőkeállomány bővülése és az import a szakképzett és szakképzetlen munkaerő relatív keresletére Magyarországon 1980 és 2002 között. A történelmi adatok azt mutatják, hogy az elmúlt évtizedek, melyek során a gazdasági rendszerváltás lezajlott, a szakképzett munkaerő viszonylatában kedvezően befolyásolták mind a relatív foglalkoztatást, mind pedig a relatív béreket. A tanulmány célja annak elemzése, hogy ezek a hatások mennyiben felelnek meg a nemzetközi irodalom fejlett és fejlődő országok esetében is dokumentált eredményeknek. A nemzetközi összehasonlításon kívül, a tanulmány a magyar szakirodalom kapcsolódó eredményeinek kiegészítésére is szolgál.

Kulcsszavak: a kereskedelem és a munkaerőpiac kölcsönhatásai, szakképzettség alapú bérkülönbségek

INTRODUCTION

The fact that economic processes in Hungary favoured skilled labour relative to unskilled labour in the past decades is well documented in the literature. Historical data shows a significant increase in relative employment and wages of skilled labour. The main reason behind these tendencies is that demand conditions for the different types of labour have changed. (Kertesi and Köllő, 2000, Kézdi 2002) The international literature identifies two factors as major determinants of these changes.

Skill biased technology change (SBTC) impacts the demand side of the labour market in such a way, that both the relative supply and relative wages of skilled labour may increase at the same time. The introduction of new, technologically more advanced capital goods entails structural changes in labour demand, as more skilled or better-educated workers are needed to operate machinery and equipment. Many attempts have been made in the literature to explore the possible causes of SBTC but there is no standard theory to interpret the mechanism. A possible way to explicitly represent and examine SBTC in the production function is through the mechanism of capital-skill complementarity. This was first formalised by Griliches in (1969) and many studies since have provided evidence for it as well as against it (See for example Berman et al., 1998, Card and DiNardo, 2002, DeSantis, 2002, Fallon and Layard, 1975, Goldin and Katz, 1996, Haskel and Slaughter, 1999, Juhn et al., 1993)

Increasing imports may also influence relative employment and wages of skilled and unskilled labour through output substitution and downstream processing of imports. Given this framework, it is assumed hat developing countries are relatively abundant in unskilled labour thus tend to export goods that are intensive in unskilled labour. Increasing imports from less developed countries decrease production in unskilled labour intensive industries in the developed country and there is a general shift in production towards sectors that are intensive in skills rather than in physical labour. This increases demand for skilled labour while employment and wages of unskilled labour decrease. Feenstra and Hanson (2001) provide a review of studies that estimate the importance of these effects.

In most cases, effects of downstream processing are not discussed in studies analysing the effects of imports. However, imported goods may require further processing, handling and distribution activities on the domestic market. These additional activities may also generate domestic employment for skilled and unskilled labour.

There is an extensive range of literature examining the effects of capital accumulation and increased imports on the labour markets in both developed and less developed countries. (Bound and Johnson, 1992, Chennells and Reenen, 1999, Feenstra and Hanson, 2001) The question is whether technological development and trade liberalisation had similar effects on the labour market in a transition economy to those observed in developed countries. Empirical evidence from Hungary reveals that both relative employment and relative wages of skilled labour changed favourably during the transformation of the economy. At the same time, historical data shows a significant increase in capital accumulation and imports on the factor markets. Although these data suggests that capital accumulation and imports affected the labour markets in a similar way, the pace and pattern of the changes might have been different in a transition environment.

Many studies, like Ábrahám and Kézdi, (2000), Fazekas (2003), Köllő (2002), Kőrösi (1998, 2002) examine different aspects of the relationship between the transformation of the economy and the evolution of demand and wages of labour in the Hungarian context. A study by Egger and Stehrer (2003) investigates the effect of increasing imports on the skill premium in Poland, The Czech Republic and Hungary and conclude that increased trade of intermediate products between the EU and Hungary resulted in a 38 percent decrease in the growth rate of the skill premium annually. Regarding the effects of technology, Kézdi (2002) provides evidence that SBTC took place in Hungary, particularly in the second phase of the transition. Kertesi and Köllő (2002) estimate a translog cost function on panel data from 1993 to 1999 to examine – among other things – capital-skill complementarity. Their main conclusion supports *relative* capital-skill complementarity as the elasticity of substitution between capital and unskilled labour is higher than that of capital and skilled labour.

The literature However lacks a comprehensive and simultaneous estimation of the effects of capital accumulation and imports in Hungary. The purpose of this study is to analyse the role of these factors in changing demand for skilled and unskilled labour, enabling comparisons with both developed countries and other transition economies.

ANALYTICAL FRAMEWORK

The analysis is based on a production theory approach, in which imports are treated as inputs for production. This ensures that the potential employment generating effects of downstream processing are also included in the analysis. In order to analyse the factors behind changing relative employment, a cost function setting is implemented, assuming that the cost function is well defined for all nonnegative input quantities and positive input prices, nonnegative, non-decreasing, concave and homogeneous of degree on in input prices and output. Through the application of Shepard's Lemma, the system of cost minimising direct input demand equations can be derived and effects of price changes on quantities can be examined.

