THE USAGE OF FACTORS IN A DUAL ECONOMY: SPECIALISATION IN THE CZECH FOREIGN TRADE

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Presented at MACROMODELS'99 Conference, Rydzyna, Poland, 2 December, 1999
and published in Proceedings, Volume II., University of Lodz, 2000

A B S T R A C T

In this paper we aim at assessing the nature and patterns in the specialisation of foreign trade in a country in transition. We evaluate how the industrial specialisation in foreign trade was influenced by supply-side characteristics of production by using a variant of the index of revealed comparative advantage. Since industries and firms in an economy in transition are at a different level of restructuring, the standard methods of estimation fail to reveal the diverse behavioural patterns of producers which, on average, counterbalance the disparate impacts of each other. Thus we have applied an alternative statistical method based on least trimmed squares of residuals which could help separate the subpopulations of firms with opposite strategies for a location of production.

1. Introduction [*]

This paper aims at opening a discussion about the nature and patterns in the specialisation of foreign trade in a country in transition. The pattern of specialisation is a crucial concept in the theory of international economics and the location of production. In the last 20 years there have been only few analytical studies dealing with this topic in Czechia. Let us mention the studies of Drabek [1981, 1984] and Benacek [1986, 1987, 1988]. In 1990s there were few new additions, the most important among them were the studies of Landesmann [1994], Hanel [1995] and Stolze [1997]. All of the latter papers had problems with data and their results were to a large extent inconclusive. We are attempting to uncover the reasons for weak statistical properties of such data samples.

Though the international trade theory has evolved quite dramatically in the last 20 years, its core has remained concentrated on the conditions on the **supply side**. It is assumed that both the intensity of trade and the pattern of industrial specialisation depend preponderantly on the relative characteristics of production factors, such as their productivity and endowments. There is assumed a high degree of inertia on the supply side, that sets conditions for predictions in the long-run and for the economic policy decisions. The **demand side**, which is much more volatile, is entering the picture only indirectly. For example, its influence is propagated through an ability of producers to wield control over the market (the market power) or exert initiative in the strategic R&D developments (such as a leadership in the product innovation) which generate new demand. The traditional analysis, concentrated on the relative differences in costs (Ricardian approach) or the relative differences in capital, labour and natural resource endowments (Heckscher-Ohlin approach), has been extended toward the analysis of endowments of **human capital**. As an outcome, there is a wide variance of competing exogenous variables for the econometric analysis of the determining factors of trade.

[*] I am grateful to Jan Kmenta for fruitful comments on this paper. The existing shortcomings remain, however, mine.

2. Construction and Interpretation of Revealed Comparative Advantage (RCA)

Our basic problem can be outlined first by a standard situation of a country with two commodities i = {A, B}, each representing an industry, and two factors {K, L}. It is implicitly assumed that commodity A is capital intensive and commodity B is labour intensive and that the analysed country is relatively better endowed with labour than with capital. Thus it can be assumed that this country's revealed comparative advantage will be manifested in exports of B while A will be imported.

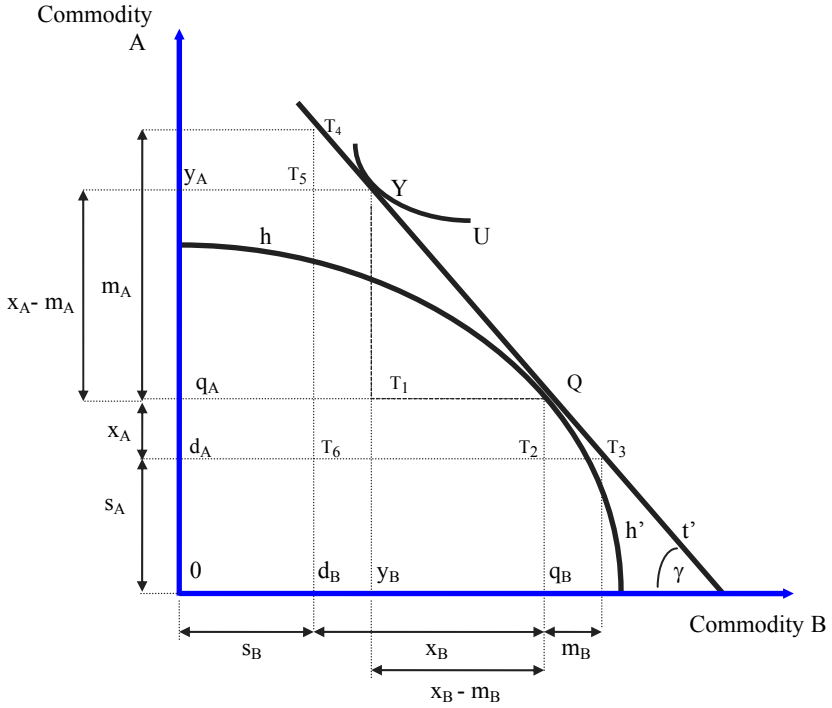

Figure 1: The geometry of production and trade in commodities A and B. Production is in point Q while consumers prefer the consumption in point Y. The existence of the intra-industrial specialisation means that both commodities are exported and imported along the terms of trade line tt'.

