Determining Factors of the Czech Balance of Trade: Structural Issues in Trade and Growth

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Project objective, as declared in Project Proposal of September 2002:

The research will be an extension of our project that began in January 2002. The basic objective for the proposed forthcoming stage of research will be to build on the already estimated microeconomic determinants of the Czech balance of trade and:

1) include additional explanatory variables;
2) employ more sophisticated methods of quantitative analysis;
3) align the findings closer with both the modern theories of growth and the policy tasks;
4) elaborate simulations suitable for predictions of future developments of trade.

Research area: D. Real Economy

1. Introduction

Since the time of Adam Smith economics has been searching for the causes and effects of the growth of income and wealth and for the explanation of the structure of international trade. Notwithstanding the enormous progress in those matters, Joan Robinson (1978, p. 213) came with a sweeping criticism nearly 200 years after the Wealth of Nations: „There is not a branch in economics in which there is a wider gap between orthodox doctrine and actual problems then in the theory of international trade". It is true, while there are fascinating pure theories running parallel to each other, their synthesis is seldom proposed. In addition, the analysis of the structure of specialisation is methodologically very different from the quantitative assessments of total trade developments. While the former is subject to microeconomic analysis in a commodity breakdown, the latter is explained generally by macroeconomic aggregates. The schism is also evident from the textbooks of international economics where former problems are discussed in the part of international trade, while the latter are explained in the part of international finance. There is hardly any methodological bridge between these two.

Although practically all European post-communist economies still fall significantly behind the level of development in their West European counterparts and the expected grand real convergence is still far out of sight, in one aspect of crucial importance the Central European countries of the next accession outperform the western incumbents: in the degree of macroeconomic openness to trade. Countries like Slovenia, Hungary, Slovakia, Estonia or Czechia emulate in this parameter the competitive edge of two top European performers – Belgium and Netherlands. What is even more amazing is the speed of opening-up in practically all transition economies. Meanwhile their GDP growth during the last 13 years was generally disappointing, their trade grew often above 10% per year (see Table 1). It signals that these economies have in themselves more hidden dynamics and higher capacities for real adjustments than what may be presumed from overall figures. In addition, by penetrating further into the structural details of trade specialization, we may reveal further unexpected phenomena in these economies.

There has been proceeding a significant change in this respect in the last 20 years. Aggregate production functions estimated by using macroeconomic identities have been subjected to harsh criticism (see Felipe and McCombie, 2002). The theory of endogenous growth (Grossman and Helpman, 1991, Rivera-Batiz and Romer, 1991 or Aghion and Howitt, 1998) came with a systematic inclusion of factors covering comparative advantages into their explanatory variables. Therefore changing trading patterns, structure of production and institutional factors of an integrated world, conceived as endogenous factors closing the object and idea gaps, became ever more used not only in theoretical explanations but also in empirical studies. Lutz (2002) has also argued that the traditional chasm between "economic" and "institutional" factors in explaining international trade has been narrowing in the last ten years.

With the hindsight of information about the developments in the more successful transition economies (Campos and Corricelli (2002)) it is evident that competition and competitiveness induced by high openness to trade was one of the crucial driving forces of restructuring and growth in these economies. In many of the mentioned countries exports contribute by more than a half to the net production and imports represent more than a half of final consumption. The impact of dramatically changing trade on employment, evolution of relative prices and external equilibrium were also of major importance. Yet many national policy domains remained dominated by information derived from macroeconomic aggregates that ignore or cancel-out the information about the undergoing profound restructuring at lower levels.

Quite often a short-cut leading to logical inconsistency is made in assessing the macroeconomic drivers of GDP growth when only the balance of the current account is considered as a factor of aggregate demand: $Y = C + I + G + (X-M)$. In addition, the residual (X-M) is often negative. The result is a bias to a spurious conclusion that the driving forces (or actually the lack of them) in the local development rest in the domestic demand.