The specification of the model is based on a more recent element in the family of flexible functional forms, the symmetric normalised quadratic (SNQ) or symmetric generalised McFadden function, introduced by Diewert and Wales (1987, 1988). Although this model is considerably more complex than the translog specification, the SNQ still might be preferable as global curvature conditions can be imposed on the system without endangering the flexibility of the function. Estimates of demand elasticities from the SNQ yield credible results even after curvature reinforcing reparametrisation. (Kohli, 1991, Tombazos 2003a)

The SNQ cost function is extended to include the effects of imports and technological change at the same time. Technological change is captured partially by capital accumulation, as new equipment is embodied in new capital goods, and by a factor which indicates technological change invoked by the passage of time as in Kohli (1991, 1994) and Tombazos (1998, 1999, 2003a). This is done through the application of a four-factor cost function including capital, skilled and unskilled labour and imports as inputs of production:

$$c = \sum_j \alpha_j \cdot w_j + \frac{1}{2}\sum_j \sum_i b_{j,i} \cdot \frac{w_j \cdot w_i}{\sum_j \beta_j w_j} + \sum_j \delta_j \cdot w_j \cdot t + \frac{1}{2}\beta_j w_j \cdot \delta_{tt} \cdot t^2 \qquad (1)$$

where c is the per unit cost of output, w_j is the price of input j, $\alpha, \beta,$ and b are the parameters of estimation. General characteristics of the cost function of linear homogeneity of degree one in prices and symmetry apply to equation (1). Additional restrictions on the parameters require that $\Sigma_j b_{ji} = 0$ and that $b_{ji} = b_{ij.}$ Values of the β_j parameters are required to be nonnegtive, and their sum must be equal to one. Its values are normally selected arbitrarily, either by setting it equal to the sample midpoint value of output, or by normalising by the number of inputs. (Kohli, 1991) In this case, it means setting the value of β equal to $1/4^{th}$. Characteristics of monotonicity and concavity do not necessarily hold, therefore it needs to be checked whether the parameter estimates fulfil these criteria. Concavity requires the matrix of b_j parameter estimates be negative semidefinite. In case concavity does not hold, this property can be imposed on the function globally, without limiting the flexibility of the function.

Through the application of Shephard`s Lemma the system of input demand equations become:

$$c_j = \alpha_j + \frac{\sum_k b_{jk} w_k}{\sum_k \beta_j w_k} - \frac{1}{8} \frac{\sum_k \sum_m b_{km} w_k w_m}{\left(\sum_k \beta_j w_k \right)^2} + \delta_j t + \frac{1}{2} \beta_j \delta_{tt} t^2 \qquad (2)$$

for all inputs of j = s, u, k, i, where x_j shows the quantity of input j employed and Y represents total output. Estimation of the parameters is done through estimating the system of equations described in equation (2) simultaneously. Price elasticities can be calculated from the estimated parameters according to equation (3):

$$\varepsilon_{ij} = \frac{b_{ij}}{\Sigma_m \beta_m w_m} - \frac{\beta_i \Sigma_m b_{jm} w_m}{(\Sigma_m \beta_m w_m)^2} - \frac{\beta_j \Sigma_m b_{im} w_m}{(\Sigma_m \beta_m w_m)^2} + \frac{\beta_i \beta_j \Sigma_m \Sigma_n b_{mn} w_m w_n}{(\Sigma_m \beta_m w_m)^3} \qquad (3)$$

DATA

Estimation of the system of equations requires data on the quantities and prices of skilled and unskilled labour, aggregate capital stock, imports and total output.

Skilled and unskilled labour are defined as equivalents to manual and non-manual workers, using aggregate data for all sectors of the economy. The main source of data on wages and employment is the Labour Force Survey (KSH, 2002a) and Employment and earnings (KSH, 2002b) published by the Central Statistical office of Hungary. For years before 1992, Statistical Yearbooks published by the Central Statistical Office of Hungary were used for both employment data and national accounts statistics. (KSH, 2002c, d)

The quality of capital stock data is of crucial importance regarding the credibility of the results. It is rather difficult to obtain reliable series on the capital stock, as the Central Statistical Office of Hungary stopped publishing capital-stock data in the early 1990s due to inefficiencies in the method employed to construct data. A more reliable capital stock data was prepared for the National Bank of Hungary by Darvas and Simon (2000), for the 1980-2002 period. Total output data was constructed through the Tornquist aggregation of categories of household and government consumption, investment and exports. These data were derived from the National Accounts of Hungary (KSH, 2002d) and from the National Bank of Hungary. Net capital expenditure is defined as the difference between the sum of wages and imports and total output. The price of capital is derived indirectly, from the national accounting identity by dividing capital expenditure by the capital stock.

ESTIMATION PROCEDURE AND RESULTS

The process of transition raises a number of issues concerning the econometric analysis of these questions. Considering that macro-level data is used in the analysis, it is reasonable to assume that these changes did not mean the complete reorganisation of economic activity from one year to another but could rather be treated as a gradual process. For this reason, a flexible representation of the production function is used in the analysis, which, to a certain extent, allows for annual changes in technology.