Figure 1 describes a small open economy that produces both commodities {A, B} in point Q. It exports a part of its production of commodity B (in which it has comparative advantage) in exchange for imports of commodity A. This trade would get it into the potential pattern of consumption in point Y, trading along the triangle of QT_1Y. However, in addition to this, our country also exports commodity A. It happens in spite of the fact that, on average, the producers of commodity A in the studied country do not have comparative advantage [1]. Similarly, a small trade can be found also in imports of commodity B. Because the total trade is assumed to be balanced, exports of A must be also traded for imports of B. This is depicted by a triangle of additional trade QT_3T_2. This triangle can be „moved up" to point Y, forming an identical triangle T_4YT_5. The final commodity endowments are thus at point Y, which is equal to the structure of the final domestic demand, as determined by the utility function U.

Because it is assumed that the analysis will be applied only to a **small open economy** and its terms of trade (with a parameter γ) are always exogenous to it, the whole problem of

[1] *Thus we accept the existence of the intra-industrial trade and a fuzzy distinction between exported and imported commodities. This means that it is assumed that there is a lack of either a perfect information on the demand side or a homogenous set of producers on the supply side. The latter can be also supported by the assumption that the rising marginal costs imply an upward sloping supply curve which, at some segments, is internationally competitive.*

international specialisation (i.e. the export and import structures) is determined exclusively by the **production possibilities function hh'**. The shape of hh' is given by the input factor characteristics and the functional (technological) relationships between them. Therefore, our aim of this paper will be to find out what relationship there is between the structure of trade and the factor intensities.

Let us now extend the number of industries (formerly commodities) from two to n. Since we take the existence of the intra-industrial trade for intrinsic characteristics of all modern patterns of specialisation, it is neither the total export nor the total import flows that determine the comparative advantage. It is the **net trade balance in commodities (industries)** ***i*** that matters. The value of trade balance is then normalised by the net trade flows of an industry ***i*** by its trade turnover, so that the size of the industry does not influence the results. The result is an indicator of revealed comparative advantage (RCA): [2]

$$RCA_i = (x_i - m_i) / (x_i + m_i) \qquad \text{for } i = \{1, 2, \dots, n\} \qquad [1]$$

The values of RCA are within the interval of <+1, -1>. Values close to +1 signal that given industry i has a tendency to an exclusive export specialisation, values close to -1 signal a tendency to an exclusive import specialisation and values around 0 signal a high degree of intra-industrial specialisation (with exports and imports balanced inside the industry). In figure 1 this construction of RCA can be illustrated as the relationship between two triangles of trade: the net trade of YQT_1 and the gross trade (turnover) of $T_4T_3T_6$. Namely it is the relationship between their parallel sides. For example, for the commodity A it is the proportion between the segments $YT_1 \div T_4T_6$. The differences between net exports and net imports among various industries are magnified by opposite signs.

Our task would then be to test the relationship between the index of RCA_i (describing the structure of trade) and a set of characteristics describing the use of input factors, the demand and the market structure. Though the interaction of exogenously given supply side conditions (that determine the shape of the production frontier) and the terms of trade determine the structure of production specialisation (in figure 1 it is the line tt' tangent to hh'), they are **not** able to determine the structure of trade. In case of the intra-industrial trade, we would need for that not only the consumers' preferences [3] but also additional parameters, describing such variables as the market structure, product differentiation, etc.

Of course, it must be also assumed that the markets have not failed and the allocation of resources has been determined exclusively by the existing country's comparative advantage. In practice this would imply that the duration of the process of restructuring during the early years of transition (in the Czech case the years 1990-94) must have been long enough to cause a correct reallocation in both the trade and the production in accordance to the world prices. In another words, it should be assumed that in figure 1 the points characterising the domestic production $Q = \{q_A, q_B\}$, domestic expenditure $Y = \{y_A, y_B\}$, total exports (x_B+x_A) and total imports (m_A+m_B) had sufficient time for their adjustment and thus had been economically rational (i.e. they are Pareto efficient) even from the long-run perspective. Only upon this condition the ensuing flow of **net imports** of commodity A (as $y_A - q_A$) and **net exports** of commodity B (as $q_B - y_B$) will reveal correctly the hidden

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[2] *There are many alternative ways of quantifying the net trade flows by means of various indexes of RCA. For better insight in this problem see Greenaway, Milner (1986), Vollrath (1991), Landesmann (1994) or Stolze (1997).*

[3] *In figure 1 the consumers' preferences are given by function U. We will assume in the tests that domestic tastes are not significantly different from the tastes in the trading partners. If this condition would not be valid than the role of the supply side factors would be impaired.*

comparative advantages, as depicted by a triangle of the net trade YQT_1.

3. Alternative specification of RCA

The concept of the revealed comparative advantage represents a formula assessing the potential strength of comparative advantage by its presumed economic pressure on the real pattern of trade. The measurement is in cardinal quantitative scale. Though in theory the comparative advantage is clearly defined in Ricardian (relative productivities of labour) or Heckscher-Ohlin (relative factor endowments) models, the reality is not consistent with their strict assumptions and thus it is measured with difficulties. As an outcome, the intrinsic „real comparative advantages" remain hidden. Thus a myriad of various indices of a „revealed comparative advantage" are arrangements out of necessity which are always imperfect (Vollrath [1991]). In order to understand the meaning of RCA, we should realise that **RCA aims at quantifying the intensity of the competitiveness of domestic production vis-à-vis the foreign competition, as can be figured out from the relative intensity of the past trade flows**. The industrial allocation of production then reveals the specialisation pattern based on comparative advantage.

