Specialization, Competitiveness, Growth and Trade Policies: Microeconomic Factors behind the Balance of Trade

Vladimír Benáček [1], Ladislav Prokop [2] and Jan Víšek [3]

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The basic objective of this paper is to test the microeconomic foundations of the trade specialization and growth, and the relevance of some policy instruments, as illustrated on the case of the Czech economy. The export and import functions are estimated as panels for the EU and the non-EU countries, desaggregated into industries during the time period of 1993-2001. The models aim at an explanatory analysis of factors behind comparative advantages in exports and comparative disadvantages in imports.

Alternative specifications of the model at the endogenous side are considered, depending at which aspect of trade dynamics is tested: volumes, growth, balance, intra-industrial specialization, peculiarities in adjustments by industries, or the trade creation and diversion. All tests are based on a common list of exogenous variables representing the changes in aggregate demand, real exchange rate, structure of inflation, quality of products, factor endowments, FDI inflows and tariffs.

Though this research is still at a preliminary stage, it is almost certain that some of the conventional views on the dynamics of Czech trade should be reconsidered:

- The main drivers of Czech trade's dynamics and specialisation are associated with the changes in factor endowments and the inflows of FDI.
- The dependence of exports on foreign aggregate demand and imports on domestic absorption is confirmed by the data but their global influence is rather weak.
- The impact of real exchange rate changes on trade dynamics was also of a secondary importance.
- The differentiated "inflationary pressures" in individual industries were only very loosely associated with the trade structure; thus their impact on the weakening of the trade balance could be of marginal importance only.
- The pricing policies for gaining competitiveness in Czech exports and their support by exchange rate depreciation had a measurable impact on trade intensities; nevertheless, their role was not of a strategic significance.
- The role of quality in production for the competitiveness of both exports and imports is gaining on importance quite substantially.
- The role of tariffs on trade with the non-EU countries is significant and a switchover to the EU structure of tariffs can lead to a series of structural changes in imported structures.
- There is a strong structural inertia present in both Czech exports to the EU and imports from the non-EU countries.
- The exceptionally fast dynamics of trade with the EU are subject to strong (and growing) intra-industrial complementarities that are insensitive to exchange rate fluctuations.

[1] IIASA, Laxenburg, Austria, project on Economic Transition and Integration, and Charles University, Prague
[2] Czech National Bank, Prague, Monetary Department
[3] Charles University, Institute of Economic Studies

1. Introduction

The policy of any national bank has two domains: the state of inflation and the state of exchange rate. From them, however, there are both forward and backward linkages with the remaining economy dealing with growth, employment and external equilibrium. The effects and the causes influencing the national bank's policy "domains" cannot be studied by concentrating on the macroeconomic aggregates if the country is subject to a deep restructuring that is microeconomic at its core. It deals with enterprises, industrial product specialization, quality changes and competitiveness. Macroeconomic aggregates can give a false picture of real changes if there are perfect tradeoffs between enterprises (or industries) in a sense that the expansion of some of them is countervailed by a demise of others. The estimation of the factors behind **structural changes**, especially in the sector of manufacturing, is therefore a highly relevant issue to the monetary policy-making.

Exchange rate is an economic parameter that is closely related with both the sustainability of the current balance and the direction of net flows on the capital account. It is a mistake of many economists to rely just on the macroeconomic analysis when talking about the exchange rate regime options, nominal convergence and the trade balance. In the transition economies the exchange rate level is not just a function of price level changes between the traded and the non-traded sectors, or the changes in the average productivities of capital and labour. For example, in the most recent study in that train of pure macroeconomic thought Egert (2002) could explain only 5-20% of the real appreciation in countries like Poland, Hungary, Czechia or Slovakia. In some cases his estimation of macroeconomic parameters was not even significant. The Balassa-Samuelson effect may be relevant for economies where the condition of *ceteris paribus* holds for those variables that were not an explicit part of the model. Egert's study abstracted from changes in such dynamic variables like the intensity of inter and intra-industrial restructuring, market organization (e.g. the level of competition), terms of trade, quality of products, trade diversion, relative price developments at the commodity level, subsidies, demand changes; physical capital, human capital and labour endowments, FDI inflows and tariffs, which are standard theoretical instruments in the microeconomic models. The issues of an altered exchange rate sustainability of transition countries are related to the **qualitative changes** after the economic recovery, especially if there are changes in trade competitiveness associated with the **growth** boosted from the export side and the **gains in the terms of trade** due to product and marketing **quality upgrades**. Macroeconomic analysis of the real exchange rate has only a limited scope in explaining the depth of such underlying factors.

Our applied study is offering an alternative microeconomic approach by concentrating on the dynamics of export and import part of the GDP. The field of exports and imports is dominated by three theories of specialization: Ricardian, neo-classic (Heckscher-Ohlin) and "new". At this stage of research we could consider only a part of them. On the other hand, we cannot expect that our research would be able to address the issues of exchange rate and trade balance forecasts directly. Our conclusions are related to the past trends and the quantitative characteristics (e.g. elasticities) of their determining factors. It is expected that trends in these fundamental factors are not excessively volatile or easily reverted. Our analysis offers more confidence to the policy-makers about the intensity of underlying changes at the micro and mezzo-levels. However, it would be naïve to assume that such models could supersede the creative role of policy-making by offering finished quantitative guidelines for the future developments in the economy.

2. Trade, growth, competitiveness and modelling

The problem of this paper centres on the growth and the evolution of competitiveness of domestic production vis-à-vis the competition with producers from abroad. A large part of such changes is reflected in the exchange rate pressures. The opening up of the post-communist economies and the process of their integration into the European Union (EU) had a big impact on the structure of specialization and on growth throughout the whole of Europe. The need to divert the trade from the East to the West and to restructure the supply side resulted in large terms of trade losses and large transformation costs. The competitiveness of the domestic economy was first sharply decreasing, what was reflected in exchange rate real depreciation and profound decreases in the unit labour costs. After the stabilization and economic recovery the real exchange rate commenced to appreciate and the price of labour was rising, reflecting the gains in competitiveness and exponentially increasing exports.

All transition economies experienced a substantial growth in their trade with the EU after the economic liberalization. For the majority of them that was a permanent trend that lasted throughout the whole of 1990s. For example, the Czech exports to the EU during 1993-99 rose from US$ 8 billion to US$ 18.4 billion. That implied an average annual growth of exports by a striking 16.3%, while Czech exports with the rest of the world grew at a normal rate of 4%. At the same time the trade creation with the OECD partners was accompanied by a large trade diversion from former partners grouped in the Council for Mutual Economic Assistance (COMECON). Trade liberalization concessions on the Czech and the EU sides have therefore opened an unprecedented window of opportunity. Their particular structural development was country specific – determined by particular local characteristics, such as factor endowments, policies and other economic factors.

The liberalization of trade had large repercussions on the whole domestic economies of transition countries by bringing with itself new strategic incentives to growth and restructuring. This automatic impact of the openness could be so strong that it dominated the economic growth. For example, we can find out that the **fast development of Czech international trade throughout the 1990s became one of the crucial constructive moments of transition in the whole Czech economy.** It is the purpose of this study to deal more closely with the theoretical, quantitative, and technical aspects of the analysis of such changes.

Taken theoretically, the developments in international trade in small open economies determine the allocation and the efficacy of the majority of domestic resources. Since the share of traded commodities produced for exports and for domestic replacement of imports on the GDP is very high in such countries, export and import functions overlap to a large extent with the empirical models proposed for the explanation of the GDP dynamics, as proposed for example by Barro (1991), Levine and Renelt (1992), Sala-i-Martin (1996) or recently by Crespo-Cuaresma, Dimitz and Ritzberger-Grünwald (2001) and Badinger, Tondl (2002). The overlap can be explained on the macro identities for production (Y) and absorption (A):

$$Y = C + I + G + X$$

$$A = C + I + G + M$$

The export and import functions are relevant not only for explaining exports and imports (X, M) but also for that part of domestic production for domestic consumption (C + I + G) which is traded. That means, some determining factors for X and M can be also potentially relevant for the allocation of resources to those domestically produced and domestically consumed commodities where there are either alternatives to export, or where the imports compete with domestic production. In the Czech case it means the relevance for not only 65% of GDP that is exported (or imported, respectively) but also for potentially that part of C+I+G that is traded internationally – which is estimated to additional 15-20% of the GDP. Thus the

location, redistribution and demise of resources for the production of at least 80% of the Czech GDP can be subject to the evolution of comparative advantages and competitive advantages estimated by export or import functions.

The general relevance of export and import functions for the growth in transition economies and their crowding-out of the standard macromodels of growth, can be strengthened by technical arguments for the estimation of the parameters of growth [4]. While the estimation of macroeconomic production functions depends on time series, which are usually too short and hide the depth of adjustment processes in the economy, the estimation of export and import functions can benefit from more information contained in their sectoral dimension. On top of it, export and import functions are (pragmatically) superior to closed economy growth models because they can deal more naturally with the interaction of the domestic economy with the outside world. **Intrinsically asymmetric evolution of sectors is in the core of growth dynamics**. It has little meaning in closed economies where the determining factors of specialization are completely exogenous to the economy.

Though "**competitiveness**" is a word very often used in the statements of business or government officials, it can be seldom found in economic textbooks [5]. There the word "comparative advantage" is rather preferred – describing the causes of success or failure of producers' performance on world markets. However, as one gets through to the substance of comparative advantages, as explained by either the Ricardian or the Heckscher-Ohlin theories, it is not difficult to understand that "comparative advantage" and "competitiveness" need not necessarily overlap because competitiveness is a wider and more heterogeneous concept. In the Ricardian sense "the comparative advantage" means a favourable starting position in the **physical labour contents** (intensities, requirements) of a physical unit of production of one producer **relative to the labour contents of the production of its competitors**. In the Heckscher-Ohlin context it is **the ability of firms to adjust the structure of production to the relative factor endowments** of that particular country. Here "comparative advantage" and "competitiveness" can be taken for synonyms. On the other hand, the term **"competitiveness"**, as defined in the business literature, has strictly pragmatic meaning: as **the capacity of firms to sustain their market share**, or even as their ability **to increase** the market share. Market structure changes are often in the background of the competitiveness in their sense. Hardly anything is said there about their relative labour contents or about the factor requirements matching the endowments, even though implicitly they may be important.

Competitiveness can be also achieved by **taking advantage of the scale economies, the product differentiation, and the market power [6]**. At that point the argument may still remain within the tenets of the **new trade theories**, though its causes shifted far away from the classical theories of comparative advantages. As a crucial alternative, competitiveness can be explained by **institutional and policy factors, such as using (or abusing) the public**

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[4] *Aggregate production functions estimated on macroeconomic identities were subjected to a harsh criticism recently. The best overview is provided by Felipe and McCombie (2002).*

[5] *Paul Krugman made a very pronounced critique of this fashionable term. According to him, "competitiveness" may be interpreted as "a poetic way of saying productivity, without actually implying that international competition has anything to do with it" (Krugman 1994, p.33). On the other hand, the economists from business circles argue that "It is widely accepted in economic literature that a country's competitiveness cannot be reduced only to GDP and productivity, because firms must cope with the political, cultural, and educational dimensions of countries, as well as their economies" (WCY, 2001). So "competitiveness" is not a concept related to a whole nation (as Krugman imputes) but it still may remain at a level of enterprises.*

[6] *The literature most often referred to in this respect is Helpman and Krugman (1985). A textbook description is in Krugman and Obstfeld (1997). Coming to terms with these factors is a crucial condition of growth in all modern open economies.*

resources in the hands of the government and by various protectionist measures (Bayard and Elliott 1992). There the most notorious case is the subsidization of agricultural products in the European Commission. The EU agriculture may afterwards turn from goods out-competed by imports to "successful" export commodities (Pelkmans 1997, p. 168-171). The rising social costs of such gains in competitiveness are often disregarded.

Higher competitiveness in international trading can be also achieved by the **exchange rate depreciation or by directly lowering the wage rates**. The theories behind various definitions of real exchange rates are important theoretic contributions for the explanation of "competitiveness". In its less orthodox version, an appreciation of the real exchange rate, defined as a higher growth in the price level of non-traded goods over the growth in the price level of traded goods (well structured in compliance with comparative advantages), could become a serious threat undermining the competitiveness of internationally traded production in the large segment of the economy. Further on, the imbalances on the monetary and internal side have links to problems on the external side of the real economy, as was first analysed by Salter (1959). Various monetary policy instruments can therefore influence the competitiveness beyond the objectively determined comparative advantages (Dornbusch 1973). Though the theory of real exchange rate can tell a lot about competitiveness in stabilized economies, it can offer only a small part of the story in cases of transition economies, as the paper of Egert (2002) has shown.