Given this issue, the study also draws conclusions on the applicability of a production theory approach in the period of economic transition. In order to distinguish the effects of transition, besides estimating the model on the 1980-2002 period, estimations are also performed on a sub-period from 1992 to 2002, and by using a dummy variable for the pre-transition years.

The system of equations under (2) can be efficiently estimated using a nonlinear version of Zellner`s seemingly unrelated regressor equations (Greene, 2000). As preliminary investigations suggest, the data suffers from serial correlation[1]. Because of this, the data has been adjusted according to the Cochrane-Orcutt procedure and results from the autocorrelation-adjusted NSUR are reported. In order to eliminate the inconsistency of the results that might arise because of the potential endogeneity of variables in the cost-function setting, the parameters are also estimated using an instrumental variables approach, the nonlinear three stage least squares (N3SLS) method. [2] It is common to use instrumental variables techniques in the literature to handle the issue of endogeneity when estimating factor demand functions.[3] (Grossman 1982, Aw and Roberts 1985 and Kohli, 1991)

Kohli (1991) suggests that appropriate instruments can be derived considering the dimensions of the household sector – that determines the

[1] Based on White, K. J. (1992) *The Durbin-Watson test for autocorrelation in nonlinear models*, Review of Economics and Statistics, Vol.74 pp. 370-373.

[2] The Hausman test is insignificant on the model and the selected instrumental variables, with value of 0.11. This suggests that results from the NSUR estimation are not likely to be distorted by the endogeneity of variables. Results of the instrumental variable estimations are presented in order to provide additional information about changes of demand elasticities.

[3] According to Kohli (1991, pp 203), given the potential endogeneity of one or more explanatory variables and the availability of relevant instruments, the proper estimation procedure calls for the application of the N3SLS method

demand for consumption goods and supply of labour – a portfolio model – that determines the prices of investment goods – and foreign supply and demand conditions – that determine the supply of imports. Some of the commonly used instrumental variables chosen for this estimation are: the population of Hungary; household savings as a percentage of disposable income; the government budget balance as a percentage of GDP; the discount rate; foreign direct investment as a percentage of GDP; the populations of Germany, Austria and the states of the former Soviet Federation[4]; a time trend and time trend squared.

In order to gain an insight into how serial correlation and potentially endogenous variables might affect the estimates, three sets of results are reported. Results from the autocorrelation adjusted NSUR (ANSUR) estimation, a N3SLS (N3SLS) estimation, and an autocorrelation adjusted N3SLS (AN3SLS) estimation are presented in the following sections[5]. The resulting parameter estimates for the system of equations under (2) together with their standard errors using the three methods described above are reported in Table 1.

The estimations resulted in most parameters being statistically significant, especially in the AN3SLS procedure. The system's R^2 values (as in Berndt, 1991) indicate good fit of the model under all three estimation methods. But as Table 2 suggests, concavity of the cost function does not hold because it would require the matrix of estimated coefficients to be negative semidefinite. Since the matrix of parameter estimates produces positive eigenvalues under all three methods, concavity must be imposed on the system.

[4] These data were collected from four main sources: the National Bank of Hungary, the International Financial Statistics database from IMF, various issues of the World Investment Report and the Populations Database from the United Nations.

[5] The AN3SLS estimation is based on ρ values derived from the NSUR estimation.

Table 1

Parameter estimates from the original system of equations

Coefficient	ANSUR Value	Standard Error	N3SLS Value	Standard Error	AN3SLS Value	AN3SLS Standard Error
α_s	-446.04****	42.232	1.905	1.189	15.535****	6.215
α_u	-146.65****	14.717	6.9****	1.951	4.559	3.327
α_k	-630.46****	51.178	6.808****	1.706	13.009****	0.9438
α_i	-298.91****	27.49	2.292*	1.218	88.325****	12.48
b_{ss}	-0.03719	0.257	1.315	1.6208	-2.366****	0.611
b_{su}	-0.3907	0.3408	-1.178	2.24	-1.61*	0.963
b_{sk}	0.0199	0.0873	-0.379***	0.147	-0.231****	0.02
b_{si}	0.4079***	0.1545	0.243	0.6857	4.208****	1.252
b_{uu}	-0.3143	0.5489	0.395	3.06	8.073	5.768
b_{uk}	0.3923	0.5431	2.106	0.73	-8.195****	2.762
b_{ui}	0.3127	0.3505	-1.322	1.03	1.732	2.958
b_{kk}	1.7534*	1.013	-3.187**	1.356	3.68***	1.51
b_{ki}	-2.1657****	0.7478	1.46*	0.867	4.747****	1.585
b_{ii}	1.445***	0.5584	-0.38	0.744	-10.688****	2.442
δ_s	-5.329	0.3828	-0.152****	0.0258	-0.84	0.69
δ_u	-3.17****	0.3411	-0.242****	0.0381	1.365***	0.541
δ_k	4.0752****	1.3286	-0.1*	0.0558	0.959***	0.383
δ_I	-16.058	1.446	-0.0153	0.0334	-86.565****	12.663
δ_{tt}	-0.2541****	0.0388	0.0217****	0.004	-0.495	0.104
R^2	0.998		0.993		0.94	
D.O.F.	58		58		58	

Based on t-values, **** indicates statistical significance at the 1 percent level, *** at the 2 percent level, ** at the 5 percent level, *at the 10 percent level with a two tailed test.