The traditional theory of intra-industrial trade is based on an idea that the index of RCA is influenced solely by the relative trade intensities (for example, the net trade relative to the total turnover of trade in the given commodity or industry, as indicated above). One can ask why also the **domestic sales** are not included in the link along with the trade competitiveness? Our alternative approach attempts to formulate RCA as a relationship between the net intensities of trade (net exports) and the **total „relevant" demand** (for the given commodity or industry). The „relevant" demand includes both the turnover of foreign trade (i.e. x_i and m_i) and the size of domestic sales of production of domestic origin (s_i). The RCA index adjusted to our alternative definition is constructed as follows:

$$RCA_i^{adj} = (x_i - m_i) / (s_i + x_i + m_i) \qquad \text{for } i = \{1, 2, \dots, n\} \qquad [2]$$

This would mean that in our adjusted formula we do not discriminate against sales to domestic market - which means to a market where the domestic firms must show a similar competence, and are challenged by a similar competition, as on the foreign markets. The values of this RCA are again within the interval of <+1, -1>. In the figure 1 the index of RCA^{adj} can be illustrated as the relationship between two parallel lines: a cathetus of a triangle of net trade and the ordinate for the total demand. For example, for the commodity A it is the proportion between segments $YT_1 \div T_4d_B$.

A given industry ***i*** reveals its maximum of comparative advantage not in case when it eliminates all imports, while its exports are just a small dent of its total sales, but only if it takes over the **whole world demand**, including the full domestic market. This is our innovative interpretation of the comparative advantage of a small country. It means that, for a small country, the RCA_i should be at an absolute maximum only if the relationship x_i / s_i approaches infinity, while m_i converge to zero and s_i is much smaller than x_i. Our adjusted RCA_i^{adj} would then be a limity to 1. Its results may be lower than what traditional $RCA_i = 1$ would otherwise claim for the same intensity of trade. Or let us now look at this problem for cases where
$x_i - m_i < 0$. An industry which is not able to export ($x_i = 0$), but is able to retain a large part of the domestic sales, should not fall into the same category of RCA as an industry that was fully eliminated by foreign imports.

Our alternative specification, where the domestic sales also matter, is of crucial

importance to the whole theory of comparative advantage, especially for the case of a small country. It has some advantages over the traditional concepts of RCA:

- It offers more sensitive scaling of the importance of net trade in industries for the domestic economy
- It can be interpreted as a variable quantifying the **potential** of expansion or contraction of the domestic production. For example, an index taken as a complement of the actual value of RCA_i^{adj} to -1 can be interpreted as a „degree of viability".[4] In another words, it can be interpreted as a measure of competitiveness and efficiency of one industry relative to other industries at home or abroad.

For example, the strategy „stay at home" (i.e. retaining the domestic market share without a prohibitive tariff to imports) is still a relevant strategy related to both actual and potential trade even though both exports and imports are minimal. At least it is valid currently as an effective import substitution policy. Under favourable circumstances this dormant industrial potential can improve its trade position, e.g. with changes in domestic factor endowments. Thus this industry has retained some potential for starting with future growth by fending off all imports or even for entering the export market.

4. Constraints on Data Availability and a Simplified Specification of the Model

Our next step would be to test empirically the simple model described above. The breakdown of firms by NACE three-digit classification, with a variety of numerous input characteristics, would offer a good representation of a mix of sufficient number of products (i.e. 93 industries). Unfortunately, the crucial problem is that since 1992 the Czech Statistical Office resigned from supporting the collection of import data. Willy-nilly, in our first stage of estimates we were forced to eliminate imports from our analysis and concentrate only on the last export data available - the statistics of 1994.

With some loss of theoretical purity and generality we thus have a second best alternative by omitting the imports from both numerator and denominator from our index of RDA^{adj}. Thus we must abandon the concept of net exports and work with full exports x_i. However, the role of domestic sales as a benchmark for the measurement of exports was retained. The result is what we call „index of export penetration" IEP:

$$IEP_i = x_i / (s_i . + x_i) \qquad [3]$$

This ratio, measuring exports per output, is definitely different from the conventional testing of RCA. However, the loss of the relevant information about the depth of specialisation is only partial and this index is often used as a measure of competitiveness. By taking some behavioural assumptions we can even get an interesting new view on some aspects of the international division of labour. IEP_i cannot be taken as a theoretically unimpeachable index of RCA. The missing imports, as the complementary part of trade openness, is a too heavy loss of structural information and therefore it should not have been disregarded. Thus we must put up with it as with a second best alternative.