Theoretical terms like comparative advantages, factor endowments and factor productivities are treated as **objectively given** economic fundamentals that directly influence the competitiveness in exchanges on international markets. However, "competitiveness" can be significantly influenced by subjective factors, among which economic policies are the most important. Different policies can have different real outcomes, influencing thus the development in fundamentals. The effects of policies can have a polar direction: they can be directed either towards a support of fundamentals (e.g. improved education promoting efficiency) or against them (e.g. subsidies to inefficient firms). We can therefore judge policies in open economies as instruments for enhancing the market pressures, growth and competitiveness – calling them the **policies of encouragement and disciplining**. Or alternatively, policies can act as instruments of **discouragement and protection** that decreases the competitiveness in the long run (see Selowsky, Mitra *et al*. 2001). **Therefore, competitiveness is a term describing empirical phenomena related to both fundamental determining factors and policies**.

Observed empirically, the competitiveness in foreign trade is therefore revealed as **differences in the growth rate that lead to a change in the composition of exports or imports in time**, which can be related to two structural aspects:

- geographical (territorial) breakdown,
- commodity breakdown.

Our problem can be depicted by a matrix of trade growth indices π_{ij} , taken separately for annual changes in exports (ΔX) and imports (ΔM):

$\pi_{ij}^{(X)} = \Delta X_{ij} / X_{ij}$

$\pi_{ij}^{(M)} = \Delta M_{ij} / M_{ij}$

where i = 1, 2, 3, …, m are countries as trading partners of the analysed "home" country;
j = 1, 2, 3, …, n are commodities traded.

The empirical estimation of the whole problem can be simplified by taking natural logarithms of the trade flows. The aim of this study will be to find out what determining factors were behind these changes in the trade flows. The analysis will be based on econometric hypothesis testing by using the export and import functions applied on Czech

data. The policy implications and predictions for the process of EU enlargement are also among the aims of this paper.

3. Structural Trade Changes and Restructuring in the Process of Opening Up

The international trade of Communist countries, under the institutional backing of COMECON, was relatively intensive. However, it lacked the support of the market mechanism for the determination of the structure of specialization at the level of standard economic agents, such as producers, exporters, and importers. The structural microeconomic problem of specialization was therefore determined at the level of bureaucratic decision-making – to a large extent outside of enterprises and market signals. It was then highly probable that the resultant specialization pattern would miss some of the absolutely crucial economic criteria, such as comparative advantages, efficiency, or competitiveness. The result is then obvious: the allocation of resources would be sub-optimal and, in the long run, the problems with external balance and the GDP growth would intensify.

If we look at the nature of trading among the COMECON countries until the end of the 1980s, the situation looked quite satisfactory, at least at the level of macro statistics. The trade was growing and the external imbalances were always accommodated by some administrative intervention. In all cases the trade of COMECON countries revealed signs of **preferential trading characteristics,** so typical for countries with economies integrated under a formal (institutionally controlled) treaty. That means, they revealed features of trading where the preferential treatment of international exchanges was guaranteed for the member states only. No attempts were even made to hide the fact that the decision-making was grossly discretionary (administrative) and that discrimination was an obvious rule. Most surprisingly, however, the commodity breakdown of trade among the COMECON partners revealed characteristics compatible with Heckscher-Ohlin criteria. That means, in the majority of cases, that the trade structure was compatible with endowments and scarcities in the basic productive factors (labour, capital, human capital, and natural resources) – see Benacek (1988a, 1988b, and 1989).

Once the institutions of COMECON collapsed and price and trade liberalization became a standard policy among its former member states, an intensive **trade diversion** was a natural process that followed as an aftermath. Already in 1991, negotiations began about the trade preferential arrangements offered by the European Commission to some of the post-communist countries. The Association Agreements of these economies with the EU countries, aiming at creating a free trade area at the end of the century, intensified during 1992-94. The trend of channelling the majority trade through free trade arrangements led to the creation of the Central European Free Trade Agreement (CEFTA) in 1993. Its impact was visible in an intensive trade creation among its members, often at the expense of trade diversion from countries outside the EU and CEFTA alliances. In that sense CEFTA behaved like a typical customs union (Pelkmans 1997).

Our empirical analysis will concentrate on the comparison of developments in Czech trade with two geographical regions:

(1) EU 15 (comprising 69% of Czech exports and 64.5% of imports in 1999);

(2) Rest of the world that includes the remaining developed market economies (comprising 5.8% of Czech exports and 11.2% of imports), post-communist countries (21,6% X and 20% M), and newly industrialized countries and less developed countries (4.4% X and 3.3% M).

Though the trade of the Czech Republic with the EU is dominant and steadily growing, the regional trade balances will remain open to large changes due to expected EU accession and fluctuations in enormous capital account surpluses with market economies. **Trade re-adjustments** due to trade diversion and diversified intensity of **trade creation** with

alternative trade partners associated with **restructuring at the enterprise level** will remain for long a sensitive issue in all transition economies. The balance of trade can be brought to equilibrium by various mechanisms and policies, and we should be aware which factors could be hiding behind the dynamics of exports and imports.

4. The Bias in Statistics

The purpose of this paper – to quantify the factors related to the intensity of trade flows with the EU after the opening up – depends to a large extent on the quality of data. Though both international and Czech trade statistics appear to be highly elaborated, their contents have many methodological problems. Extensive data overhauling and conversion must be performed before model computations. First, the exports of the Czech Republic to the EU need not be the same as the imports of the EU from the Czech Republic. The significant differences in the national customs statistics can be subject to different commercial statuses of the trade – the first one is in the parity of FOB (free on board), the other is measured as CIF (cost, insurance and freight), where the difference is caused by transportation and insurance costs between the Czech border and the reporting country. Different periods of customs declaration can be also a source of variations in national annual statistics.

We should also consider the potential for errors or omissions, the latter being sometimes intentional due to tax evasion. Especially the statistics on the quantities of trade (e.g., in tons) are prone to errors, since not all commodities are declared in the same measures of quantities. Some data can be in a different system of nomenclature. For example, trade is usually recorded in the Standard Industrial Trade Classification (SITC) codes or the Combined Nomenclature (CN) classifications describing products, while the statistics of production and supply side characteristics is in the Statistical Classification of Economic Activity (such as NACE or OKEČ) codes, describing processes. The researcher has no better option than to transform one system of statistics into another, what may become a cause for bias. From practical reasons, in the interim testing of our model we took the trade and tariff data in SITC and correspondingly transformed the industrial data in NACE (OKEC) into SITC classification. Unfortunately a serious inverse **conversion (from SITC into NACE)** was much more difficult than we expected – becoming one of the highlights of this paper.

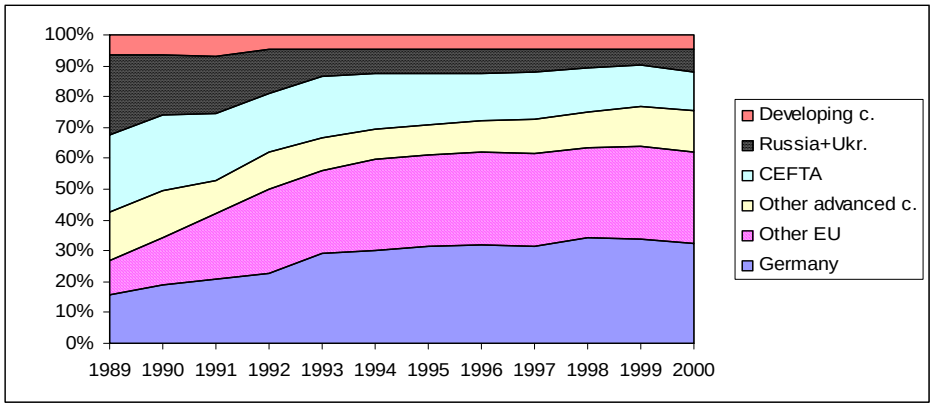
In addition there were two further problems. International trade may be recorded in different currency units (US dollars or euros) than the remaining domestic statistics. The average exchange rate can bias the **conversion into CZK**, since the exchange rates may fluctuate daily and the given variable of sectoral trade need not develop linearly with it in time. Last but not least, the **methodological changes in statistical reporting** can lead to a serious bias in trade time series. For example, the post-communist countries adopted the World Trade Organization (WTO) statistical standards without adjusting back the time series. Thus the addition of re-export, inward or outward processing trade and leasing can seriously damage the compatibility of data for 1993-95. Therefore it is highly advisable to devote sufficient time and statistical techniques to the data checking and adjustments for evident errors and omissions.

Figures 1 and 2 depict how the shares of Czech imports and exports changed over the period from 1989-1999, if we consider 6 major regions. We can see that the trade with OECD countries had the fastest positive dynamics. The trade with CEFTA and with developing countries lost its share only marginally, while Russia and Ukraine were the main losers. We can also observe that the bulk of changes occurred during 1990-94 [7]. The period of 1995-

[7] *A similar structural change is revealed in the Hungarian structure of trade (Darvas and Sass 2001). In a more detailed examination we can see that it was Germany that became the main winner in the*

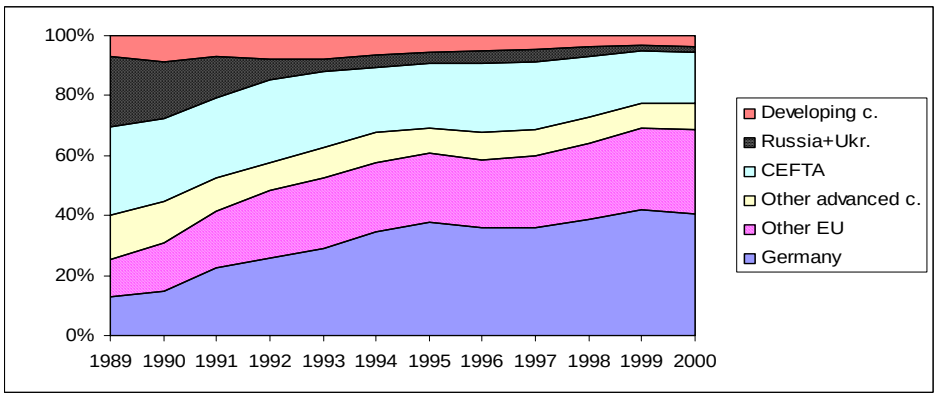
1999 can be characterized as a period of geographical stabilization. The growth rates of trade remained very high (over 15% annually) but the shares of regions on the total trade changed only mildly during 1995-99. On the other hand, there were proceeding deep changes in the industrial structure of trade [8]. This is an important moment to be realized for our analysis, since our nine-year period of 1993-99 is composed of two parts: 1993-94, when trade diversion prevailed, and 1995-2001, when the trade creation was dominant**.**

Figure 1: Share of Czech imports from economic regions in 1989-2000



Source: trade statistics of Czech Statistical Office adjusted for changes in methodology

Figure 2: Share of Czech exports to economic regions in 1989-2000



Source: ibid

There is a consistency problem when we work with time series in an environment that is subject to intensive qualitative changes, such as an economic transition. A priori we cannot exclude a case that during the studied period the nature of **economic agents** (especially firms) changed to such a degree that the underlying trade was subject to different behavioural patterns. An artificial amalgamation of disparate time periods and disparate groups of industries (or enterprises inside of industries) could then result in a weak statistical

long-run battle for the Czech market. German-speaking advanced markets (Germany, Austria, and Switzerland) make up more than half of the Czech trade turnover. In 1971 it was just below 10%.

[8] The best studies in this respect were elaborated by Tomsik, Kubicek and Srholec (2002a and 2002b). According to them, the structural changes (at NACE 2-digit classification) were present in all transition economies, though Hungary was the country with the most extensive restructuring. Nevertheless, the intensity of structural changes is a microeconomic phenomenon and only a more disaggregated level of industries (e.g. at 3 or 4 digits) can unveil the real intensity of new specialisation patterns.

significance of estimated behavioural characteristics. Mixing two populations of data into one dataset for testing, each of which responds differently to the explanatory variables, can be dangerous. This problem can intensify if the data are composed of industries of two types: those developing under the pressure of FDI and international competition and those resisting the restructuring (for example, in an expectation for a bailout from the government or other implicit subsidies). Special statistical methods were developed in order to reveal such situations. One of them is, for example, robust statistics (Visek 1996). For more information about such applications on problems of international trade see Benacek and Visek (1999). From this aspect, this study was not concluded. The next step in our future research would be to concentrate more on the inconsistencies in data and in the behaviour of enterprises (industries).

A serious methodological problem is associated with the statistics measuring the physical capital – a crucial variable for the Heckscher-Ohlin theory of trade. There are only two official time series in constant prices. The first one, for 1993-97, is in adjusted purchasing prices without depreciation. The question is what might be the real price of inactive assets in so many still surviving but heavily indebted enterprises with ever decreasing output. The alternative time series is only for 1998-2000 where the assets are in replacement costs (market values) adjusted to depreciation. The transformation of the latter to the former (which we used) is to a large extent a rough approach. There are also missing OECD statistics of physical capital that could be used for an estimation of relative capital endowments.