Table 2

Eigenvalues derived from the coefficients of the original system of equations

Method	Eigenvalues			
NSUR	3.791	0.2235	0.2175E-04	-1.1677
N3SLS	2.722	0.366	0.524E-04	-4.946
AN3SLS	14.5758	-0.399E-04	-1.372848	-14.50371

There are a number of techniques available to impose curvature conditions locally, but they often fail to result in proper estimates globally. Kohli (1991)[6] suggests that using a method that was developed by Wiley et al.(1973) the imposition of curvature conditions delivers results that satisfy curvature conditions globally in most cases. The imposition of curvature conditions involves imposing additional criteria on the estimated parameters based on the following arguments.

A sufficient and necessary condition for any matrix A to be negative semidefinite is that it can be written in a form:

$$A = -TT' \tag{4}$$

where $T \equiv \lfloor \tau_{jk} \rfloor$ is a lower triangular matrix.

Then T, together with its transpose can be written as in (5):

$$A = \begin{bmatrix} -\tau_{1,1}^2 & -\tau_{1,2}\tau_{2,1} & \cdots & -\tau_{1,1}\tau_{J,1} \\ -\tau_{1,2}\tau_{2,1} & -\tau_{2,1}^2 - \tau_{2,2}^2 & \cdots & -\tau_{2,1}\tau_{J,1} - \tau_{2,2}\tau_{J,2} \\ \vdots & \vdots & \vdots & \vdots \\ -\tau_{1,1}\tau_{J,1} & -\tau_{2,1}\tau_{J,1} - \tau_{2,2}\tau_{J,2} & \ldots & -\tau_{J,1}^2 - \tau_{J,2}^2 - \ldots - \tau_{J,J}^2 \end{bmatrix} \tag{5}$$

From the Wiley–Schmidt–Bramble procedure, it is a sufficient and necessary condition for the concavity of the function that the matrix of parameter estimates have the form specified under (5). This means that the elements of the matrix of parameter estimates must be replaced by the corresponding elements of (5). Resulting parameter estimates are reported in Table 3.

[6] For a detailed explanation of this procedure see Kohli (1991), p 110.

Table 3

Parameter estimates from the reparametrised system of equations

Coefficient	ANSUR Value	ANSUR Standard Error	N3SLS Value	N3SLS Standard Error	AN3SLS Value	AN3SLS Standard Error
α_s	409.82**	191.320	2.3558****	0.6079	1.6794****	0.8717
α_u	3.2771****	0.3878	3.2665****	0.8445	17.272****	4.3406
α_k	9.4392****	1.7541	2.8449*	1.6345	-69.793****	12.147
α_i	-113.27	108.84	3.0477****	0.7595	0.81711****	0.18065
τ_{11}	-0.3815*	0.2082	-0.9427***	0.3668	-0.2271	0.5958
τ_{21}	0.7557**	0.3214	0.8248	0.6624	0.1668	1.2653
τ_{31}	-0.1899	0.2614	1.0364**	0.4735	-0.0223	2.4637
τ_{22}	-0.0617	0.2559	-1.0428****	0.2276	0.1217	2.3062
τ_{32}	0.6351	1.3941	1.9649****	0.4169	-0.1787	5.4662
τ_{33}	0.3655	2.1748	0.102E-09	0.5648E+10	-0.481E-10	0.187E-10
δ_s	1.1992*	0.7027	0.0043	0.02	-25.115*	13.044
δ_u	-0.132****	0.0185	-0.1036****	0.0202	-2.6167****	0.8299
δ_k	-0.185**	0.0917	0.0649	0.048	118.1****	18.642
δ_I	-3.3039**	1.6275	0.0843****	0.0222	3.7365***	1.4602
δ_{tt}	0.0051	0.0043	0.0096****	0.0033	3.4476	3.0674
R^2	0.9965		0.9813		0.907	
D.O.F.	58					

Based on t-values ****indicates statistical significance at the 1 percent level, *** at the 2 percent level, ** at the 5 percent level, * at the 10 percent level with a two tailed test

Eigenvalues calculated form the matrices of estimated coefficients are listed in Table 4. The matrices of these parameter estimates produce no positive eigenvalues that are significantly different from zero in all three cases, thus the concavity of the cost function is fulfilled by these estimates.