This shortcoming notwithstanding, IEP_i in equation [3] has still retained important structural characteristics, which offer relevant information for empirical testing. It classifies in each industry its **average relationship of firms to two alternative behavioural strategies of production and sales: „going abroad" or „staying at home"**. Then the input (factor) variables help „explain" how the particular strategy is related to technological determining

[4] *This index would lie within the limit <0, 2>. An index of 0 would indicate „completely eliminated" while an index of 2 would indicate „absolutely viable".*

factors. For example, if we discover an empirical fact that a strategy of „going abroad“ is closely related with high labour requirements of production (and with a complementary low capital requirements) then it means that the opposite strategy of „staying at home“ must have for its factor characteristics **opposite signs.** I.e. it should have a low labour intensity of production and a high physical capital intensity. In another words, **our regression coefficients for IEP, with merely its signs reversed, would always describe the input characteristics of the domestic production for the domestic use** defined as $s_i / (s_i.+ x_i)$.

The proof of this crucial statement is simple: if our endogenous variable of IEP_i is defined as $x_i / (s_i.+ x_i)$ then $1-(x_i / (s_i.+ x_i))$ must be equal to $s_i / (s_i.+ x_i)$. That means: the indices of the domestic sales of firms per their output are just a complement to unity of their indices of IEP_i. If they are regressed separately on the same set of exogenous variables, regression coefficients of the former must have the **same absolute value but different sign** as the regression coefficients of the latter.

This is a very important aspect of all tests of the comparative advantage, the lack of which in the Leontief methodology of empirical testing was criticised by Leamer in his seminal article (Leamer [1980]). According to Leamer, **testing of factor intensity is consistent with the theoretical foundations of trade (i.e. Heckscher-Ohlin theorem) only if the average factor requirements of exports are different than the factor intensities of the total final production.** Namely, for a country better endowed with labour relative to capital the average K/L ratio „explaining“ all exports must be less than the average K/L ratio of the domestic production for domestic use. The opposite signs of significant parameters for the estimation of production for export and for the estimation of production for domestic usage are consistent with the pre-requisites outlined by Leamer.

5. Determining Factors and the Hypotheses Tested

The following explanatory variables were used in our tests of null hypotheses. All of them represent a factor that is used by some variant of the pure theory of trade for the explanation of the trade flows.

1. Labour per unit of net production (i.e. value added) L/VA: all previous studies of Czech trade have confirmed that labour was a statistically significant variable with a positive sign: the higher is the labour intensity of production, the more competitive are the exports.
2. Physical capital per unit of net production (i.e. value added) K/VA: as a substitute for labour intensity we should expect its statistically significant parameter with a negative sign. A functioning non-antiquated capital is a scarce (and thus too expensive) factor in Czechia. Therefore exports from capital intensive industries ought not to be competitive.
3. Capital per labour (K/L): as a combination of variables no. 1 and 2, it becomes an alternative to them. This should result in its high statistical significance with a negative sign.
4. Unit labour cost (ULC): it is argued that it is a combined influence of wages and productivity that matters for the competitiveness of exports based on high labour intensities. A positive correlation between export penetration and ULC is expected.
5. Total factor productivity (TFP). We have used it as a proxy for the technical efficiency of factor usage: the higher is TFP, the lower volume of factors is necessary to produce a unit-value of output. Thus a positive sign associates a high efficiency of factor usage with a high export orientation. A negative sign would imply a paradox in the Czech export specialisation.
6. Foreign direct investment (FDI): many studies abroad and in this country have shown that the positive relationship between export competitiveness and incoming FDI is highly significant.

7. Increasing returns to scale (IRS): a dummy variable derived from CES production functions. It is expected that high export performance is positively correlated with the use of increasing returns (a strategy ascribed to multinationals).
8. Concentration ratio (CR3): characteristics related either to market power (with an orientation to large domestic market) or to increasing returns and exports. CR3 was calculated as a share of three largest firms in a given industry on the total output of the industry.
9. Balassa index of inter-industrial specialisation (BAL): a tendency to relate high export performance of industries with their pattern of inter-industrial specialisation is assumed. Thus a positive sign should be expected.
10. Change of nominal prices in time (DP): it is assumed that the difference in indices of the industrial inflation in 1991-1994 reflects the narrowing of the gap between the world prices and former prices under central planning. The index of DP reflects how the domestic relative prices changed after opening up to the West. This is also closely related with the improvements in terms of trade. The higher is the imported "inflation" in the given industry, the higher is the growth in its exports. The Stolper-Samuelson and the Haberler theorems are consistent with this hypothesis.
11. Kilogram prices or Czech exports (KGP). It is argued that kilogram prices reflect the intensity of natural resources embodied in the product. These are usually products at low stage of processing with low value added. Since Czechia does not have a comparative advantage in natural resources a negative sign can be expected.
12. Research and development (R&D): the R&D expenditure is testing the influence of high value added. High R&D is also a sign of an intensive use of human capital and resulting high quality. In case Czechia does not have a comparative advantage in human capital, this factor should have a negative sign.
13. Human capital (UE/VA): the employment of university educated employees per value added is just another indicator of the previous factor. In case Czechia does not have a comparative advantage in human capital, this factor should have a negative sign.
14. Contents of labour with lower education (LE/VA): this variable complements the previous one. If the use of labour with lower education (primary or secondary school leavers) is correlated with exports, than its coefficient should be positive.