5. Specification of Models for Empirical Testing of Imports and Exports

Our basic import and export models for the empirical testing were derived from the theory of international economics. Unfortunately, there is not just one theory of trade and specialization. Econometric studies dealing with the estimation of factors influencing the commodity structure of international trade had to tackle this problem by using a number of exogenous variables that do not come from just one theoretical school of trade specialization (see Pain and Wakelin, 1997) or Aturupane, Djankov and Hoekman, 1997). Luckily, the parallel paradigms seem to concentrate on **alternative aspects of the causal forces leading to trade**.

For the **imports**, we have tested which factors were active in determining the value of imported commodities in industrial groups aggregated by two-digit classification i = 1, 2, …, 28 during the nine years t = 1993 through 2001, as expressed in nominal values (in CZK). In accordance with the Keynesian theory, imports (M_{it}) of the Czech Republic were considered a function of Czech gross domestic product (GDP) in real terms (constant CZK of 1995) and a variable of inflation (IN_{it}). The combination of these two variables reflects the potential of the purchasing absorption of the aggregate domestic demand in nominal terms. The coefficient of the variable of inflation has an additional interpretation: if it is statistically significant and negative then we can treat it as a standard demand factor. The inflation in the given industry discourages the consumers to purchase the given product. If the sign is positive, then we should look more at the supply side: the products were either improving their quality or the industry was subject to evolving oligopolistic pricing. In addition, we could extend this set of explanatory variables by adding the real exchange rate [9] (based on CPI), since individual industry-based inflators are not correlated with real exchange rate changes that are universal for the whole economy. The real exchange rate appreciation (i.e. the higher values of RER) should be associated with rising imports.

[9] *The discussion of the inclusion of the real exchange rate (or even the nominal exchange rate) should deserve more theoretical attention. At this preliminary stage we leave this issue still open.*

On the other hand, the **exports** were tested as a function of GDP in the partner countries (in nominal EUR) and the real exchange rate, which transfers the aggregate demand abroad into a part of Czech effective aggregate demand related to potential exports. In addition we could retain here the variable of Czech domestic inflation. It is assumed that the difference in indices of the sectoral inflation reflects the narrowing of the gap between the world prices and the former prices under central planning. It is a measure of **nominal convergence** related to the intensity of trading. The inflation index reflects how the domestic relative prices changed after opening up to the West. We could expect that in sectors open to trade the nominal convergence will proceed faster. This is also closely related to the improvements in terms of trade which "pass-through" into the domestic price level. The higher is the imported "inflation" in the given industry, the higher should be the growth in its exports. The Stolper-Samuelson and the Haberler theorems are consistent with this hypothesis. They explain why the export sectors have higher "inflation" than the sectors without comparative advantages.

Let us now continue with the specification of our functions. In accordance with the neo-classical theory of trade, imports are considered a function of **relative unit prices**. Namely, we should relate domestic and foreign unit prices. But this raises a discussion about which prices should be concretely compared. Either we can take the internal prices at home relative to the internal prices abroad, as is done in the literature describing the evolution of trade from autarchy. Such statistics unfortunately do not exist. Alternatively we could compare the domestic export prices with the export prices of our foreign competitors. That is again a problem since there are too many varied competitors all over the world and we are not sure which of them are the relevant ones. Last but not least, because we deal with tradable commodities in highly open and competing economies, we could **compare the domestic export prices with the prices of domestic imports**, which was finally the case in this study. It is assumed that these two prices represent competing products. A similar option was taken, for example, in the seminal papers by MacDougall, 1951 and 1952. If the model is non-linear (e.g. a power function of Cobb-Douglas type),[10] then its coefficient represents the "elasticity of substitution" of world consumers (importers) of the given product between our country's exports and the production of our competitors. A review of the problem is provided in Harberger, 1957).

Here we were challenged by methodological problems concerning both the numerator and the denominator:

a] Since neither the unit prices for aggregated NACE groups of products nor even the time series of their inflators are available, the analysts are obliged to resort to substitutes. In our case we used **values of exports and imports (in CZK) per ton** of given products as proxy variables for unit prices. This is evidently a second best option that has only pragmatic justification. However, its bias as a representative of unit prices can be present.

b] Unit prices based on values per ton can have an ambiguous interpretation since they reflect both the **cost** (i.e. the price competitiveness of two otherwise identical products) and the **quality**. In the latter case, if the prices differ, the products are differentiated. In case of a vertical differentiation the products look only seemingly similar because they belong to "vertically" different consumer baskets due to different quality (e.g., to up-market and down-market products). According to various studies, vertical differentiation dominates the trade among industrial countries (Fontagné *et al*. 1998). If our indicator of relative prices changes in time, we may interpret that in two ways: first we may assume that there was a "vertical"

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[10] Taken concretely we could "explain" the intensity of Czech exports to the EU by a model: $X_{it}^{EU} = A\,(PX_{it}^{(EU)} / PM_{it}^{(EU)})^{B}$ *where A is the constant term and B is the coefficient of the elasticity of substitution between the purchases of an identical commodity* ***i*** *produced in Czechia and in the EU. PX and PM are price indices of Czech exports to the EU and Czech imports from the EU, respectively.*

shift in relative quality and not in relative costs – the reason for that may be that the law of one world price precludes such competition. But the law of one price has its clear limits. Thus we may take a second assumption where the competition is based only on changed prices without any recourse to shifts in quality. Both of these important alternative aspects should be estimated in our empirical analysis.

c] Problem of relative price competitiveness can be even better revealed if the differentiation is horizontal. There the products belong to a similar category of quality, but otherwise they need not be identical in their prices or costs.

The problems mentioned under b] and c] are associated with representation. The measurement of comparative advantages, in the strictest sense of the Ricardian theory, is subject to two different price comparisons (see Brenton *et al*., 1997, p. 15 and 23):

- relative prices of two identical products from two countries (before the trade starts) and
- terms of trade of two different products from two countries (when the trade exists).

In the first case, we compare **identical products** from two countries, where the relationship PX_{it}/PM_{it} can be applied only for **autarchy**, since the opening-up of trade equalises prices of identical products and the product with local comparative disadvantage is not traded by that country.

In our estimated models the condition of export product homogeneity and its perfect substitutability by imports is therefore infringed because in any of our 29 NACE product groups we compare two bundles (vectors) of products subject to an unpredictable degree of variety. Though such relative prices have hardly any meaning in the given year, we can at least interpret their changes in time because our relative price index becomes actually an ***index of terms of trade*** – and that is a concept that has definitely its economic relevance. In other words, in the variable PX_{it}/PM_{it} we are located in a space defined from an index of price competitiveness between two perfectly homogenous products (competing in prices under horizontal differentiation), up to an index of classical terms of trade derived from barter between two completely different (and mutually non-competing) products. Though these concepts have a different theoretical interpretation, their changes in time still retain one or the other aspect of competitiveness.

All three of our caveats a], b], c] are serious. We know that in PX/PM we are measuring some important features of competitiveness, however, the complications in interpretation of the signs make our conclusions rather uncertain. The conclusions must be very cautious, especially if the price variable is statistically significant. We offer some clues for getting out of the tangle by accepting some simplifications that have a high degree of credibility. We once again repeat that it is not the absolute values in the price variables that matter in our regressions, but their **annual changes during 9 years**. For example, in the model of Czech **exports** to the EU we test the price variable PX_{it}/PM_{it}. After taking the natural logarithms we can separate them and get $Ln(PX_{it})$ and $Ln(PM_{it})$. If the sign of the first variable is statistically significant and **negative**, then export price decreases in time are compatible with more intensive exports. The case that higher exports would be compatible with decreases in their quality can be refuted as logically incorrect. Therefore, we can judge that it must have been the **price (cost) competitiveness** in Czech exports that was the dominant feature in their penetration on the EU markets.

On the other hand, if the coefficient for PX had a **positive sign**, that would indicate the dominance of Czech **quality competition**. Higher exports are compatible only with improvements in quality that are reflected in price increases. The complication is that, if at the same time also the coefficient of PM is positive. Then we can say that, with high probability, the Czech "average" export growth happened **in spite** of the EU's rising quality. Thus both competitions in quality were successful, for example, due to well-chosen differentiation of products.

Additional information can be potentially derived from the previous results – i.e., when both coefficients were positive. First we should be aware that it was just the prevailing tendency among 29 industries. Of course, there could exist some less successful Czech industries that lost their competitiveness in exports because they were not able to offset the rising quality in the EU domestic products by their own quality improvements. Their only short-run strategy for survival would be to lower the export prices [11]. Then our coefficients should change in time: the coefficient for PM should remain positive (i.e. the quality abroad in increasing) while the coefficient for PX becomes negative (our export prices go down in order to gain competitiveness). As an addition to our analysis, we could separate by robust methods of estimation those industries that are competing in prices from those competing in quality.

Another problem to discuss is if both price variables are statistically insignificant. Then we would end up in a shadow area: both the price and the quality competitions seem to be irrelevant in their global impact on trading. That is logically untenable (once the ton-prices were changing in time), because the competition should have one or the other form. It is not very credible that the elasticity of demand to price or quality changes would be zero. Either we conclude (1) that our price data were wrongly measured and therefore they were not correlated with the real factors of competitiveness, or (2) that our data consisted of two mutually perfectly balanced mixed populations of products that, in their relationship to unit prices, behaved in opposite directions. For example, one subpopulation was subject to price competition while the other subpopulation was subject to quality competition. Again, a robust technique of estimation should be used to separate the subpopulations.

Let us now discuss the explanatory variables that deal with pure institutional interferences with imports. Tariffs (Tar_{it}) are the most common trade policy instruments. They represent an important barrier that impedes the penetration of imports on the domestic market. It is our task to find out how Czech trade behaved as the tariffs with the EU were gradually lifted throughout 1992-99, while they were kept with the majority of non-EU countries. We will estimate this influence by the coefficient of elasticity that should have a negative sign. Tariffs, however, may not be the most important institutional instruments influencing the intensity of trade flows. We should also consider the non-tariff barriers (NTBs) and subsidies.

NTBs are expected to be sharply decreasing after the EU accession. In some studies (see Broeker (2002)) the NTB decrease due to full EU membership can be estimated to be 12-16% in the cost gains. Here both exports and import gain. In addition, the competitiveness of the domestic economy can be artificially increased by **subsidies**. For example, subsidies can increase the price competitiveness of domestic producers vis-à-vis competing imported goods as much as they can help exporters. With the exception of subsidies for agriculture, the subsidies provided to the Czech economy directly from public budgets were quite low. On the other hand, the **implicit quasi-subsidies** provided by the semi-state banking system were huge. They were hidden in soft credit lines that in many cases were *a priory* not expected to be disbursed (fully or partially) at the time of maturity. By May 2000, 34% of all accumulated bank credits were classified, which amounted to approximately US$10 billion (15% of GDP). As the banking insolvency threatened to destabilize the whole Czech economy, the bad debts were either converted into securities and purchased by the Consolidation Bank or directly bailed out by the state institutions. The commercial banks and some large corporations were thus directly subsidised for their losses by the Ministry of Finance, Czech National Bank, or

[11] *Such result can now also have an impact on policies for a longer period: the losing industry can survive either by decreasing their costs (by increased productivity or by decreased labour costs) or by investing into a quality improvement. In addition there are further alternatives: the losing industry can lobby for depreciation or for subsidy. It is obvious that the last two policies of competitiveness are economically inferior to the former two.*

the National Property Fund. The debtors of commercial banks were then subsidised indirectly (implicitly).

Inter-enterprise indebtedness represented another source of implicit subsidies, representing nearly US$8 billion. The usual rule was that a successful enterprise ended up in a position of a creditor, while a less competitive producer became a net beneficiary of such arrangements. The third form of implicit subsidization of enterprises was offered by waiving their taxes, social security, and health insurance payments or the instalments for the privatisation of state property. In aggregate for the 10 years of transition, these three unofficial (but officially widely tolerated) sources of relief represented at least US$30 billion (approximately a half of the Czech GDP). Since their recipients recruited mostly from declining industries, which cannot be assumed to abound in comparative advantages, the implicit subsidies represented a potential defence against import competition in the given industry. We will estimate the intensity of implicit subsidies (S_i) [12] by a proxy of accumulated net stock of debts in given industry *i*. In order to exclude the bias of different sizes of industries, we weighted this variable by the value added in industries. We would expect a negative sign of this variable in the import function. On the other hand, implicit subsidies increase the competitiveness in exports, too, and the sign of this variable in the export function should be positive.

Relative factor endowments of production, measured by capital per labour ratios, are the exclusive determining factors in the Heckscher-Ohlin models of trade specialization. It is traditionally assumed that the Czechia is a country relatively better endowed with labour, if the international comparison of the K/L endowments is made as a trade-weighted average with trading partners. Relative to the EU, it is expected that Czech exports should be biased toward intensive-intensive products. We cannot be as certain about the sign with the rest of the world. Our test is therefore a test of the factor intensities and of the relevance of factor proportions in determining the trade patterns.