Table 4

Eigenvalues derived from the coefficients of the reparametrised system of equations

Method	Eigenvalues			
NSUR	-0.637E-08	-0.356E-06	-0.102E-04	-1.108
N3SLS	0.147E-0.6	-0.264E-07	-2.312	-6.972
AN3SLS	0.866E-07	-0.749E-08	-0.256E-02	-0.514

Average price elasticities calculated from these parameters at sample means according to equation (3) are reported in Table 5. The directions and magnitudes of statistically significant estimates are similar, although in most cases, the N3SLS estimation resulted in estimates with consistently higher absolute values. [7]

In the ANSUR and N3SLS estimations, unskilled labour exhibited the highest values in absolute terms among the factors of production, suggesting that employment of unskilled labour reacted more sensitively to wage changes than that of skilled labour. All elasticity estimates show inelastic demand for capital, indicating its importance in economic restructuring. At the same time, results from the ANSUR and N3SLS estimations indicate that the demand for imports is elastic. In all three cases, the own-price elasticity of imports is higher than that of capital, suggesting that imports were more sensitive to price changes.

[7] A possible reason for the differences in the magnitudes of estimates is the potential non-stationarity of variables, which issue is beyond the scope of this analysis.

Table 5

Average price elasticities calculated from the reparametrised equations

Price elasticity	ANSUR Value	ANSUR Standard Error	N3SLS Value	N3SLS Standard Error	AN3SLS Value	AN3SLS Standard Error
ε_{ss}	-1.1389	0.8627	-5.7026	4.6296	-0.4866**	0.2319
ε_{su}	1.4459	1.2996	4.5463	3.8653	0.2324	0.1864
ε_{sk}	-0.2442****	0.0911	0.2211[sr]	0.4316	-0.0112**	0.0053
ε_{si}	0.3568*	0.2039	-1.4551**	0.6382	0.0993****	0.0138
ε_{uu}	-2.4618	2.5874	-7.0975	7.5843	-0.1801	0.1955
ε_{uk}	0.08	0.1019	0.3502 [sr]	0.4329	0.0205	0.017
ε_{ui}	0.6814****	0.0828	1.0329****	0.2123	-0.0598****	0.0183
ε_{kk}	-0.1417**	0.0606	-1.2094**	0.5588	-0.0074**	0.0034
ε_{ki}	0.4786****	0.0926	2.6418****	0.4019	0.01****	0.0027
ε_{ii}	-1.2213****	0.4495	-3.8638***	1.4896	-0.0306****	0.01

Based on the t-values, **** indicates statistical significance at the 1 percent level, *** at the 2 percent level, ** at the 5 percent level, * at the 10 percent level with a two tailed test.

[sr] indicates sign reversals

Considering the estimates of cross-price elasticities, ε_{sk}, $\varepsilon_{si,}$ ε_{ui} and ε_{ki} are statistically significant. The value of ε_{su} is not significant from any of the estimations, however it exhibits positive values in all three cases. This suggests that skilled and unskilled labour were used as substitutes in production during the observed period. Cross-price elasticity between unskilled labour and capital also shows substitutability, although the estimates are statistically insignificant. Annual elasticity estimates exhibit sign reversals in the first years of the observed period under the N3SLS method. Except for this very small (-0.0004) negative value unskilled labour and capital were found to be substitutes for all years, under all three implementations. Considering that the quantity of capital used in production has significantly increased throughout the whole period, substitutability between the two factors of production entails a decreasing unskilled labour employment, which is also supported by historical data. The value of ε_{sk} is significant under the ANSUR and AN3SLS methods. Although their magnitudes differ significantly, these results show an *absolute* complementary relationship between skilled labour and capital in both estimations.

Results from the ANSUR estimation indicate a positive relationship between imports and both skilled and unskilled labour. This would suggest, that imports generated employment in both categories. Furthermore, this effect is fairly strong with values of 0.35–0.68, which implies that the output substitution effect in both the skilled and unskilled labour intensive industries has been overbalanced by the employment generating effects of downstream processing. ε_{ki} is significant from all three estimations and shows substitutability between capital and imports. Although the magnitudes differ significantly under the different methods, annual elasticity estimates indicate a fairly stable relationship.

In an attempt to overcome the inconsistency originating from the differences between the magnitudes of estimates under different methods, the role of capital and imports in increasing the relative quantities of skilled labour are calculated using a simple averaging method, in a similar way as in Tombazos, 1999. Since ε_{sk} and ε_{uk} exhibit sign reversals in case of the N3SLS estimation, only results from the ANSUR and AN3SLS implementations are considered. Averages of ε_{sk} and ε_{uk} and ε_{si} and ε_{ui} are calculated across the two methods, then values of the difference between ε_{sk} and ε_{uk} and ε_{si} and ε_{ui} are considered as indicators of the role of capital/imports in increasing the relative employment of skilled labour.

Given the elasticity values from Table 5, these indicators are as follows:

Capital elasticity: ((-0.2442-0.0112)-(0.08+0.0205))/2= -0.177
Import elasticity: ((0.358+0.099)-(0.6814-0.0598))/2= -0.082

Values of ε_{sk} show absolute complementarity between skilled labour and capital, and values of ε_{uk} indicate substitutability between capital and unskilled labour. The indicator shows a positive relationship between the capital and skilled labour intensity of production and suggests that a 1 percent decrease in the price of capital would increase the relative quantity of skilled labour by 0.17 percent.