Remark: Of-course, some of the enlisted exogenous variables represent alternatives. Thus, for avoiding the problems of multicolinearity we had to use only one representative variable of the competing group.

6. Empirical Tests Using the OLS Method of Estimation

Our empirical results are based on data for 91 manufacturing industries in the year 1994. As the index of revealed comparative advantage, which is taken as the dependent variable in our model, we use the variable $x_i/(s_i+x_i)$, where x_i denotes total exports of *i*-th industry and s_i are total domestic sales of *i*-th industry. The list of explanatory variables in our basic equation was selected on grounds of main theories of trade (factor proportions, comparative costs and intra-industrial exchange) and industrial organisation (market power and increasing returns to scale).

- The measures of factor intensities were defined as L_i/VA_i and K_i/VA_i. We have also used the variable K_i/L_i as an alternative measure of factor intensity.
- Total factor productivity (TFP_i) was used as an inverse proxy for costs

$$TFP_i = \frac{VA_i}{K_i^{\,a} L_i^{\,1-a}} \ , \qquad [4]$$

where the coefficient *a* was set to 0.3 in accordance with the coefficients estimated from aggregate production function of the Cobb-Douglas type. The variable TFP_i is thus equal to a constant A_i assigned to the unit-value isoquant of industry *i*, provided its real values of L_i, K_i per output VA_i are fitted into equation [4].

- The price change between years 1990 and 1994 defined as an index of inflation (DP_i).
- The measure of concentration in each industry ($CR3_i$), as a proxy for market power, is defined as the share of three largest firms in the industry *i* on total output of that industry.
- Balassa index (BAL) of intra and inter-industry exchange is defined in the form:

$$BAL_i = \frac{|X94_i - M94_i|}{X94_i + M94_i} \quad , \qquad [5]$$

where $X94_i$ ($M94_i$) denotes total exports (imports) of the industry *i* in the year 1994. $X94_i$ and $M94_i$ [5].

With the theoretical considerations done in the previous part of the paper, our empirical work is based on a linear specification of the basic equation:

$$x_i/(s_i+x_i) = b_0+b_1*(L_i/VA_i) + b_2*(K_i/VA_i) + b_3*CR3_i + b_4*TFP_i + b_5*BAL_i + b_6*DP_i + \varepsilon_i \qquad [6]$$

where *i=1, 2, ..., 91* are manufacturing industries in NACE 3-digit nomenclature. In order to extend our analysis, the measure of labour intensity is later replaced by two variables (UE/VA and LE/VA), in order to involve the influence of human capital and simple labour endowments into our model. For that purpose we estimated the following regression equation:

$$x_i/(s_i+x_i)=b_0+b_1(UE_i/VA_i)+b_2(LE_i/VA_i)+b_3(K_i/VA_i)+b_4*CR3_i+b_5*TFP_i+b_6*BAL_i+b_7*DP_i + \varepsilon_i \qquad [7]$$

We also employ another measure of factor intensity (K/L). Our specification of the regression equation then becomes:

$$x_i/(s_i+x_i) = b_0 + b_1*(K_i/L_i) + b_2*CR3_i + b_3*TFP_i + b_4*BAL_i + b_5*DP_i + \varepsilon_i \qquad [8]$$

Equations [6, 7, and 8] are our starting points of analysis. The exogenous variables represent basic theoretical instruments for explaining the specialisation pattern of international trade. The most important is the influence of factor proportions (Heckscher-Ohlin relative endowments K/L), the market power (CR3), the minimisation of factor inputs per a unit-value of output (TFP), the influence of inter-industrial trade (BAL) and the price developments (DP). In fact, the above specifications cover the basic determining factors of trade, as they are explained by the mainstream of theories of industrial location and specialisation.

For the empirical tests we have applied the OLS estimation to our cross-sectional data set. Tables 1a, 1b and 1c report the estimation results of OLS regressions. Since we had a large list of explanatory variables, we first tested for the presence of multicolinearity among the exogenous variables. Our test did not identify any symptoms confirming its presence in the model, even though, in a perfect market environment, there could be expected a high correlation between K and L. However, after examination of the residuals, we found the presence of heteroscedasticity. Therefore, we used White correction to adjust the variance-covariance matrix of the estimated coefficients for purposes of inference. Thus, the results are

[5] *In this case both imports and exports were taken from* ***customs*** *statistics. Their exports have been, however, incompatible with exports from* ***industrial*** *statistics. Therefore we could not mix these two for the construction of the endogenous variable defined as* RCA^{adj}.

robust with respect to arbitrary forms of heteroscedasticity in the error structure. Tables 1a, 1b and 1c report the estimation results of OLS regressions.