The intensities of Czech trade can be influenced by the presence of foreign direct investment (FDI), namely the FDI industrial stock (Benacek *et al*., 2000). Together with the relative factor endowments, this variable characterises the supply side of production. It can reflect especially the qualitative aspects of managerial skills, the ability to penetrate world markets, and the quality of the physical capital. In the export function, the presence of a large FDI stock in an industry should boost its exports, since FDI location is attracted by comparative advantages and by the potential for growth they offer. The relationship is less obvious in the import function. We can assume that, in the long run, FDI can be a **substitute for imports** in the given category of products *i* and its sign should thus be negative. At the same time, however, FDI can be a **complement** to imports of inputs and machines to the given production in the short run. This can be especially our case because our NACE two-digit classification of products is too gross. On top of that, FDI can also boost imports of inputs in the subcontracting industries. As a result, we cannot be certain a priori about the expected sign of FDI in the import function, even though FDI can be assumed to be an instrument for balance of trade improvements and exchange rate appreciation.

At this closing stage of our model specification we should solve the following problem: up until this moment the absolute values of trade flows have been "explained" either by dummies (such as GDP or real exchange rate) or by intensities (indices) unrelated to the size of industries. The only exception was the variable for the stock of FDI, which in fact is only loosely related to the "size" of a given industry. Intensities of trade flows by commodity groups are definitely subject to the size of given industries that were defined to a large extent

[12] *Unfortunately, at this stage of research we could not reconstruct the full time series of data for implicit subsidies by individual industries. Thus this variable was not used in our estimations.*

arbitrarily.[13] Therefore, we should add to the given list a variable that could explain better both the import "pull" and the export "push" caused by the size of the productive capacity in industries. Material inputs [14] were chosen for that purpose for one additional reason. Exports and imports (or domestic import replacements) of an industry are a composite category that includes both the value added in the given industry and the cumulated intermediate inputs from the previous stages of production. Along with the inputs of capital and labour we should therefore also keep track how the inputs of energy and material are related to the competitiveness of exports or imports (the latter relative to the domestic import replacements). Our models would be then able to emulate the KLEM production functions working with capital, labour, energy and material inputs.

The basic models for empirical testing therefore are defined as follows:

$$\mathbf{M_{it}^{w} = \Phi_M^{w} (GDP_t, RER_t^{w}, IN_{it}, PM_{it}^{w}/PX_{it}^{w}, K_{it}/L_{it}, FDI_{it}, Tar_{it}, \varepsilon_{it}^{w})}$$
$$\mathbf{X_{it}^{w} = \Phi_X^{w} (GDP_t^{w}, RER_t^{w}, IN_{it}, PX_{it}^{w}/PM_{it}^{w}, K_{it}/L_{it}, FDI_{it}, Tar_{it}^{w}, \varepsilon_{it}^{w})}$$

where
i = 1, 2, …, 28 are commodity groups at NACE two-digit classification;
t = years 1993 through 2001;
w = regions from where the imports originated or to where the exports were directed: $w \in \{EU, RW\}$, i.e. the EU and the rest of world (=RW) which can be broken down in further stages of research into the EU accession countries, remaining advanced countries and the rest;
M_{it}^{w} = Czech imports from w (in current CZK);
X_{it}^{w} = Czech exports to w (in current CZK);
GDP_t = Czech GDP in constant CZK measuring the real aggregate demand absorption capacity;
GDP_t^{w} = aggregated GDP in EUR for countries w importing Czech products measuring their aggregate demand absorption capacity;
RER_t^{w} = effective real exchange rate index based on CPI and related to currencies of given trade partners (its increase means appreciation);
IN_{it} = Czech inflation in industries *i* (as price deflators where 1994 has index 1.00)
$PM_{it}^{w} / PX_{it}^{w}$ = relative prices in import equation measuring the competitiveness in prices or in quality;
$PX_{it}^{w} / PM_{it}^{w}$ = relative prices in export equation measuring the competitiveness in prices or in quality;
K_{it}/L_{it} = capital (in constant prices of 1994) per labour characterizing the domestic technologies;
FDI_{it} = foreign direct investment stocks (in CZK);
Tar_{it}^{w} = Czech tariff rates for imports from w or average tariffs levied by countries w on Czech exports;

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[13] *The alternative to working with absolute values of imports or exports, that are subject to the arbitrariness in the size of industry, is to normalise them by dividing trade intensities by value added in industry or by using indices of growth or various revealed comparative advantages. Then even an industry of a negligible size can become as important as the main industry. This modification of the model would have, however, a different interpretation and its link to the task of trade intensities and GDP growth would be further complicated. We therefore did not normalise the trade flows.*

[14] *Unfortunately, at this stage of research we could not reconstruct the full time series of data for material inputs by individual industries. Thus this variable was not used in our estimations.*

ε_{it}^{w} = random term.

In the first phase of estimations functions Φ^{w} will be specified as a power function with coefficients as exponents. Such a model can be linearised by taking natural logarithms of all variables [15]. Its coefficients have an interpretation as coefficients of elasticities.

Summing up the specification of the models:

In econometric testing it is of paramount importance that the specification of the model involves all real causal influences – i.e. that there is not a single substantial variable left that is non-random. It is actually the theory that helps in approaching this aim at perfection. Unfortunately the microeconomic theories of trade are able to "explain" only the specialisation pattern and not the intensities. Their combination with macroeconomic theories (open economy multiplier, real exchange rates and elasticities approach to balance of trade) is unavoidable.

In our specification we commenced with placing Heckscher-Ohlin hypothesis to the forefront. Thus relative factor requirements (K/L) and FDI stocks (proxy for human capital) became our core variables, assisted by tariffs. The real intensities of trade are then determined by aggregate consumer demand (GDP), pricing policies (PX, PM) and real exchange rate. Since RER is a global parameter common for the whole economy, sectoral inflators (IN) were added as an industry-specific variable.

Missing links: This model need not be still theoretically complete. The Ricardian theory, representing the differences in relative productivities (invariant to relative endowments and common technologies) can be here represented by gaps in total factor productivities (or in relative labour productivities). Implicit subsidies and non-tariff barriers could represent a part of the industrial policies. Alternatively to unit prices we could use material inputs as characteristics of the degree of processing. If the data would be available (what is still not the present case) we could even distinguish between the inputs from imports and from domestic supplies.

[15] *We can think about a more general data transformation than logarithm - for example, Box-Cox transformation for the power between 0 and 1. If the power coefficient is not asymptotically converging to zero it can result in bringing the residuals to normality better than the logarithmic model.*

6. Results of the First Step of Testing the Czech Trade [16]

Before describing the procedures and results of our econometric estimations we cannot avoid discussing some common features of all regressions. They concern the significance of factor endowments, FDI and time autoregressivity in the industrial structure of trade.

Factor endowments, FDI and trade

All estimations in our import and export functions with the EU and RW resulted in coefficients that were highly significant for the K/L factor endowments and the FDI stock [17]. Their fundamental influence on the pattern of specialization was clear-cut and also the tests for co-integration could not refute their role by finding technical reasons for a biased estimation. In all equations for the trade with EU the K/L variable had always a negative sign pointing to an intensive labour intensity of both Czech imports and exports. The latter is not surprising because that was the fundamental property of Czech exports ever since 19th century.

Unfortunately at this stage we could not test directly the structure of labour contents: for example, whether the labour requirements in imports were significantly more biased to workers with high skills than it was in exports. All indirect evidence about unit prices, however, leads to a conclusion that it was true. Then Czech exports to Western Europe cannot be considered directly competing with EU imports – implying that additional imports displacing domestic production would not undermine the competitiveness in Czech exports. We could only expect that rising import penetration crowds-out a disproportionately larger number of labour from the domestic production than the domestic capital that has to be re-allocated. Thus Czech problems with unemployment can be explained by imports.

Another aspect of factor endowments concerns the question what will happen if the factor endowments will change in time, what is explained by Rybczynski theorem. If Czechia has a declining labour participation and its level of investment is one of the highest in Europe, then the structure of trade and production will respond to this fundamental determining factor very sensitively. Shortage of labour and rising wages will press not only for a factor substitution but actually for a restructuring of exports in favour of capital-intensive products. At the same time domestic import substitution will not strengthen sufficiently because imports are also labour intensive. The pressure on exchange rate will be eminent.

FDI is internationally recognized as a powerful engine for both exports and import penetration (Bellak (1999), Pfaffermayr (1996)). In the Czech economy it became the most powerful factor behind both the structure and the dynamics of imports. If the FDI is divided

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[16] Remark: The econometric estimations prepared for the interim report on this project (discussed at CNB on 17th June 2002 – see Benacek, Prokop and Visek (2002) – were based on our preliminary data sets in the SITC classification and in US$. Since the balance of trade in CNB is in current CZK and the majority of data come from enterprise statistics, we have built an alternative database for 29 industries in NACE classification. After July 2002, when we have assembled the new datasets, the provisional estimations had to be discarded. Nevertheless, they represented a large block of experiences, on which the present updated estimations could rely. Surprisingly, the majority of revealed economic relationships and the technical shortcomings in the SITC data set were similar to those of NACE data set, showing that the fundamentals of the problem and the data were isomorphic and robust enough to avoid a loss of property due to mere alternative methodology of reporting or aggregation pattern.

[17] The testing for the relative endowments (K/L) is more convenient than testing for absolute endowments, as is the case in production functions, because domestic import replacements and exports are composite products, with material inputs coming various other industries.

between the FDI from the EU and from the rest of world, we can see that not only their structure is different (the coefficient of correlation is 0.41) but also the FDI from non-EU countries is less oriented to imports from EU. As our later results will indicate, FDI was also one of the most powerful factors behind the accelerated Czech exports to EU. At this stage we cannot conclude if it is also a net contributor to the balance of trade. The most positive, in that respect, is the FDI from non-EU countries that is even significantly stronger exporter to EU than remaining 87% of FDI stocks coming from the EU countries. As a policy recommendation, the promotion of the FDI from non-EU countries would result in an improvement of the trade balance, as it is using more domestic inputs and concentrates more on exports.

In the next four chapters we will discuss separately the models of imports and exports divided into trade with EU and the rest of world (RW). The latter is still an important part of Czech economy, comprising at present 31% of all exports and 38% of all imports.

Autoregressivity in imports and exports

The restructuring of industries is a process that changes the nature of the commodities traded and their geographic orientation. It is not a repetition of the past structures. An analysis of autoregressivity characteristics in our 29 industries throughout the analysed period describes how the past structures influenced the evolving trends. Table 1 shows the results of simple autoregressive models of imports and exports with a lag of one year.

Table 1: Autoregressive models of trade decomposed to 29 industries
(after logarithmic transformation of the original power function)

		Interc.	Slope	F stat.	R^2 (adj.)	DW
$Ln(M_{it}^{EU}) = a + b\ ln(M_{i,t-1}^{EU}) + u_{it}$	Coeffic.	0.580	0.950	2244	0.907	2.85
	t-test	1.343	47.37			
$Ln(X_{it}^{EU}) = a + ln(bX_{i,t-1}^{EU}) + u_{it}$	Coeffic.	0.337	0.979	5922	0.962	1.64
	t-test	1.617	44.21			
$Ln(M_{it}^{RW}) = a + ln(bM_{i,t-1}^{RW}) + u_{it}$	Coeffic.	0.596	0.947	5073	0.956	1.91
	t-test	1.545	22.02			
$Ln(X_{it}^{RW}) = a + ln(bX_{i,t-1}^{RW}) + u_{it}$	Coeffic.	0.079	0.999	8019	0.972	2.08
	t-test	0.877	89.6			

Remark: Estimated by TSP, where intercept and *t*-statistics were evaluated by employing heteroscedasticity resistant White's covariance matrix.

The results indicate that exports to the RW were the most stable part of Czech trade throughout 1993-2001, followed closely by exports to the EU. The structural stability of the export growth in all industries (at a level of 29 industries) is evident from the slope coefficient close to unity (0.999 and 0.979). If the logarithmic model of exports to EU is transformed into its original power function of $X_{it} = A*X_{it-1}**b*\varepsilon_{it}$ then the multiplicative constant $\boldsymbol{A=e^a}$ would be 1.40 – implying a very fast autonomous growth (unfortunately subject to high random fluctuations). As the autoregressive "core" (estimated by the slope) reproduces nearly all past values, the component of a structural change is nearly fully embodied in the "random" autonomous growth. Thus these are the "black box" parameters of intercepts that should be figured out in more detail by our main models containing economic variables only.