In assessing the transition country's performance and prospects an analysis of macroeconomic factors should be complemented with an analysis of microeconomic factors concerning enterprises, industrial product specialisation, its quality changes and requirements of certain inputs. Macroeconomic aggregates can give a false picture of real changes if there are perfect trade-offs between enterprises (or industries) in the sense of creative destruction. What we mean by that is an expansion in one industry that is countervailed at the same extent by demise in some other industry. The estimation of factors associated with **structural changes**, especially in the manufacturing sector, provides therefore essential information for policy-making, prediction and evaluation of economic performance.

Another macroeconomic short cut in the assessment of international trade intensities is by means of exchange rate and the aggregate demand import absorption. However, in the transition economies neither the trade balance is determined exclusively by exchange rate (Karadeloglou (2002)), nor the real exchange rate is just a function of relative price level changes (between countries or between the traded and non-traded sectors), or an outcome of changes in average productivities of labour. For example, Egert (2002) could explain only 5–20% of the real appreciation in countries such as Poland, Hungary, Czechia and Slovakia by means of standard macroeconomic variables. Macroeconomic models used for such purposes are too simplified if compared with the excessive structural non-stationarity of transition economies. They abstract from asymmetries in inter- and intra-industrial restructuring, market organisation (e.g. the level of competition), structure of terms of trade, quality of products, trade diversion, relative price developments at the commodity level, subsidies, tariffs and demand changes; as well as from changes in endowments of physical capital, human capital, labour and FDI.

Many macroeconomic analyses put in parallel the development in the aggregate inflation, exchange rate, employment, growth abroad and external equilibrium. Unfortunately that bypasses the real causes or constraints of economic development that remain hidden behind the macroeconomic aggregates. Dealing quantitatively with the global growth or global external or internal equilibrium, when the country is subject to a profound industry-dependent restructuring, may be therefore too simplifying. The analysis should address also the microeconomic causes of growth that concern industries, enterprises, changes in factor endowments, product specialization, shifts in quality and gains in competitiveness. For example, macroeconomic aggregates can give a false picture of real changes if there are perfect trade-offs between enterprises (or industries) in the sense that an expansion of some of them is countervailed by the demise of others.

The estimation of the factors behind structural changes, especially in the manufacturing sector, is therefore an issue highly relevant to monetary and fiscal policy-making. The depth of the problem can be illustrated on such fundamental policy instrument like exchange rate. The exchange rate is an economic parameter that is closely related both to the sustainability of the current account balance and to the direction of net flows on the capital account. Many economists make the mistake of relying on macroeconomic analysis alone when talking about exchange rate regime options, nominal convergence and the trade balance. In the transition economies, the exchange rate level is neither just a function of relative price

level changes (between countries or between the traded and non-traded sectors at home) nor an outcome of changes in average productivities of labour. [1]

The sustainability of the real exchange rates in transition countries is related to qualitative changes in products and technology that are not uniform throughout all industries. For example, there may be gains in output growth in one particular industry due to its export expansion accompanied by gains in the terms of trade caused by product quality and marketing strategy upgrades. At the same time there may proceed a contraction of other, less efficient export industries and a restructuring of imports. The new structure of trade thus reflects a higher level of competitiveness of the national economy. The external balance can be in equilibrium only if the real exchange rate appreciates.

Our approach to modelling of export and import flows concentrates on the dynamics of competitiveness that is inter-linked by its causes and effects with the whole national economy. Such models must be strictly structural – open to the world competition and based on asymmetric industrial trends. These asymmetries are explained by three theories of specialization: Ricardian, neo-classical (Heckscher–Ohlin) and the "new theory".

The objective of this paper is to outline a synthetic model that, in its explanatory functions, would be compatible with the major alternative economic theories of trade and, at the same time, that would be subject to empirical testing of its hypotheses. Such a model should include macroeconomic factors (e.g. the international transmission of growth), microeconomic impacts of changing economic factor endowments, diffusion of technologies via foreign direct investment and various policy factors. Our models have three functions:

(1) explanatory – by stating the theoretical relationships between the variables;
(2) analytical – by estimating the quantitative dependency between variables in the concrete past structure of trade;
(3) predictive – by extrapolating past behavioural patterns in accordance with certain assumptions included in scenarios.