With regards to imports, the relationship between imports and skilled and unskilled labour varies across the two methods. The negative value of the indicator suggests that the increasing amount of imports would generate relatively more employment for skilled labour than for unskilled labour. Based on their average, a 1 percent decrease in import prices would result in a 0.08 percent increase in the quantity of skilled labour compared to unskilled labour. Assuming that changes in the relative demand for the different types of labour are reflected in the skill premium, this result would contradict the results of Egger and Stehrer (2003) to a certain extent by indicating relative complementarity between skilled labour and imports. Although results from the calculations above do not rule out that imports impacted on unskilled labour favourably, the skill premium could not have decreased through this effect because of its more substantial positive impact on skilled labour.

The cross-price elasticity estimates reveal that skilled and unskilled labour, and unskilled labour and capital were used as substitutes in production, while skilled labour and capital were used as complementary factors in production during the observed period. These tendencies support the hypothesis of absolute capital-skill complementarity and skill biased technology change. With technological advancement, more skilled labour was required to operate the new capital equipment, which meant a direct increase in the demand for skilled labour. At the same time, demand for unskilled labour decreased as they did not have the specific skills to operate the new production technologies and substitutability between the two types of labour was limited. As a result of these effects, demand for skilled labour increased relative to unskilled labour.

The role of imports in shaping demand and wages of skilled and unskilled labour remains more ambiguous. Although cross-price elasticity estimates between imports and skilled labour, unskilled labour and capital are significant in all three cases, they exhibit different signs and magnitudes under the different methods. Based on their average values, the results suggest that the increasing amount of imports has enhanced the effects of SBTC, although by a far less significant measure.

Examination of the technology parameters in Table 3 also supports these findings. Values of δ_j show how technological change affected usage of the various factors of production. Positive δ_j values imply that technological change increased usage of the j-th input, while a negative δ_j value implies that technological change was j-factor saving. Based on the results of the ANSUR estimation, the factor specific technological change parameters show a decrease in the usage of unskilled labour. At the same time, technological change is shown to be factor using in the case of skilled labour. Since the coefficient of skilled labour is smaller than the coefficient of unskilled labour, the net effect of these changes is likely to be a decrease in the overall level of employment. These findings also confirm that more skilled labour was used in production as a result of technological change and reinforce the skill biased technology change hypothesis. The slightly positive value of δ_{tt} in all three estimations suggests that technological change that influenced all inputs resulted in a marginal increase in factor usage.

Finally, it must be mentioned that robustness of the results concerning the effects of a structural break was also tested by including a dummy variable in the estimated model, and through comparisons of elasticity values derived from pre- and after transition years. These estimations include changes in the underlying structure of production in 1992, as a structural shock is likely to have happened by this time. The aim of these estimations is not to analyse the structural break per se, but merely to examine whether the elasticity estimates change systematically due to a structural change in 1992. Although the dummy variable turns out statistically significant under all three econometric implementations, the elasticity estimates remain similar in direction and magnitude to the values listed in Table 5. Elasticity estimates derived from these estimations are presented in Tables 6.

Table 6

Average price elasticities from the 1992 – 2002 subperiod, and from the model with dummy variable (1980-2002)

Price elasticity	ANSUR Value (1992 – 2002)	ANSUR Standard Error (1992 – 2002)	ANSUR Value (with dummy)	ANSUR Standard Error (with dummy)
ε_{ss}	-1.1871*	0.6477	-0.5684	0.4351
ε_{su}	0.9673*	0.5085	0.8008	0.7486
ε_{sk}	-0.1862***	0.0743	-0.1661***	0.0656
ε_{si}	0.4055****	0.0634	0.2996*	0.1744
ε_{uu}	-2.1586	1.3659	-1.7283	1.7988
ε_{uk}	0.0531	0.0461	0.0597	0.0708
ε_{ui}	0.4885****	0.0591	0.5847****	0.0726
ε_{kk}	-0.1765**	0.0736	-0.0817***	0.0346
ε_{ki}	0.3874****	0.023	0.2932****	0.0609
ε_{ii}	-0.8551****	0.2676	-0.8672****	0.3182

Based on t-values **** indicates statistical significance at the 1 percent level, *** at the 2 percent level, ** at the 5 percent level, * at the 10 percent level with a two tailed test

Comparison of results from the 1980-2002 and 1992-2002 periods and the model which includes a dummy variable suggests that estimations that incorporate measures to identify the effects of transition generate similar average elasticity values to those of the basic model. Except for the fact that the dummy is significant and that the 1992-2002 sample produces estimates which are somewhat higher in absolute value, these two methods does not seem to contradict the applicability of the production theory approach due to a structural break. This potentially results from the application of a flexible functional form, which allows for gradual annual changes in technology.