On the other hand, imports from both the EU and RW show much more varied behaviour, determined less by past structures and more by the "autonomous" influences estimated by intercepts. These tests are reminding us that Czech exports have been highly resistant to structural changes – retaining their traditional industrial composition. At the same time the pressure for a structural change in the economy came mainly via imports, i.e. by

crowding-out domestic producers [18]. Taken from the technical side, we could retain the lagged variable in the list of exogenous variables and expect that it will explain the stationary trend, while the dynamics of changes will be explained by remaining economic variables. This will also help us in our predictive simulations.

6.1. Model of Czech imports from the EU

The data for empirical testing are for 29 commodity groups (industries) of the Czech economy in time series of 1993-2001. The data available is therefore a combination of cross-section and time-series statistics for more than just one object (industry). Therefore we could not estimate the model as a classical panel. Data were arranged as a segmented "panel", which means that we created consecutive sections of 29 blocks, one for each industry, each containing a sequence of 9 rows for individual years. Economic information about every industry (block), described by indices ***i***, was therefore contained by columns, each of them representing one variable – starting from import values and continuing for the explanatory variables: Czech GDP, RER, deflators, import and export prices (they were separated after taking their logarithm), capital per labour, FDI stocks and tariff rates.

In the first step we were estimating the regression coefficients by the OLS method. We have tested the sensitivity of our model to four theoretical fundamentals, such as the importance of aggregate demand, real exchange rate, K/L endowments and FDI. In addition, we tested the importance of autoregressive import and export model and a correlation between exports and imports.

6.1.1. The nature of aggregate demand in imports from the EU

Here the Keynesian macroeconomic view is simple: an increase in Czech aggregate demand (the volume of GDP in constant prices) should be spilled into a demand for imports. However, due to Engel's law, Vernon's product cycle hypothesis and the Linder's representative demand (see Lindert (1986) for a summary) – there are good reasons to expect that this relationship is not proportional for all industries. On top of it, according to Rybczynski's theorem, the growth induced by a change in relative factor endowments can become import replacing and expanding the Czech domestic import-competing production. This may happen (provided Czech imports from the EU are human capital intensive) when Czech human capital sharply rises (what was behind the Irish economic miracle in 1990s).

In our initial sensitivity testing we have combined real changes in aggregate demand with nominal changes – i.e. with the changes in inflation by industries (variable IN_{it}) and in the real exchange rate of Euro (RER_t), whose continuing sharp appreciation (=increase in the index) should be a major instrument for opening the Czech market to imports. Though we found a positive and statistically significant correlation with imports in all three variables, the coefficients were largely disappointing. Their p-values indicated significance at 1.5-4% levels

[18] *We could speculate at this moment what could be the other drivers of structural changes in the Czech economy. It can be gathered from the identity Y=C+I+G+X-M that the "domestic" part of production could be most strongly shaped only from the part residual to trade. These causes should be therefore searched in the non-traded sector. Because the ever-expanding exports and imports represented a highly dynamic segment of the economy (covering over 60% of Czech GDP and absorption), the domestic production for domestic consumption must have been rather declining and slowing the growth, while joining imports for placing high demands on structural changes.*

only and the R^2 was hardly above 0.03. The income elasticity of imports was extremely high – in no case it decreased below 2 and for the majority of industries it was around 6 [19].

The inflation variable was always positive, indicating that Czech inflation can be explained as a combination of imported price reflecting the rising quality of imported products and the cost-inefficiency of the domestic production. Unfortunately there must have been many exceptions to this rule, as the significance of this coefficient was at 3% only. It is also evident that industry-specific inflation in the Czech economy could not be completely neutralized by nominal exchange rate changes, nevertheless the linkage between the inflation and exchange rate adjustment on one hand and competitiveness on the other hand, was very weak in the Czech economy.

The previous results can explain why the estimation of the RER variable was also highly unsatisfactory. Its sign was fluctuating between positive and negative values, what implied low significance and contradicted the theory of PPP that real appreciation is a cause of increased imports. As the RER was appreciating in time, together with accelerated imports from the EU, there was not a statistical evidence that this relation might be the dominant force driving the Czech balance of trade to deficit ! Evidently there were some other forces that determined the dynamics of Czech imports.

Here we may conclude that our study revealed that Czech aggregate demand did not perform as a leading instrument to imports. At this stage of research we are not able to determine whether it was so weak as a whole or whether the antagonistic structural developments, so typical for unfinished restructuring, cancelled-out the global result to a very weak aggregate signal. In every case it is evident that the role of supply-side determinants of imports and trade policy variables should deserve more attention when we talk about the dynamics of imports.

6.1.2. Cointegration between imports and exports to EU

A high interdependence between imports and exports from the same industry is a sign of a high degree of intra-industry trade. Given our low level of desaggregation to mere 29 industries, we cannot say much about the nature of intra-industry trade. We may only assume from the different unit prices that the trade flows inside the same industry cannot be in identical products, but that there must be a tendency to a vertical differentiation. EU imports of high quality are exchanged for Czech exports of products in medium or low quality standards. Table 2 presents results of a regression where imports from EU are related to exogenously given exports to EU:

$$M_{it}^{EU} = \beta_1 + \beta_2 * X_{it}^{EU} + \varepsilon_{it}$$

[19] *As we found in the experiments with SITC data, especially this elasticity was subject to a bias caused by a serial autocorrelation of residuals. The "true" elasticities there declined to 1.18, what looks much more credible and similar to monthly elasticities estimated by Tomsik (2001). What is certain, the income elasticities for products with high ton-prices (i.e. those with high value added contents, or at higher stages of manufacturing) are much higher than income elasticities of primary inputs. Another problem is the accommodation of income growth with the monetary policy of CNB. Since for the majority of 1993-2001 the money supply grew faster than GDP, it would be recommendable to include the M2 variable (and perhaps even the government spending) into the equation.*

Table 2: Dependence between imports and exports from the EU (linear model)

Variables	Estimated parameters	Standard error	t-statistics	P-value
Intercept	3071.6	943.2	3.256	[.001]
X from EU	0.7574	0.080	9.412	[.000]
Std. error of regression	= 12477	Adjusted R-squared	= 0.674	
F-test	= 538.8	Durbin-Watson	= 0.456 [20]	

The estimated coefficient of elasticity between imports and exports was 1.143, what implies that exports to EU may be highly dependent of imports from EU. An increase of exports to EU by 1% is associated with EU imports higher by 1.143%. Of course, we cannot interpret this as a cause-effect relationship (the imports are not evidently inputs to exports) but this relationship points to a tendency of an unbalanced trade with EU in time. The difference is striking if we compare it with the balancing mechanism in trade flows with the rest of world (RW). For the RW the same relationship between imports and exports leads to coefficients 5660 and 0.593, with an "elasticity" of 0.815 only. The trade with the RW had therefore much lesser problems with the balance due to its growth.

We can conclude from the evidence in the last three paragraphs that Czech trade, at least with the EU at this level of aggregation, cannot be explained by the Ricardian paradigm of homogenous products and similar degrees of comparative advantages or disadvantages inside of the product groups, that would lead to inter-industrial specialization. More modern theories of trade should be therefore applied for the analysis of this trade, including the estimation of coefficients simultaneously for both exports and imports. Nevertheless, there is evident that there is a convergence in both trade patterns and quality in the trade with EU, what reveals Table 3.

Table 3: Evolution in volumes traded and unit prices in the Czech trade with EU

Year	Exports in tons	Imports in tons	Export price per kg	Import price per kg
1993	20628586	4449221	10.77	53.78
1994	26130418	5760948	10.30	51.49
1995	25069631	6422456	13.66	63.20
1996	22789898	7587375	15.47	62.09
1997	23095802	8794855	18.36	60.43
1998	23467268	9354015	22.75	62.07
1999	25530894	10362512	24.63	60.31
2000	25802067	11054160	29.79	69.70
2001	25070818	11947578	34.91	71.71

Source: Czech trade statistics. CSU, Prague, 2002

While the physical volumes of exports to EU went down after 1994, its total value increased 3.94-times and the kg prices increased 3.38-times between 1994-2001. Therefore also the structure of exports must have shifted in favour of products of higher quality or higher value added per unit. No such breakthrough can be seen in Czech imports where shifts to products of higher quality (above the long-term inflationary trend) can be seen only in 1995 and 2000. The catching-up of the Czech economy with the EU has been visibly a process that

[20] See the next footnote on DW statistics for more explanation.

was progressing throughout 1993-2001. The ongoing appreciation of Koruna was only a small part of the profound changes.

6.1.3. Complete OLS test – imports from the EU

The test of all model variables for the imports from EU brought the following results:

Table 4a: Results of the import function for M^{EU}
(orientational OLS logarithmic estimation)

Variables	Estimated parameters	Standard Error [21]	t-statistics	P-value
Intercept	46.12	22.8	1.99	0.047
M price/kg	**0.345**	**0.188**	**1.87**	**0.076**
X price/kg	**-0.371**	**0.173**	**-2.08**	**0.039**
Inflators	1.268	1.182	0.96	0.336
FDI stock	**0.454**	**0.034**	**11.7**	**0.000**
Tariffs CZ	**-8.433**	**2.055**	**-4.90**	**0.001**
K/L ratio	**-1.744**	**0.143**	**-8.38**	**0.000**
GDP CZ	2.306	2.837	0.86	0.389
REER to EUR	-3.895	2.191	-1.80	0.094

Std. error of regression	=	1.329	Adjusted R-squared	=	0.529
F-test	=	37.4	Durbin-Watson	=	0.544
White heterosc. Test	=	132.6			

The final estimation of our model of imports from EU (after removing the statistically insignificant variables) is given in Table 4b:

Table 4b: Results of the import function for M^{EU} (OLS logarithmic estimation)

Variables	Estimated parameters	Standard error	t-statistics	P-value
Intercept	42.18	7.32	5.76	0.000
M price/kg	0.370	0.192	1.92	0.055
X price/kg	-0.409	0.179	-2.28	0.023
FDI stock	**0.445**	**0.035**	**12.7**	**0.000**
Tariffs CZ	**-7.576**	**1.591**	**-4.76**	**0.000**
K/L ratio	**-1.736**	**0.209**	**-8.32**	**0.000**

Std. error of regression	=	1.330	Adjusted R-squared	=	0.528
F-test	=	59.2	Durbin-Watson	=	0.530
White heterosc. Test	=	99.5			

The results from the OLS estimation offer an interesting material for economic interpretation, notwithstanding that many of the models are subject to problems with the autocorrelation of residuals [22]. Additional tests of the models, treating the problems of autocorrelation and heteroscedasticity, are in chapter 6. Nevertheless, we should stress that

[21] *Due to the presence of heteroscedasticity the standard error and t-statistics were adjusted in accordance to the White test significance.*

[22] ***It is necessary to admit that in the segmented panel data the D-W statistics cannot not be measured accurately. One ninth of the D-W statistics (due to 9 years of observation) is based on "randomly positioned" data – that means on data from two different industrial blocks and therefore also out of the time sequence. However, if we also assume that the nature of this disturbance is truly random, then the ensuing bias should not pose a major threat to the significance of the D-W statistics. Nevertheless, we can be never fully certain that it was true in each particular case.***

the "naïve OLS estimations" (i.e. neglecting the interdependence in disturbances) described in this chapter remain still unbiased and consistent. Only the standard error and significance tests are biased.

We have tested the data for homogeneity of patterns by splitting the time series to two periods: 1993-96 and 1997-2001 representing two different governments and their approaches to transition policies. The first ("conservative") period was characterized by fast growth, balanced budget, modest expansionary monetary policy, "banking socialism" and failing judiciary. The following "socialist" period was marked by a reversal in these characteristics.

Strangely enough, **the intensity of trade with the EU was not significantly influenced by these substantial institutional changes**, even though there were evidently present some minor behavioural differences. The three factors with the highest t-significance (i.e. FDI, endowments and tariffs) have shown high stability throughout all time. On the other hand, **the variables associated with GDP, RER and inflation were volatile in both significance and signs. Since these three variables are fundamental factors for both the macroeconomic theory and the decision-making in the national bank, it is our task to uncover the backgrounds of the role of GDP, exchange rate and inflation in the Czech economy.**

The variables based on kilogram prices suggest that Czech imports from the EU are based on quality competition and these imports are not competing with the Czech products with high value added contents. Nevertheless, further investigation is necessary for a more rigorous analysis of these factors.

6.2. Model of Czech exports to the EU

6.2.1. The nature of aggregate demand in exports to the EU

We have found a general property in all our models that, when we were testing the complete model, the role of aggregate demand was subsiding up to a complete statistical insignificance. Nevertheless, in the tests of the pure demand side, the foreign aggregate demand for Czech exports was quite significant. For example, the elasticity coefficient ***b*** in the model $\ln (X_{it}^{eu}) = \ln (a) + b*\ln (GDP_t^{eu}) + \ln (\varepsilon_{it}^{w})$ was 2.9 with t-statistics of 4.8. It was also increasing proportionally with the degree of manufacturing and the value added. For example, it ranged from 1.8 for the primary processing industries up to 4.1 in the industries with high stages of processing. The R^2 was also following suit from 0.02 up to 0.28. Nevertheless, we should be aware that the relationship between Czech exports and the foreign aggregate demand is much more complicated than many journalistically minded economists assume.