Table 1a – results for Equation 6:

Statistics	b_0 const.	b_1 (L/VA)	b_2 (K/VA)	b_3 (CR3)	b_4 (TFP)	b_5 (BAL)	b_6 (DP)
Coefficients	0.380	8.26	-0.016	0.155	-0.006	0.063	0.0003
t-statistics	5.33	1.61	-4.52	2.32	-4.00	1.57	1.48
Probability of 0 hypothesis	0.00	0.11	0.00	0.02	0.00	0.12	0.14

R-squared: 0.324 R-adj.: 0.280 F-statistics (prob. of 0 hypothesis): 0.00

Table 1b - results for Equation 7:

Statistics	b_1 (UE/VA)	b_2 (LE/VA)	b_3 (K/VA)	b_4 (CR3)	b_5 (TFP)	b_6 (BAL)	b_7 (DP)
slope coefficients	20.35	7.96	-0.016	0.156	-0.006	0.066	0.0003
t-statistics	0.41	1.59	-4.49	2.30	-3.74	1.54	1.47
Probability of 0 hypothesis	0.68	0.12	0.00	0.02	0.00	0.13	0.15

R-squared: 0.325 R-adj.: 0.277 F-statistics (prob. of 0 hypothesis): 0.00

Table 1c – results for Equation 8:

Statistics	b_1 (K/L)	b_2 (CR3)	b_3 (TFP)	b_4 (BAL)	b_5 (DP)
Slope coefficients	-1.5E-5	0.127	-0.006	0.084	2.1E-4
t-statistics (slope coefficients)	-1.68	1.70	-2.26	1.90	1.59
Probability of 0 hypothesis	0.09	0.09	0.03	0.06	1.26

R-squared: 0.221 R-adj.: 0.175 F-statistics (prob. of 0 hypothesis): 0.00

Table 1a presents the basic theoretical approach to the explanation of the industrial patterns of export and specialisation. The first two variables deal with the Heckscher-Ohlin explanation of trade caused by country's relative endowments and factor requirements in production. It has been accepted by all previous studies that Czech Lands have a comparative advantage in the use of labour. From this fact it was implicitly inferred that it was due to relatively better domestic endowments of labour than of capital. It has been visible after 1990, when the market economy commenced to function, that the previous enormous accumulation of physical capital stock (measured in purchasing prices unadjusted for depreciation) was found antiquated and widely inefficient. At the same time there rose the demand for expensive imported physical capital, for the financing of which there was an enormous shortage of liquidity. Thus it is not surprising that the usage of physical capital stock has a negative sign and it becomes our most important explanatory variable in this model.

Exports diverting away from the capital intensive industries were at the same time avoiding to be involved in industries the expansion of which would require a large financial investment into their capital revamping. A cheaper alternative would be if the firms started their export expansion in the labour intensive industries. Surprisingly, this strategy was not confirmed by our estimation because the coefficient for labour per value added has a low statistical significance. There could be two explanations of this phenomenon. First, that the capital and labour are mutually correlated and therefore just one of the two variables (i.e. K/VA) would be sufficient. The second argument assumes that shunning away from the capital intensive industries does not always imply entering into a world of industries which would require more labour per output (i.e. where the substitution between K and L is the basic philosophy of efficiency). In case of unequal level of restructuring among industries, high export penetration could be expected from industries with both high and low levels of labour usage. The statistical significance of such mixed cases would be low.

Thus we have discovered that the assumption of an efficient substitutability between K and L need not be valid in an economy in transition. It was found in the analysis of efficiency by Benacek, Shemetilo and Petrov [1998]) that there may be industries with extensive exports where both capital and labour have been hoarded. Such industries can be ”technically inefficient” and their high export performance would be a paradox. This phenomenon deserves further analysis, for which we shall use the results from the test of total factor productivity (TFP). Our hypothesis, that exports should be associated with efficient industries only, was refuted because the coefficient for TFP is negative and highly significant. Thus we are challenged with a paradox that the Czech pattern of trade is not consistent with the principles of a prudent specialisation in exports. The industries where the factors are used efficiently are orientated to domestic sales while the industries with high technical inefficiency are orientated to the world market. An attempt to explain this paradox by an assumption that the restructuring in export industries in 1994 was more difficult than in industries with low export performance is even more paradoxical. In the latter part of this paper we will inquire further in order to break through this paradox.

The paradox with TFP can throw a new light on the explanation of the paradox of low significance of the L/VA variable. We know that the restructuring even in industries with high exports has not been completed. We also know that labour intensive industries in Czechia have certain advantage in export competitiveness due to endowments. But, though some high exporting labour intensive industries succeeded in downsizing the stock of labour inherited from the Communist past, many of them did not. Thus, a mixture of technically efficient and inefficient labour-intensive industries „spoiled“ the significance of L/VA in table 1a. Therefore we can infer that this indeterminate characteristic can last in the future, and be economically rational, provided the following processes will materialise:

a) There will be a shift of exports from capital-intensive to labour intensive industries - a process which **increases** the average L/VA ratio in exports (i.e. it decreases the productivity of labour embodied in exports),

b) in parallel there will be a process of improving the productivity of labour by labour shedding in labour-intensive industries - a process which **decreases** the L/VA ratio.

The next important variable is the concentration index (CR3). Its meaning can be explained that higher concentration ratio in industries implied not only a market power at home but also an outward oriented economic activity of multinationals associated with exports. The theories of industrial organisation and strategic trade (e.g. by Krugman [1995]) help explain this kind of pattern.