This paper is a follow-up of the research of Benacek, Prokop and Visek, 2003. At this stage it concentrates primarily on the analytical function that is extended by an illustrative predictive scenario.

2. Trade, Growth, Competitiveness and Modelling

The problem addressed in this paper therefore centres on the basic dilemma of small open economies in transition: how the domestic growth can be compatible with intensive structural adjustments due to competition with producers from abroad. The adjustments are necessary for future catching-up but they are also extremely costly, what is a barrier to the GDP growth in the short-run. At least we should see that adjustments were attenuating in time. The opening up of the post-communist economies and the process of their integration into the European Union (EU) had a big positive impact on the structure of their specialisation and external competitiveness (Pelkmans, 2002).

However, the diversion of trade from the East to the West and the sectoral restructuring at an extent unparalleled in European history, did not lead to high over-all growth immediately. At the same time the equilibrium real exchange rates remained at levels deeply below the benchmarks expected by the purchasing power parity. After the initial losses

[1] For example, in the recent study in that train of macroeconomic thought, Egert (2002) could explain only 5–20% of the real appreciation in countries such as Poland, Hungary, Czechia and Slovakia by the Balassa-Samuelson effect. Unfortunately, the standard macroeconomic models used for such purposes are too simplified if compared with the excessive structural non-stationarity of transition economies, so that their results may give an incomplete picture of reality.

in output, employment, real exchange rate, unit labour costs and terms of trade, the transition economies rallied. They were able to withstand the competition on world markets and since 1992 they were preparing for the EU membership. Their real exchange rate began to appreciate, real wages rose and exports increased exponentially, reflecting gains in competitiveness.

In all transition economies, the highest rates of trade growth were achieved in trade with the EU. For example, during 1993–2001, Czech exports to the EU rose from EUR 6.3 billion to EUR 25.6 billion. This fourfold increase implied average annual growth in exports to the EU of a remarkable 17.6%, while Czech exports to the rest of the world grew at a normal nominal rate of 4% (including inflation). At the same time, the trade creation with OECD partners was accompanied by a large trade diversion from the former partners grouped in COMECON (see Figure 1). Trade liberalisation concessions on the Czech and EU sides have therefore opened an unprecedented window of opportunity. It is the purpose of this study to deal more closely with the theoretical, quantitative and technical aspects of the analysis of such changes.