The most disappointing variable was the RER, which should have a negative sign. In theory, a larger appreciation of Koruna to Euro should incapacitate exports to EU. In contrast to that, here the coefficient was either insignificant (and negative) or slightly significant but positive. In no case we observed a case that a real appreciation alone would smother the aggregate export performance. Here we were challenged by a paradox that Koruna was constantly appreciating while exports remained adamant in their growth, though perhaps less than it was in imports. That would suggest that during 1993-2001 Koruna was either appreciating along its equilibrium level (supported by gains in productivity, quality and terms of trade), or the foreign demand was not very elastic to import price increases. Both cases would be consistent with the rising kg prices in exports, as shown in Table 3. Let us also remind that the correlation between Czech exports and imports has been shockingly high, pointing to a very close inter-dependence. Further investigation is needed for uncovering the background of these crucial problems.

6.2.2. Complete OLS test – Exports to the EU

Czech exports to the EU can be explained by a simpler model than imports. The dominant factors seem to come from the supply side: FDI and relative factor endowments, plus from the EU tariff concessions that commenced in 1992, as is shown in Table 5a.

Table 5a: Results of the export function for X^{EU}
(orientational OLS logarithmic estimation)

Variables	Estimated parameters	Standard error	t-statistics	P-value
Intercept	12.3	10.6	1.164	[.245]
X price/kg	0.007	0.108	0.064	[.949]
M price/kg	-0.099	0.109	-0.924	[.356]
Inflators	-0.848	0.887	-0.965	[.340]
FDI stock	**0.271**	**0.019**	**14.04**	[.000]
Tariffs EU	**-4.367**	**0.338**	**-12.90**	[.000]
K/L ratio	**-0.940**	**0.074**	**-12.66**	[.000]
GDP EU	2.450	3.830	0.640	[.523]
REER to EUR	-0.953	5.551	-0.172	[.864]

Std. error of regression	=	0.800	Adjusted R-squared	=	0.621
F-test	=	54.1	Durbin-Watson	=	0.506
White heterosc. test	=	130.4			

Unfortunately in this case the estimation was evidently biased due to a colinearity between some variables, what required to apply adjustment routines necessary for unveiling the true specification and coefficients of the model. The correlation between prices – i.e. between *ln(PE)* and *ln(PM)* was 0.96793 - and similarly too high it was between *ln(GDPeu)* and *ln(DEF), and between ln(GDPeu)* and *ln(REER).* After removing stepwise the statistically least insignificant and colinear variables (export prices, inflators and REER) we got the narrower specification of exports to EU by OLS:

Table 5b: Results of the export function for X^{EU} (logarithmic estimation)

Variables	Estimated parameters	Standard error	t-statistics	P-value
Intercept	19.32	4.585	4.21	[.000]
X price/kg	-0.073	0.034	-2.15	[.033]
FDI stock	**0.267**	**0.019**	**14.35**	**[.000]**
Tariffs EU	**-4.409**	**0.340**	**-12.96**	**[.000]**
K/L ratio	**-0.930**	**0.071**	**-13.08**	**[.000]**
GDP EU	1.059	0.450	2.35	[.019]

Std. error of regression	=	0.805	Adjusted R-squared	=	0.616
F-test	=	84.3	Durbin-Watson	=	0.491
White heterosc. test	=	74.0			

By this operation we can see that export prices and GDP of EU became significant. Nevertheless, the core of the export determinant (FDI, decrease in tariffs of the EU, and K/L endowments) remained nearly unchanged. The negative sign in the export price variable suggests that Czech exports to the EU were in industries where domestic competing products were not of high quality (or high value added). An alternative explanation here could be that the competitiveness of exports was gained by lowering the price relative to competitors.

The GDP of EU is another significant factor that should be considered. Its elasticity slightly above the unity implies that a fluctuation in the growth of the EU economies would

have only a minor influence on Czech exports. However, further tests are needed in order to confirm that income elasticity of exports is not high. An alternative "narrow" specification of this function is by replacing GDP by REER:

Table 5c: Alternative specification of the export function for X^{EU}

Variables	Estimated parameters	Standard error	t-statistics	P-value
Intercept	21.47	3.764	5.70	[.000]
X price/kg	-0.073	0.034	-2.14	[.033]
FDI stock	0.267	0.019	14.38	[.000]
Tariffs EU	-4.412	0.340	-12.96	[.000]
K/L ratio	-0.929	0.071	-13.03	[.000]
REER	1.556	0.668	2.331	[.021]

Std. error of regression	=	0.799	Adjusted R-squared	=	0.621
F-test	=	86.3	Original R-squared	=	0.629
White heterosc. test	=	71.3	Durbin-Watson	=	0.488

As it is evident, the cross-industrial variables of GDP ^{EU} and REER (in CPI definition) are crowding-out each other in the "explanation" of Czech exports to the EU due to their extremely high correlation. Nevertheless, they are two theoretically distinct influences on exports and dropping one of them induces specification error into the equation. That in fact attributes the simultaneous influence of both variables into the included one. In addition, the positive sign of the real effective exchange rate of euro is paradoxical: its appreciation during 1993-2001 by 29.4% is interpreted in our model as an instrument of promotion of exports, what could not have been the case. In the case of retaining the GDP (see Table 5b) and dropping the REER the specification error would explain why the estimated income elasticity was so low: this already included the REER effect that must have been negative. Thus the real much higher income elasticity was suppressed by the excluded REER variable that had in fact negative influence. In order to unveil the real income elasticity we will have to remedy the whole estimation.

6.3. Model of Czech imports from the rest of world

In this model we had again a similar problem in finding the relationship between imports and domestic aggregate demand or REER, respectively. Though individually they have a statistically significant link on RW imports, in a more complex specification of the model they are over-ruled by other factors or distorted by too many defaults in our data. We could see that imports from the non-EU countries are evidently less determined by uniform economic factors than imports from EU. The conglomerate of too eclectic economies in this group distorts the estimation. We can see that the tariff liberalization became a highly important policy move boosting imports. It is also evident that even here the conditions on the domestic supply side (i.e. the FDI and K/L) are decisive. Surprisingly, the EU imports are labour intensive, what may sound like a conflict with the labour intensive Czech exports. The clue for solving this paradox is provided by the price variables. Their dual significance reveals that imports form EU are of high quality and the domestic competition does not show a serious threat to them. The import substitution will be a difficult process to implement. Thus the specialization pattern is actually formed by human capital (not tested at this stage) whose endowments are different between Czechia and EU.

Table 6: Results of the import function for M^{RW} (logarithmic estimation)

Variables	Estimated parameters	Standard error	t-statistics	P-value
Intercept	29.530	2.385	12.38	[.000]
M price/kg	0.320	0.104	3.080	[.002]
X price/kg	-0.509	0.127	-4.009	[.000]
FDI stock	0.345	0.048	7.254	[.000]
Tariff CZ	-4.637	0.520	-8.913	[.000]
K/L ratio	-1.071	0.165	-6.495	[.000]

Std. error of regression	=	1.212	Adjusted R-squared	=	0.348
F-test	=	28.8	Durbin-Watson	=	0.441
White heterosc. test	=	166.4			

6.4. Model of Czech exports to the rest of world

The structural pattern in this segment of the Czech trade was determined by mere three factors: FDI, factor endowments and tariffs of the importing countries. It also revealed a strongest resilience to the exchange rate changes or the GDP fluctuations in the partner countries.

Table 7: Results of the export function for X^{RW} (logarithmic estimation)

Variables	Estimated parameters	Standard error	t-statistics	P-value
Intercept	10.665	0.828	12.882	[.000]
FDI stock	0.357	0.025	14.115	[.000]
Tariffs RW	-0.889	0.180	-4.942	[.000]
K/L ratio	-0.646	0.098	-6.609	[.000]

Std. error of regression	=	0.993	Adjusted R-squared	=	0.494
F-test	=	86.6	Durbin-Watson	=	0.440
White heterosc. test	=	65.3			

The trade with the rest of world resembles much more to the Heckscher-Ohlin explanation of specialization than the trade with the EU. The export and import structures are not very similar in their absolute values. There is not present a high correlation between them and much of the intra-industry trade, as the table 8 reveals. In comparison to Table 2 (with a similar regression for the EU), the differences between these two regions are quite striking. Nevertheless, if a similar regression is made on the growth of RW imports and exports (not shown here), the tendency for a build-up in the intra-industry trade would become strong. We can see that even though the initial conditions for trade with RW were very different than it was with the EU, the actual dynamics of trade with RW converge to similar patterns as it is with the EU.

Table 8: Dependence between imports and exports from the RW (linear model)

Variables	Estimated parameters	Standard error	t-statistics	P-value
Intercept	5659	851.4	6.65	[.000]
X from EU	0.5925	0.0638	9.49	[.000]

Std. error of regression	=	10727	Adjusted R-squared	=	0.247
F-test	=	86.1	Durbin-Watson	=	0.471

6.5. Industrial balances of trade with the EU

The specification of the model that would test the evolution in the Czech trade balance in a commodity breakdown with the EU is as follows:

$$X_{it}^{EC} - M_{it}^{EC} =$$
$$= \Phi_B (GDP_t^{cz}, GDP_t^{EU}, RER_t^{eur}, IN_{it}, PM_{it}, PX_{it}, K_{it}/L_{it}, FDI_{it}, Tar_{it}^{cz}, Tar_{it}^{EU}, \varepsilon_{it}^{w})$$

Since we get a negative trade balance for approximately a half of the industries, what does not allow logarithmic transformation, we divided the data into two subsets: for positive and for negative balances, respectively. For the policy-making purposes we could thus distinguish between policies supporting the positive balance and policies supporting the domestic import substitution. Separated equations also offer an interesting description of factors behind Czech clear-cut inter-industrial comparative advantages (in Table 9a) and comparative disadvantages (in Table 9b).

The first experiments with the linear model have shown that nearly all of our explanatory variables were statistically significant. However, only the two variables (FDI and K/L endowments were statistically significant after the logarithmic transformation, as the Table 9b indicates.

Table 9a : Balance of trade (X-M) with EU – surpluses only, linear specification

Variables	Estimated parameters	Standard error	t-statistics	P-value
Intercept	44457.800	19319.600	2.301	[.023]
M price/kg	-15.635	6.390	-2.447	[.016]
X price/kg	19.056	6.887	2.767	[.007]
Inflation	-20971.400	9313.500	-2.252	[.026]
FDI stock	0.484	0.109	4.443	[.000]
Tariffs CZ	-453.766	145.191	-3.125	[.002]
K/L ratio	-1287.940	204.341	-6.303	[.000]
REER to euro	314.746	137.118	2.295	[.023]

Std. error of regression	=	5969	Adjusted R-squared	=	0.545
F-test	=	23.4	Durbin-Watson	=	---[23]
White heterosc. test	=	110.3	Observations	=	132

Table 9b : Balance of trade (X-M) with EU – surpluses only, **logarithmic** specification

Variables	Estimated parameters	Standard error	t-statistics	P-value
Intercept	3.290	0.077	42.839	[.000]
FDI stock	0.180	0.028	6.480	[.000]
K/L ratio	-0.575	0.107	-5.390	[.000]

Std. error of regression	=	0.479	Adjusted R-squared	=	0.247
F-test	=	22.5	Durbin-Watson	=	---
White heterosc. test	=	7.44	Observations	=	132

[23] *The DW statistics have lost its meaning since the time series sequence by years 1993-2001 was in some cases impaired by splitting the data from the same industry into two subgroups.*

Table 9c : Balance of trade (X-M) with EU – deficits only, logarithmic specification

	Coefficients	Standard Error	t-statistics	P-value	
Intercept	29.919	4.245	7.048		[.000]
M price/kg	**0.961**	**0.268**	**3.590**		**[.000]**
X price/kg	-0.522	0.266	-1.962		[.052]
Inflation	-3.053	1.040	-2.936		[.004]
FDI stock	**0.186**	**0.044**	**4.239**		**[.000]**
Tariffs CZ	**-13.846**	**2.128**	**-6.508**		**[.000]**
K/L ratio	0.551	0.309	1.783		[.077]

Std. error of regression	= 0.446	Adjusted R-squared	= 0.426
F-test	= 16.6	Durbin-Watson	= ---
White heterosc. test	= 65.3	Observations	= 129

Our comments will be to a comparison of all three tables 9bc. The FDI with a positive sign is a common feature for all of them. It confirms our previous observations that during the past 9 years FDI was not a clear contributor to the balance of trade surplus. Its heavy dependence on imports reveals that Czech domestic production was not very competitive especially in providing the necessary material inputs. FDI is still oriented on Czech labour inputs necessary for the attractive assembly operations. There is much gap left for improving the Czech trade balance if the import substitution in material inputs is successful. The policies for promoting the **backward spillovers** from FDI enterprises could be instrumental in this important strategic change.