From the two statistically less significant variables of DP and BAL the former deals with a hypothesis which associates the price increases in industries with their export performance. The inflation higher than average should lead to higher export competitiveness. This would be in line with conclusions of both the Ricardian and the Stolper-Samuelson theorems after the opening up: industries with comparative advantage should benefit from an increase in relative prices when their domestic prices adjust to the level of the world prices which must be higher. Industries without a comparative advantage should have an adverse development of prices (i.e. inflation rates lower than average). We found that this relationship was present but generally quite weak.

Our test in table 1a has also rejected the hypothesis that the inter-industrial specialisation is generally a significant variable in deciding about the export penetration. A low significance of the Balassa index (BAL) indicates that high export penetration could have been achieved even in industries with high import penetration.

Let us now concentrate more closely at the role of labour and its use in the export performance. Labour is not a homogenous factor because of its different skills, which preclude its substitutability. We have therefore divided this indicator into two subgroups: UE

for university educated workers and LE for workers with lower levels of education. UE is thus a proxy variable for the human capital. In table 1b we have tested a hypothesis if the human capital could explain better why the variable of L/VA in table 1a was so indeterminate. For example, if UE and LE acted as substitutes, their distinct influence on exports could be hidden if they are taken as an aggregate.

The test, as indicated in table 1b, has shown that, on average, the Czech exports in 1994 were indifferent to the use of university educated employees. This is in sharp contrast to the export requirements of developed countries where higher skills are the main factor behind the development of exports. The remaining labour, i.e. one with middle and low skills, did not contribute with any additional information as far as the use of labour is concerned. The position of other significant variables - K/VA, CR3 and TFP - remained unchanged. The same can be said about less significant variables - BAL and DP.

In table 1c we have included both basic factors in one variable (K/L) which is a conventional way how the factors are tested in a perfect Heckscher-Ohlin environment. Unfortunately this change has decreased the significance of the model and the R-squared has fallen dramatically. After the pairing operation the data have concealed some important information, showing only a tendency that exports are preferably allocated to industries which are slightly labour intensive and close to the K/L average value for the whole economy. Once again it is suggested that figuring out the relationship between K and L is the crucial problem for discovering how the transition of the Czech economy functioned.

It is necessary to mention that we have also tested all other variables mentioned in our list above that described alternative measures of human capital, natural resources or comparative advantages, as outlined by economic theory. However, their statistical significance was generally either very low or we had problems with multicolinearity. As we can see, our empirical testing by using standard methods did not get very far. From a large list of exogenous variables only few most basic variables have proven to be (more or less) significant. It looks that Czech trade in 1994 has been developing only very partially in accordance with the determining mechanisms described by economic theory. Thus one would be tempted to come to a conclusion that the Czech export penetration pattern has developed free from the pressure of such determining factors like natural resources, R&D, costs and FDI.

What is even more disturbing is the impression from the OLS estimates that the pattern of specialisation was influenced much more by factors not included in the list of exogenous variables. Or the variables were correct, but used incorrectly. The reason for the latter statement is that, in contrast to theoretical economics and their causal linkages for testing, the real economies are seldom represented by an invariant and uniform order in the behaviour of economic agents. Also its data may be collected with errors. Thus a great deal of information can be lost in an empirical analysis by aggregating (or mixing) different populations of data with different behavioural patterns. For example, a population of firms in transition can be represented by subgroups of firms with **different objective functions and/or at different stages of transformation.** Therefore a new approach should be adopted in order to tackle this problem in a more sensitive way. One of the methods we used here is the robust econometric analysis based on **least trimmed squares.**

7. Robust Method of Estimation

When looking for determinants of some (response) variable, econometricians frequently considered a (linear) regression model and they employed typically all available data, in the sense that they selected some variables from the available ones but they used all available cases. In other words, when searching for factors, which have significant influence

on a response variable, we were prepared to accept only a model, which is valid for all observations simultaneously. Any interference with the "natural distribution" of the data is usually taken by economists as "data mining", and thus a practice worth the deepest contempt. Surprisingly, this purism in the belief of immaculate data is not shared by natural scientists.

It is evident that in the real life we may be challenged more than often with situations when a part of our data will represent either a **contamination** or our data can be **a mixture of two (or more) different populations**. To distinguish between them by means of an intuitive clustering may be rather difficult. This situation can be of a special importance in transforming economies where a multi-speed development of various segments may become a rule. The asymmetric **qualitative changes** can result in a situation where the economy is subject to heterogeneous behavioral patterns.

Robust methods of estimation of regression coefficients have been recently designed especially for solving the problems of heterogeneous patterns in data sets. The reason, why these methods were not much used in the past, was given by the extreme requirements of the method on both the memory and the speed of computers. Even now, when the Pentium processors offer a great computing comfort, the speed of one estimation prolongs approximately by a factor of approximately 25 thousand times more, relative to the time required for an OLS estimation. In the paper we have applied our own variant of a robust technique, namely the least trimmed squares. The corresponding estimator allows to adjusting breakdown point (see Visek [1994] or [1996]), and hence it is flexible for the pre-processing of data, as well as for their final study.

The detailed description technique of a robust estimation of coefficients based on least trimmed squares is in the paper by Visek [1999b], presented in this volume, or in Visek [1998a].