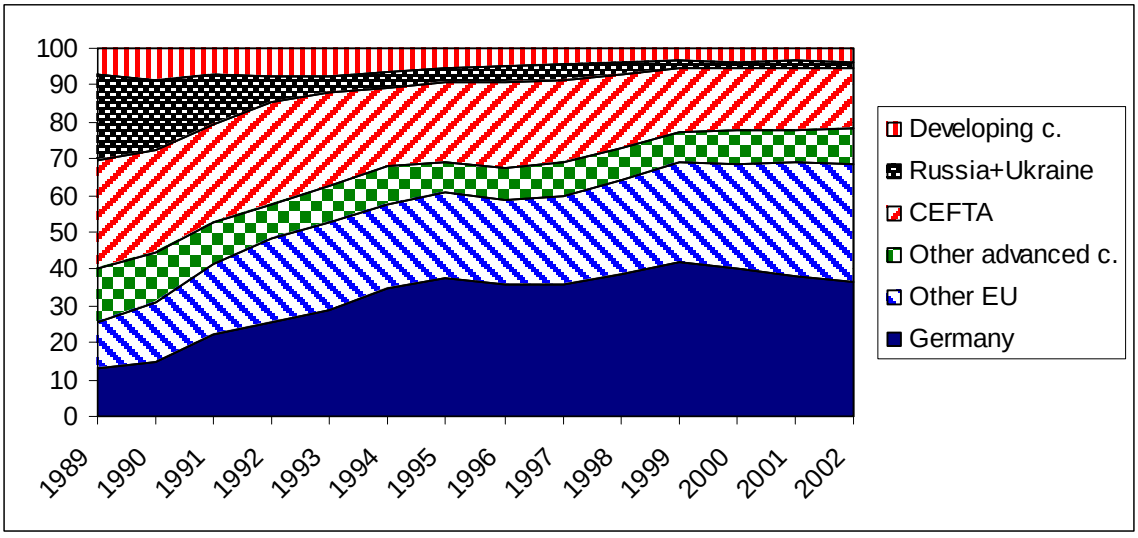

Figure 1: Share of Czech exports to economic regions in 1989–2002 (in %)
Source: Czech Statistical Office trade statistics adjusted for changes in methodology.

Figure 1 shows a picture typical for all Central European transition countries. Trade with the OECD countries had the fastest positive dynamics. The share of trade with CEFTA and with developing countries declined only marginally, while Russia and Ukraine were the main losers. We can also observe that the bulk of the changes occurred during 1990–1994. The period 1995–2002 was characterised by geographical stabilisation, while the growth rates of trade remained very high (over 12% annually). In parallel, there were profound changes proceeding in the industrial structure of trade.[2] This is an important factor to be realised for our analysis, since our studied period of 1993–2002 is composed of two parts: 1993–1994, when trade diversion prevailed, and 1995–2002, when trade creation was dominant**.**

The developments in international trade in small open economies determine the allocation and efficiency of the majority of domestic resources. Here one should abandon the

[2] *The most illustrative studies in this respect are by Tomsik, Kubicek and Srholec (2002). According to them, the structural changes (at NACE 2-digit classification) were present in all transition economies, though Hungary had the most extensive restructuring. Nevertheless, the intensity of structural changes is a microeconomic phenomenon and only a more disaggregated level of industries can unveil the real intensity of the new specialisation patterns.*

macroeconomic illusion that international trade influences the GDP by mere size of its trade balance (X-M) that is seldom higher than 10%. The rest is somehow assumed to be the domain of internal factors. Actually the share of traded commodities (i.e. those produced for exports and domestic import replacements) in GDP is very high – in some small economies even above 80% of GDP. Hence, export and import functions for small open economies overlap to a large extent with the sectoral empirical models proposed for the explanation of GDP dynamics, for example in Barro (1991), Levine and Renelt (1992), Sala-i-Martin (1996) or Crespo-Cuaresma et al. (2002).

The export and import functions are relevant not only for explaining exports and imports, but also for that part of domestic production for domestic consumption which is traded.[3] This means that 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 imports compete with domestic production. In the Czech case this implies a relevance not only for the 65% of GDP that is exported (or imported), but also for that part of domestic production for domestic consumption which is exposed to a competition from trade – which is estimated at an additional 15% of GDP. In addition, a significant part of non-traded goods can be inputs (complements) to the traded commodities, what makes their dynamics dependant on the factors determining trade.

Thus the location, redistribution and demise of resources for the production of at least 80% of the Czech GDP may be subject to the evolution of comparative advantages and competitive advantages [4] estimated by the export or import functions. **The interaction of the domestic economy with the outside world and the intrinsically asymmetric evolution of sectors following the potential for specialisation, lie at the core of the growth dynamics and allocative efficiency**. The remaining sector of the autonomous non-tradables is much more difficult to model because it acts often outside the markets. Fortunately for open transition economies dependent on an intensive specialization in manufacturing, this autonomous purely domestic sector is rather small.

Observed empirically, the evolution in the tradable sector can be quantified as **differences in the determining factors (exogenous variables) that lead to a change in the composition of exports or imports over time**, which can be related to two structural aspects:

- the geographical (territorial) breakdown,
- the commodity breakdown.