Other important common feature is in the finding that inflationary pressures are present either in industries with low net exports and low net imports, or in industries with very low trade. The former are generally the industries with large intra-industrial trade. It is known that such industries are subject to oligopolistic competition, MNC dominance and market power. The inflation is then either created internally as a rent, or it is imported from abroad – reflecting the rising quality of its products. A high inflation in low-traded sectors implies that a dominance of non-traded commodities in industries is also prone to an internally generated inflation.

The negative sign for the Czech tariffs in both models indicates only that industries that are defended at home by high tariffs are poor net exporters. On the other hand, a decrease in the tariffs with the EU was an important driver of import penetration to the Czech market.

We should comment on capital/labour ratio, which had **different signs** in our last two equations. It implies that industries with comparative advantages are highly labour intensive while the net importing industries are more capital intensive. This feature, however, is not highly characteristic, indicating that many imports (especially those in industries with high intra-industrial trade) are also labour intensive. Thus, unfortunately, a policy for import substitution based on rising capital per labour endowments can be successful only partially – only where the capital endowment shortage was the sole engine for import penetration.

The trade balance (X-M) can be improved by future heavy capital investments [24] by three ways:

[24] *Czechia has very high ratio of internal domestic savings per GDP. At the same time there are high inflows of FDI and the availability of foreign credits became quite easy for many enterprises under foreign ownership.*

A) By promoting the productivity of labour, technical change and the quality of products in the industries with present net exports. Here we can expect that investments into the human capital will be a necessary complement of physical capital build-up.
B) By investing more than proportionally into the "medium" or slightly more capital intensive industries that would turn from net imports into net exports. It should be expected that the competitiveness of traditional net exporting industries (which are labour intensive) will be eroded as the wages will rise. New replacements will be then recruited from these industries.
C) By investing into the capital intensive industries which will strengthen the domestic import substitution. Our analysis also suggests that this development can be expected to come very soon because the present Czech openness to imports is unnaturally high and the enterprises with FDI have endowed themselves sufficiently with machines. It should be a correct time now that the domestic growth would switch from being export and import driven into being capital-driven. The induced import substitution (especially in material imports) could then become an ideal driver for the future GDP growth. The export growth could then subside – becoming even negative. It could concentrate more on terms of trade gains via higher unit prices and increased quality.

Both unit prices in our Tables 9a and 9c are statistically significant and they have always an opposite sign. The industries subject to inter-industrial trade were gaining by successfully increasing their kilogram prices. The role of improvements in quality was therefore important for their growth on both sides of the trade balance. The low kilogram prices of foreign competitors to Czech exports, however, point to general low stages of processing in those Czech export products. In another words, even though Czech net exporters are not in high value added sectors, their improvements in given sectors were an important part of their export expansion. A very similar trade strategy can be seen in the developments of sectors with high net import penetration. The dominance of quality over the price competitiveness is also confirmed here. The Czech import substitutes are either of inferior quality or the imports are in material inputs that do not have a high kilogram price.

7. Models of Exports and Imports with Adjustments for Data, Specification and Estimation Problems

As was evident from the tests in the previous chapter there were several caveats that prevented us from further commenting on our results at the first round of estimations. For example, after comparing the extremely low value of the D-W statistics in Tables 4 and 5 with their critical values, we see the presence of a strong serial correlation due to autoregressive dependence in disturbances. At this moment we did not find the cause for the random cyclical pressure in the Czech trade with the EU. It may be the data problem, the specification problem or the estimation problem. The other problem was with heteroscedasticity, which, as indicated by the White test, was at the margin of tolerance. Because of its minor pressure, we concentrated primarily on the removal of serial correlation that looked more pressing [25].

[25] *Autocorrelation of residuals can aggravate the estimation if some important variable (e.g. a dummy) was not included in the tests. Since the specification error, as we hoped, was not the main cause of our case, we could proceed with remedial measures for the removal of autocorrelation.*

A/ The autoregressive procedure in the error term

The easiest remedial measure for the autocorrelation of residuals is to estimate the model by using the AR procedure, as offered by TSP. The model of exports could then be formulated as before, with the exception of the error term:

$$X_{it}^{eu} = \beta_0 + \beta_1 \ln(GDP_t^{eu}) + \beta_2 \ln(RER_t^{eur}) + \beta_3 \ln(IN_{it}) + \beta_4 \ln(PX_{it}^{eu}) + \\ + \beta_5 \ln(PM_{it}^{eu}) + \beta_6 \ln(K_{it}/L_{it}) + \beta_7 \ln(FDI_{it}) + \beta_8 Tar_{it}^{eu}) + \mathbf{\rho\ \varepsilon_{i,t-1}} + \mathbf{u_{it}}$$

The newly introduced parameter ρ estimates the functional dependence between original error terms $\varepsilon_{i,t-1}$ and $\varepsilon_{i,t}$ while u_{it} is a new non-autocorrelated error term. We have tested this procedure and the autocorrelation was eliminated by receiving the DW test of 2.06. To our relief, we found that the list of significant variables did not change. Unfortunately, we still could not be sure whether the autocorrelation was properly measured (see our footnote 20). We also could not eliminate the case that our model specification was complete (we still missed the variables of subsidies and material inputs). Also much more care should have been given to the inclusion of proper dummies into our list of variables.

B/ Estimation by Generalized Least Squares

Once we estimate ρ in the previous procedure we can proceed further by using the Cochrane-Orcutt transformation of data (see Judge et at. (1985), p. 287 or Kmenta (1986), p. 303). For example, a transformed variable of exports (X^*_{it}) should be created by using the formula: $\mathbf{X}^*_{it} = \ln(X_{it}) - \rho * \ln(X_{i,\ t-1})$. After a similar transformation is applied to all remaining variables a new linear model can be estimated, what is known as generalized least squares.

We have tested this procedure on a slightly modified model where the lagged variables (marked as "backshift" B-) were separated and were estimated together with the original variables:

Table 10: Exports to EU after the Cochrane-Orcutt transformation

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
Const.	0.505	0.240	2.099	[.037]
log(B-X)	0.963	0.026	37.596	[.000]
log(PE)	0.038	0.010	3.937	[.000]
log(B-INF)	-0.257	0.112	-2.289	[.023]
log(B-FDI)	0.017	0.008	2.245	[.026]

Std. error of regression	=	0.230	Adjusted R-squared	= 0.967
F-test	=	1719.6	Durbin-Watson	= 1.846
White heterosc. test	=	56.5		

Though from the technical point of view the estimation becomes perfect, there were three problems that should be noted:

a) The lagged endogenous variable (exports in this case) became so strongly significant that has eliminated from the model many other economically important variables. For example, we have lost here the variables of K/L, tariffs and GDP that became "encoded" into the lagged export variable.
b) The model became infested with too many lagged variables (some of them in addition to non-lagged variables), whose economic interpretation is difficult.

c) Actually the whole original economic (theoretical) specification was significantly altered. We have largely lost the ability to test the hypotheses of structural significance while gaining on predictive capacities, which were not our task at this stage of research. Therefore we did not proceed further in this way of estimation.

C/ First Differences of all variables

If the DW statistics is quite close to zero, we infer that the parameter ρ should be close to unity. In that case the taking of first differences of our variables can lead to best linear unbiased estimator of coefficients (with no constant term). Unfortunately, we could not be certain if this condition was satisfied in our case, so we did not experiment further with this technique.

D/ Re-specifying the models to the analysis of growth

Our original models were specified for the structural characteristics important for the analysis of the balance of trade that is in absolute values (in CZK). Our variables were structured into "industries" whose disaggregation and size is actually an arbitrary process. What was crucial for us, however, was that the size of industries mattered – the trade in large industries was more important for the analysis than a change in a very small industry. This could be the problem behind both heteroscedasticity and autocorrelation of residuals (e.g. some large variables and its industries were rather "inert" – not responding sufficiently to the variations of other variables). The transformation of the variables according to the next formula can eliminate this bias:

$$GX_{it} = (X_{it} - X_{i,t-1})/ X_{it}$$, where G implies "growth".

Of course, now the original models are seriously modified in their economic meaning. A high growth of a miniature industry has a higher importance than a mild growth in the largest industry. Now we analyse the dynamics that is relevant for a long-run analysis of the balance of trade. On top of it we assume that a growth in trade in a small industry can continue without any barriers to its development (e.g. on the demand side). Nevertheless, we should be aware that now we analyse different economic hypotheses than in our original specification. Therefore also the coefficients of this model must have a different interpretation and they cannot be put on an equal comparative footing with the models described in Tables 1-9.

The growth model can be even further modified by normalizing its already transformed variables by dividing them by their average (AVR) values within all years t=1994 through 2001:

$$GX^*_{it} = ((X_{it} - X_{i,t-1})/ X_{it}) / AVR_i (GX^*_{it})$$

Remark: At this stage of research we did not proceed further in this line of estimation.

E/ Estimation by robust statistics

Some of our previous problems could have their origin in wrong data or the methodology of reporting. For example, some data could be contaminated by random mistakes (e.g. typos in changing tons for kilograms in trade quantities) or by systematic differencies in the methods of reporting in individual years (see our chapter 4). The outcome may be the existence of outliers that may seriously bias the estimation.

A more complicated problem may arise when the panel data set is not behaving in a homogenous way throughout the years or throughout the industries. We have tested the former contingency by pooling the data sets by years 1993-1996 and 1997-2001. We did not

find large behavioural differences between them. On the other hand, we found that some segments of the industries (e.g. the mining and primary processing) behaved differently from the remaining ones. Our experiences from previous analyses (Benacek and Visek (1999), (2001)) have shown that some industries on lower levels of transformation and restructuring behaved in an opaque way – contradicting actually the theoretically assumed patterns. For example, a declining industry in distress could be very export oriented, even though it lacked comparative advantage for that. Export "financed" by implicit subsidies or by running debts could be a temporary salvation for its sales.

Some complicated robust statistics have been designed especially for testing which subpopulations of the data behaved differently from the "normal" sample (see Visek (1996)). For an illustration let us consider the model in Table 5b based originally on 261 observations (i.e. 29 industries and 9 years, for each of 9 variables):

$$\ln(X_{it}^{eu}) = 19.32 - 0.073 * \ln(PE_{it}) + 0.267 * \ln(FDI_{it}) - 4.409 * \ln(TARx_{it}^{eu}) - 0.930 * \ln(K_{it} / L_{it}) + 1.059 * \ln(GDP_{it}^{eu}) + \varepsilon_{it},$$

By applying the method of *least trimmed squares (LTS)* we can test the occurrence of "weird" observations and uncover to what degree they behave in opposition to the pattern estimated in the original model. We are then looking for and estimation of $\hat{\beta}^{(LTS,n,h)}$, which minimalizes the sum of *h* smallest squares of residuals *r* :

$$\hat{\beta}^{(LTS,n,h)} = \arg\min_{\beta \in R^p} \sum_{i=1}^{h} r_{(i)}^2(\beta), \qquad (1)$$

where $\beta \in R^p$ and R^p is a *p*-dimensional Euclidean space, i.e. β is a p-dimensional vector. The problem is then estimated from:

$$r_i^2(\beta) = \{ \log(X_{it}) - \beta_0 + \beta_1 * \log(PE_{it}) - \beta_2 * \log(FDI_{it}) + \beta_3 * \log(TARx_{it}) + \beta_4 * \log(K_{it} / L_{it}) - \beta_5 * \log(GDP_{it}^{eu}) + \varepsilon_{it} \}^2$$

The statistics considered in sum given by (1) are defined for each $\beta \in R^p$ as:

$$r_{(1)}^2(\beta) \le r_{(2)}^2(\beta) \le \ldots\ldots \le r_{(n)}^2(\beta).$$

By trial and error, we can choose the following sequence of estimations for *h* = 261, 250, 240, 230, 220 and 210, getting the estimation of variances of error terms and coefficients of determination for the re-estimated whole equation:

Table 11: The dependence of variances $\hat{\sigma}^2$ and R^2 on the number of observations h

h	261	250	240	230	220	210
$\hat{\sigma}^2$	0.638	0.471	0.385	0.326	0.279	0.240
R^2	0.629	0.706	0.741	0.773	0.804	0.832

The estimated coefficients of our model then change in the following way:

Table 12: Sensitivity of coefficients to the deletion of some contradictory observations

h	261	250	240	230	220	210
C	19.32	14.74	15.01	15.64	17.67	21.32
ln(PE)	-0.073	-0.129	-0.125	-0.158	-0.171	-0.171
ln(FDI)	0.267	0.266	0.257	0.253	0.265	0.272
ln(TAR)	-4.409	-4.359	-4.360	-4.507	-4.785	-4.759
ln(KL)	-0.930	-0.923	-0.917	-0.941	-0.946	-1.004
ln(GDPeu)	1.059	1.583	1.553	1.579	1.493	1.064

Table 13 enlists the excluded "weirdly-behaving" observations.