Intuitively, the general expectation is that elasticity values increase as a result of transition from a centrally planned to a market-led economy. As market forces gain higher importance in setting prices, state regulation and state intervention to bail out unsuccessful companies diminishes. Companies must optimise their behaviour subject to a hard budget constraint and thus they become more sensitive to changes on the market. Although the Hungarian literature lacks a comprehensive empirical analysis of the factor demand elasticities for this period, a few studies presented labour demand elasticities, which support the intuition above. Studies that derived labour demand elasticities using either homogenous labour or heterogenous labour resulted in unstable and in many cases unreasonably high elasticity estimates for the early years of transition. (Köllő, 2001) Kőrösi (1998) found that the wage elasticity of labour increased rapidly during the early years of transition. The main reason for this is that while socialist production was characterised by over-employment, companies became more sensitive to increasing wages and changes in regulations, and made the excess labour redundant. This resulted in a significant increase in the elasticity of labour in the first phase of the transition. When the transformation of the economy is completed, elasticity values are expected to decrease to a more moderate – though higher than their pre-transition – level.

Although systematic differences which would indicate a structural break can not be identified from the comparison of estimates from the pre- and post-transition samples, each set of estimates exhibit similar tendencies considering their annual elasticity values. Figures 1 - 3 show the evolution of annual elasticity estimates from the ANSUR implementation of the basic model estimated on the full period, the 1992 – 2002 subperiod and on the full period including a dummy variable.[8]

[8] These elasticity values belong to different price and quantity levels in each year, which means that in a strict sense they do not show the evolution of the very same elasticity value.

Figure 1 **Annual elasticity values (1980-2002)**

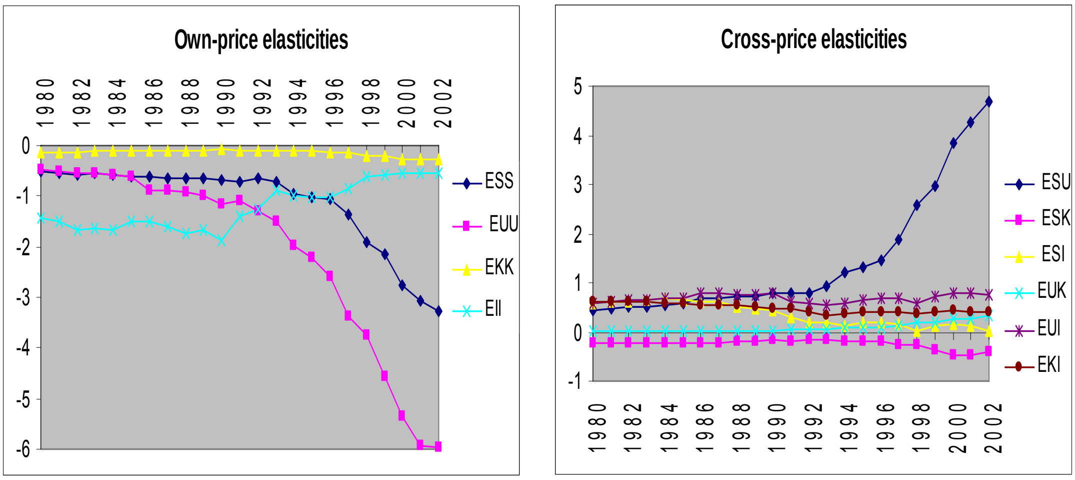


Figure 2 **Annual elasticity values (1992-2002)**

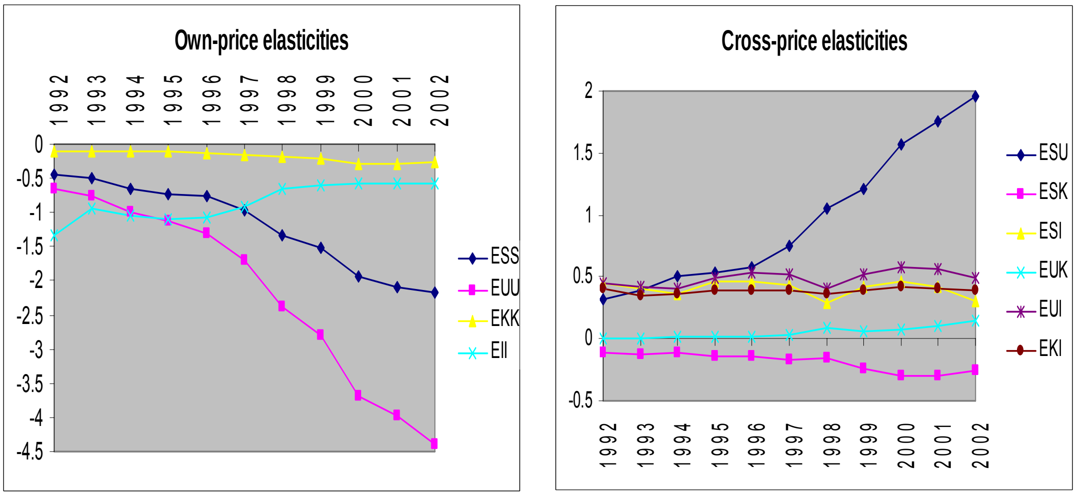
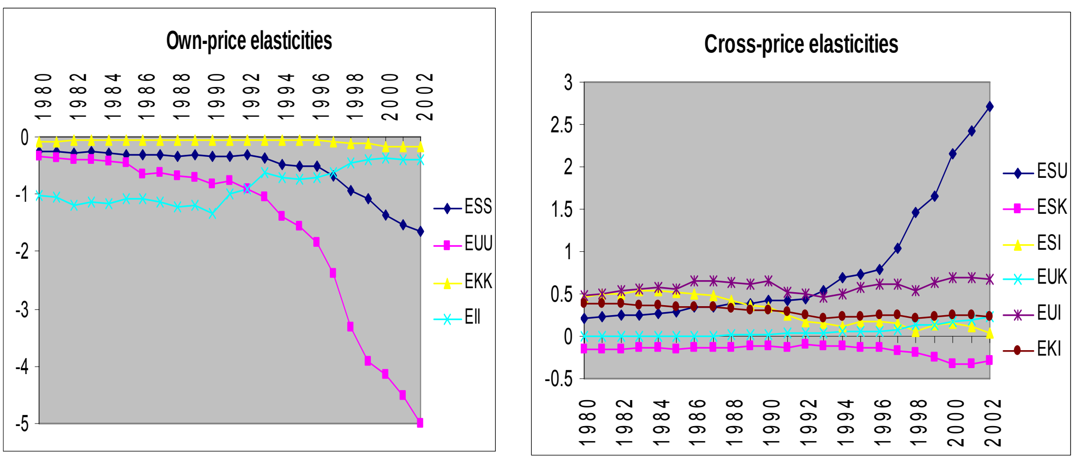