8. Numerical Results of the Robust Method of Estimation

We have applied the trimmed least squares on the same data and we have used the same initial specification of models (see equations 6-8 above). Firstly, we have separated the main subpopulation for all three models analysed in the previous chapter 4. The main population contained 49 industries (out of 91). We have started with the re-estimation of the basic equation of Table 1b, where labour was broken down to high skilled (UE) and low skilled (LE) subgroups. For comparison, a re-estimation was also performed for Table 1c. Results are summed up in Table 2b.

Table 2b:

Statistics	b_1 (UE/VA)	B_2 (LE/VA)	b_3 (K/VA)	b_4 (CR3)	b_5 (TFP)	b_6 (BAL)	b_7 (DP)
slope coefficients	11.89	7.41	-0.027	0.127	-0.006	0.002	0.190
t-statistics	6.75	2.88	-9.98	5.15	-9.78	1.24	12.98
Probability of 0 hypothesis	0.00	0.01	0.00	0.00	0.00	0.22	0.00

R-squared: 0.940 F-statistics (probability of 0 hypothesis): 0.00

If we compare Table 2b with Table 1b, it is apparent that the main improvement came in the significance of both the individual coefficients and the whole regression. The coefficient of determination rose to 0.94. Some coefficients have not been changed much - namely those of LE/VA, CR3 and TFP. The importance of the skilled labour, however,

dramatically increased, even though its coefficient in UE/VA was cut by nearly a half. We can see that there are in this country many industries where the skill labour matters in promoting higher exports. However, a bit higher importance was given to the use of physical capital (K/VA). Its negative sign confirms the hypothesis that high capital stock requirement in production is not an advantage for boosting exports.

The most important change has occurred with the role of price changes (DP). It was revealed that in the first subgroup high export performance was closely correlated with supernormal rises in price. The behavioural characteristics of the subpopulation studied in table 2b can be described as „traditional" and behaving in accordance to the theoretical assumptions.

Table 3b:

Statistics	b_1 (UE/VA)	b_2 (LE/VA)	b_3 (K/L)	b_4 (CR3)	b_5 (TFP)	b_6 (BAL)	b_7 (DP)
slope coefficients	-702.2	-698.3	0.035	0.190	0.001	0.002	0.085
t-statistics	-3.82	-3.81	4.69	2.16	0.15	0.39	2.22
Probability of 0 hypothesis	0.00	0.00	0.00	0.04	0.88	0.70	0.03

R-squared: 0.641 F-statistics (probability of 0 hypothesis): 0.00

Now let us turn our attention to the complementary subpopulation with 35 industries, which were excluded, from estimates in table 2b [6]. As we have already mentioned, it seems that its main behavioural characteristic rests in its relationship to labour. As we have seen, the first subpopulation was characterised by concentrating exports to labour intensive industries. The tests for the second subpopulation are indicated in Table 3b.

The most distinguished feature of the second subpopulation is its negative sign for the use of labour in export intensive industries. The requirements of labour per unit of net production by both categories of skills are negative. On the other hand, the positive sign for the capital-labour ratio indicates that the exports from industries in this sample belonged to capital intensive production. We can conclude our analysis with a surprising inference: it is characteristic for Czech industries with high export orientation that they profited from price inflation higher than average and from market power. However, it is less certain that they should be typically labour-intensive industries. Quite an important number of them are capital-intensive industries with low requirement of labour.

The total factor productivity, which changed its sign to positive, is not in conflict with the previous findings because it is not significant. The following hypothesis can be formulated for explaining this phenomenon: a comparative advantage in capital intensive production, coexisting with „normal" comparative advantage in labour intensive production, can be economically rational only if the physical capital was acquired at low cost. This could be the capital from huge investments from the period of central planning. Since this kind of capital was privatised either freely or very cheaply, its capitalisation can be very low and thus its cost burden can be negligible (see Benacek [1997] for more details of this peculiar behaviour). We can conclude that this type of „comparative advantage" may be in many cases neither authentic, nor permanent. After the attrition or depreciation these export capacities may shrink and be replaced by imports.

[6] *From the total of 91 industries tested the first pool contained 49 and the second pool 35 industries. The remaining 7 industries were removed because their properties in K and L usage did not fit to any of the two basic subpopulations. A contamination of data may be the cause of these irregularities.*

9. CONCLUSIONS

The results of our analysis hinted that robust methods of estimating regression coefficients in linear regression model are really powerful tools for finding ‘‘true ‘‘ (hidden) structure of data. If we did not have at hand these tools we would most probably come with a conclusion that the explanatory variables determining the structure of specialisation in trade were rather weak. On the other hand it would be intuitively clear that there were some strong factors present which shaped the emerging new industrial structure of exports.

The results gathered in the last two tables are consistent with another intuitive hypothesis: that the Czech economy in 1994 had a dual character. There could be observed two parallel patterns of behaviour among producers. In the first group we could observe behaviour similar to that in stabilised market economies. That means, behaviour compatible with standard economic theory of resource allocation. The second group consisted of industries where the restructuring was at the beginning and the behavioural pattern of their firms was similar to one under socialist ownership. Without the method of robust estimation it would very difficult to free oneself from intuition and find properties which point to the degree of restructuring in firms in the given industry, and unveil thus the path of progress of transformation in that industry.

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