Table 13: List of excluded observation by individual steps h

250	25	26						38	39		41	42	43	44
240	25	26	27					38	39		41	42	43	44
230	17	18	25	26	27		37	38	39	40	41	42	43	44
220	17	18	25	26	27	35	37	38	39	40	41	42	43	44
210	17	18	25	26	27		37	38	39	40	41	42	43	44
250	45						62	63						
240	45						62	63			109	110		
230	45					59	62	63			109	110		
220	45		51	52	58	59	62	63		90	109	110	111	113
210	45	50	51	52	58	59	62	63	89	90	109	110	111	113
250														
240		118		128	129									
230		118	127	128	129									
220	114	118	127	128	129	156								
210	114	118	127	128	129	130	131	132	133	134	135	156	161	162
250														
240							222	223	224	225				
230		178	179	180		221	222	223	224	225				
220	177	178	179	180		221	222	223	224	225				
210	177	178	179	180	189	221	222	223	224	225				

We can gather from this table that (with just one exception) the subpopulations of data excluded by individual steps h are "nested" – i.e. they are subsets of the previous ones. The exclusions have certain regularity that belongs to industries. We can also see that estimated coefficients are stable, what implies that the core of the data set is homogenous. It is free of solitary ("spurious") outliers contaminating the data and causing a serious bias in coefficients. For example, in the first step of exclusion (for h=250) among the 11 excluded points were flagged as "irregular" (except of four other points) also: 38, 39, 41, 42, 43, 44 and 45. They actually mark nearly the whole industry of "non-metal mining" that represents the exports of sand, stones and kaolin. It is an irrelevant export industry (with prohibitive transportation costs), with the exception of its high exports in 1993 and 1996 only (non-deleted observations). After deleting this practically non-tradable industry from the data set we get the following results:

Table 14: Robust estimation of Czech exports to EU
(with mining of non-energy raw materials excluded)

Variables	Estimated parameters	Standard error	t-statistics	P-value
Intercept	18.959	4.429	4.28	[.000]
X price/kg	-0.160	0.025	-6.28	[.000]
FDI stock	0.279	0.018	15.61	[.000]
Tariffs EU	-4.469	0.353	-12.65	[.000]
K/L ratio	-0.979	0.062	-15.69	[.000]
GDP EU	1.172	0.428	2.74	[.007]

Std. error of regression	=	0.716	Adjusted R-squared	=	0.688
F-test	=	111.7	Original R-squared	=	0.694
White heterosc. test	=	70.3	Durbin-Watson	=	0.576

The improvement in all tests (if compared with Table 5b) already in the first step of analysis is evident. The most significant change occurred in the income and the export price coefficients, that both gained on magnitude and significance. The dependence of exports on both the aggregate demand and the price concessions can be higher than was estimated previously. The three core variables, however, have shown their stability.

By proceeding further with our pooling we could separate a whole subset of industries, which contradict in their behaviour the patterns of the majority of Czech export oriented industries. Their further analysis may be instrumental in uncovering trends behind the declining industries, as well as emerging trends that will be important for the changing structure of the balance of trade in the future.

8. Strategic conclusions

The present analysis has shown that the microeconomic approach to the testing of determining factors of trade flows and specialization patterns can lead to conclusions better structured in their argument and more based on fundamentals than the standard macroeconomic empirical models. Some of the findings even contradict some conventional views where trade dynamics are explained by income and real exchange rate movements. As it seems, both the extraordinary growth of Czech trade creation and its structural transformation followed the microeconomic theoretical paths for its dynamics more closely than was presumed. The core of factors behind the Czech pattern of specialization and GDP growth lie in the dynamics and proportions of factor inputs (such as capital, labour and human capital relative endowments), what brings their explanation and prediction close to Heckscher-Ohlin theories, or its neo-factor extensions.

Though it was confirmed by our test that the balance of trade could be influenced by exchange rate, aggregate demand and tariff changes (especially in the short run), the underlying fundamental factors rest on the supply-side capacities that are extremely closely related between the export and the import sides. Thus we should not expect that the standard monetary and fiscal policies could influence the trade balance for a much longer period than one year. On the other hand, the industrial policies (such as the support to FDI, capital availability, build-up of human capital or labour mobility) can lead to more inherent changes.

Our experiments with alternative specifications of the basic model show that our models can serve to medium-term predictions of trade balances and similations of various policy scenarios.

We can induce from our analysis that the fundamental restructuring of Czech enterprises in the period 1990-2001 was driven by the openness to trade (especially with the

EU). While exports offered growth, accelerating imports required the phasing-out of many industries, what was extremely costly. The global GDP growth thus could not be very high. Now, in a period of economic structural stabilization, the prospects for growth could be higher. Unfortunately we should expect a secondary restructuring of Czech trade and domestic import substitution as the relative factor endowments may be gradually changing from labour-intensive to capital intensive.

REMARK: The present research is still at its initial stage of basic hypothesis testing and methodological development. Further research should concentrate more at the following problems:

- *Dynamics of revealed comparative advantages;*
- *Extension of policy variables to monetary and fiscal instruments and implicit subsidies;*
- *Role of quality in intra-industry trade (measured as horizontal and vertical trade);*
- *More sophisticated measures of the quality/price gaps;*
- *Role of human capital, market structure and technological typology of products.*

The techniques of estimation should be extended into panel analysis identification tests and the estimation based on fixed effects, random effects and random coefficient models. Eventually, the models could be estimated by simultaneously.

References

Aiginger, K.: The use of unit values to discriminate between price and quality competition. *Cambridge Journal of Economics*, 21, 1997, pp. 571-592

Aturupane, C., Djankov, S., and Hoekman, S.: Determinants of Intra-industry Trade between East and West Europe. The World Bank, Working Papers Series, 1997

Badinger H., Tondl G.: Trade, Human Capital and Innovation: The Engines of European Regional Growth in the 1990s. Economic University, IEA, Vienna and the Austrian National Bank, 2002

Barro R. J.: Economic growth in a cross section of countries. Quarterly J. of Economics, 106(2), 1991, p. 407-443

Bayard, T. O., and Elliott, K. A.: An Evaluation of Aggressive Trade Policies. Inst. for International Economics, Washington, 1992

Bellak, Ch.: Lessons from Austria's Post-War Pattern of Inward FDI for CEECs. WIIW Research Reports, Vienna, 1999

Benacek, V.: International Trade Theories and the Adaptation Process to Structural Change in a Planned Economy. Proceedings: 5th Conference on Dynamic Modelling (ed. B. Martos, L. F. Pau, E. Ziermann), Pergamon Press, Oxford, 1988a, p. 21-28

Benacek, V.: Interaction between the Structure of Foreign Trade and the Changes in Production (in Czech), Ec. Institute of CSAV, Prague, WP no. 291, 1988b

Benacek, V.: Leontief Paradox in Foreign Trade of a Socialist Country: Some Empirical Evidence Reconsidered. 8th Conference on Input-Output, Keszthely, Hungary, 1989

Benacek, V., Gronicki, M., Holland, D., and Sass, M.: The Determinants and Impact of FDI in Central and Eastern Europe: A Comparison of Survey and Econometric Evidence. Transnational Corporations, Vol. 9, No. 3, United Nations, New York, December, 2000, p. 163-212

Benacek, V., and Visek, J. A.: The Usage of Factors in a Dual Economy: Specialization in the Czech Foreign Trade. Proceedings of Macromodels'99, University of Lodz, Poland, 1999

Benacek, V.: History of Czech Economic and Political Alignments Viewed as a Transition (Engl.). In: D. Salvatore et al. (ed.): *Small Countries in a Global Economy*. Palgrave/Macmillan, New York, 2001, p. 133-154

Benáček V., Prokop L., Víšek J. A.: Determining Factors of the Czech Foreign Trade Balance: Structural Issues in Trade Creation. Midterm Research Report, ČNB, Praha, June, 2002

Benacek, V., and Visek, J. A.: Foreign Trade Balance Effects in the Czech Economy – Impacts of the EU Opening-up: Robust Statistics Applied on the Czech Exports and Imports in 1993-97. ACE Project Working Paper, Charles University, Prague, 2001

Bhagwati J. N.: Immiserizing Growth. Readings in International Economics, Amer. Ec. Association, Homewood, Ill., R. D. Irwin, 1967

Brenton, P., Scott, H., and Sinclair, P.: *International Trade*. Oxford Univ. Press, Oxford, 1997

Crespo-Cuaresma J., Dimitz M. A., Ritzberger-Grünwald D.: Growth, convergence and EU membership. Austrian National Bank, Working Paper, October, 2001

Darvas, A., and Sass, M.: Foreign Trade Balance Effects in the Hungarian Economy – Impacts of the EU Opening-up. Economic Institute, Hungarian Academy of Sciences, Budapest, 2001

Diewert, E.W.: "Exact and superlative index numbers," *Journal of Econometrics*, 4, 1976, pp. 115-145.

Dornbusch, R.: Devaluation, Money and Non-traded Goods. American Economic Review, 1973, p. 871-880

Egert B.: Investigating the Balassa-Samuelson Hypothesis in Transition: Do We Understand What We See? Economics of Transition, vol. 10, no. 2, 2002, p. 1-36
Felipe J., and McCombie J.S.L.: How sound are the foundations of the aggregate production function? Proceedings from Conference "An Enterprise Odyssey" (edititors: S. Sharma and L. Galetic), Zagreb, June, 2002
Fontagné, L., Freudenberg, M., and Peridy, N.: Intra-Industry Trade and the Single Market: Quality Matters. CEPR, London, Discussion Paper no. 1959, 1998
Hamilton, C., and Winters, A.: Opening-up International Trade in Eastern Europe. Working Paper, CEPR, London, 1992
Harberger, A. C.: Some Evidence on the International Price Mechanism. J. of Political Economy, Vol. 65, 1957, p. 506-521
Helpman, E., and Krugman, P.: Market Structure and Foreign Trade. Cambridge, MA, MIT Press, 1985
Judge, G.G., W.E. Griffiths, R. C. Hill, H. Lutkepohl, T.C. Lee: *The Theory and Practice of Econometrics.* New York, J.Wiley and Sons, 1985
Kmenta, J.: *Elements of Econometrics,* Macmillan Publishing Company, New York, 1986
Krugman, P.: Competitiveness – A Dangerous Obsession. Foreign Affairs, Vol. 73, no. 2, 1994, p. 28-44
Krugman, P., and Obstfeld, M.: International Economics. Addison Wesley, Reading, MA, 1997
Landesmann M., Burgstaller J.: Vertical Product Differentiation in EU Markets: the Relative Position of East European Producers. WIIW, Vienna, Report No. 234a, 1997
Levine R., Renelt D.: A sensitivity analysis of cross-country growth regressions. American Ec. Review, 82(4), 1992, p. 942-963
MacDougall, G. D. A.: British and American Exports: A Study Suggested by the Theory of Comparative Costs. Economic Journal, 1951 and 1952, pp. 697-724 and 487-521
Pain N., Wakelin K.: Export Performance and the role of FDI. Working Paper of NIESR, London, December, 1997
Pelkmans, J.: European Integration: Methods and Economic Analysis. Longman, Harlow, 1997
Pfaffermayr, M.: FDI and Exports: A Time Series Approach. Applied Economics, vol. 26, 1994, pp. 337-351
Sala-I-Martin X.: Regional cohesion: Evidence and theories of regional growth and covergence. European Ec. Review, 40, 1996, p. 1325-1352
Salter, W. E. G.: Internal Balance and External Balance. The Role of Price and Expenditure Effects. Economic Record, 1959, p. 226-238
Selowsky, M., and Mitra, P. et al.: Transition after a Decade. Lessons and an Agenda for Policy. The World Bank, Washington, 2001
Tomsik, V.: Analysing the Foreign Trade in Czech Republic. Charles University, Prague, PhD dissertation, 2000
Tomsik V., Kubicek J. and Srholec M.: Structural Adaptability of Manufacturing in Central European Countries during Transition. Newton Holding, a.s., Prague, 2002a
Tomsik V., Kubicek J. and Srholec M.: Structural Changes in Central Europe during Transition. Newton Holding, a.s., Prague, 2002b (see http://www.newton.cz/analyzy/)
Visek, J. A.: On high breakdown point estimation. Computational Statistics, vol. 11, Berlin, 1996, p.137-146
Wdowinski, P., Milo W.: EU Enlargement and the Foreign Trade Effects in the Polish Economy: Empirical Evidence in the SITC cross-section yearly data during 1993-97. University of Lodz, Poland, 2001
WCY: World Competitiveness Yearbook, International Institute for Management Development, Lausanne, http://www.imd.ch/wcy/, 2001