Figure 3 **Annual elasticity values with dummy variable (1980-2002)**



All three estimations indicate very similar directions, magnitudes and tendencies for the elasticity values. It seems that for most of them there is a break point at around 1992 and 1996. These years are generally associated with structural breaks resulting from transition (1992) and restrictive policy shocks (1995).

In accordance with the intuitions, own-price elasticity values for capital, skilled labour and unskilled labour started to increase quickly from 1992-1993 and their increase accelerated from 1996. This increase has plateaued out for skilled labour and capital at around 2000. Surprisingly, all three estimations indicate further increasing price elasticity for skilled and unskilled labour and decreasing price elasticity for imports. Diagrams of cross-price elasticities reinforce the complementary relationship between skilled and unskilled labour, increasing substitutability between unskilled labour and capital, and skilled and unskilled labour. They also suggest that from around 1992-1993, skilled labour became relatively more complementary with imports than unskilled labour.

The results also confirm the findings of Kertesi and Köllő (2001), who found that two phases of economic transition can be distinguished. The first phase was characterised by a dramatic decrease in unskilled employment and wages. Since job creation remained insignificant in this period, employment and real wages of skilled labour also diminished during this period. These tendencies have changed by the second phase in the mid-90'-ies. At this time, demand and wages of skilled labour started to increase, especially in the young and skilled category. Despite an increasing supply of skilled labour, skilled wages increased in real value and also in relative terms, compared to unskilled labour. This is also in accordance with Kézdi (2001).

Demand for imports shows a different pattern. The amount of imports has continuously increased during this period, especially due to trade liberalisation in the early years of transition. For example, imports of consumer durables increased by 66 percent from 1989 to 1993, while imports of food items increased by 20 percent in the same period. With the increase of domestic production, the share of final consumption goods has gradually declined in imports. By 1997, goods imported for the purpose of production of exports reached the highest share in imports. This might provide an explanation for the decreasing sensitivity of import demand to price changes.

CONCLUSIONS

The results support the hypothesis that both capital accumulation and imports played a major role in influencing the evolution of relative demand for skilled and unskilled labour in Hungary during the past two decades. Most importantly, the results confirm that skilled labour and capital were used as *absolute* complements in production. At the same time, unskilled labour and capital, and unskilled and skilled labour were used as substitutes in production, which implies that technological change was skill biased during this period. Results concerning the role of imports are rather inconclusive. They suggest that decreasing import prices would have resulted in further increasing relative demand for skilled labour, either by displacement of more unskilled labour relative to skilled labour, or by generating more employment for skilled labour. Although the role of imports is significant, effects of skill biased technology change dominated the evolution of relative demand.

These results are confirmed by further estimations, which examine the effects of transition on the elasticity values. In compliance with the intuitions and limited empirical estimates, transformation of the economy seems to have increased the absolute values of the elasticities. It is also important to note that results from the estimations are similar irrespective of whether they explicitly include the effects of transition or not. This suggests that although significant changes took place in the Hungarian economy, these changes can be captured by the technology parameters of the flexible function. The changes did not lead to the complete reorganisation of the economy from one year to another and were “small” enough so that the production function can allow for these annual changes. This is an important finding concerning the applicability of production theory to the period of transition. Although these findings are consistent with the intuitions and other empirical results, this method does not provide a comprehensive assessment of the effects of transition.

On the basis of the estimates it seems that the effects of SBTC and increased imports were similar in Hungary to those observed in developed economies, but the transition process accelerated and enhanced their effects.

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