In the structure of our models we distinguish between three types of variables (determining factors):

[3] There is a wide discussion in the economic literature whether trade is a fundamental and primary factor of growth. The studies motivated by the endogenous growth hypothesis found that, considering all countries of the world, trade openness has a large positive effect on GDP (Frankel and, Romer, 1999). However, there may be significant differences between countries that depend at the quality of market environment and the public governance. Trade can also lead to immerisation (Bhagwati, 1967) or to structural frictions known as „Dutch disease“ where the expansion of some industries is accompanied by an asymmetry in contraction of other industries (Gylfason et al., 1999).

[4] *In difference to comparative advantages (given exogenously by relative factor endowments, relative productivities or increasing returns to scale), the competitive advantages are policy-induced. For example, they can be achieved by taking advantage of competitive devaluation, pricing and marketing policies, tariffs, product differentiation (Helpman, Krugman, 1985), market power (Krugman, Obstfeld, 2003, pp. 120-159), aggressive psychological trade policies (Bayard, Elliott, 1992), government interventions (Pelkmans, 1997, pp. 168–171) or various monetary policy instruments (Dornbusch, 1973), among others.*

a) Comparative advantages based on economic fundamentals at the supply side. They are represented by capital per labour relative factor requirements (i.e. intensities and their employment according to national factor endowments), contents of human capital (represented by FDI), relative productivities and scale economies. These variables are intrinsically structural (i.e. they are presented as industrial cross-sectional data) and closely related to technologies.
b) The dynamics of aggregate demand represented by domestic GDP for imports and foreign GDP dynamics for exports. This variable has only the time dimension and no sectoral breakdown.
c) Competitive advantages determined by policies and institutional arrangements. The factors considered here are tariffs, real exchange rate, monetary policy of the CNB, producer price indices, and unit prices of exports and imports.

The variables of trade intensities, whose evolution should be somehow explained, can be depicted by a matrix of trade growth indices π_{ijt}, taken separately for annual changes in exports (ΔX) and imports (ΔM):

$$\pi_{ijt}^{(X)} = \Delta X_{ijt} / X_{ijt-1}$$
$$\pi_{ijt}^{(M)} = \Delta M_{ijt} / M_{ijt-1}$$

where i = 1, 2, 3, …, *m* are the trading partners of the analysed "home" country;
j = 1, 2, 3, …, *n* are the commodities traded; and
t = 2, 3, …, T are years.

The empirical estimation of the whole problem can be simplified by taking natural logarithms of the trade flows X_{ijt} and M_{ijt} and all relevant explanatory variables. However, the dynamics of "why and where we are headed" can have a meaning only if we understand "where we are now", which requires the study of those factors that actually determined the present structural dimension of X_{ijt} and M_{ijt}.

The methodological roots of this approach are present in the principles of economic policy modelling (Tinbergen, 1952 and 1956) where present, future and past are intertwined in the following predictive model: $X_{ijt+1} = \varphi (X_{ijt-1}, \Delta X_{ijt})$, where the structure of past X_{ijt-1} and the dynamics of present ΔX_{ijt} need not be subject to identical determining forces. For example, the former could have developed in the environment of central planning and early stages of transition, while the present and the future evolve in a globalised market environment.

Therefore the dynamic analysis open to the future (X_{ijt+1}) must be supplemented by a static (structural) analysis of the past (X_{ijt-1}), reflecting the fact that the past of transition economies was moulded by different factors than the current changes (ΔX_{ijt}). At the same time the current "flows" (ΔX_{ijt}) cannot be completely independent of the particular state of accumulated "stocks" embedded in X_{ijt-1}.

The aim of this study is thus two-pronged: to provide a theoretical framework for explaining what determining factors could be behind these changes in trade flows in the past and what forces may potentially drive them into the future. Such models can be then tested by econometric methods. The policy implications and predictions could be also a part of their applications. The transition countries are specifically targeted as objects of our analysis. The schism between their not so remote past and their presence has hardly any parallel in the history of economic development. The intensity of changes that happened to their trade during the last 12 years confirms such statement.

If we look at the trade flows from the historical perspective, Czech international trade was evolving under bureaucratic decision-making for 40 years prior to 1990. It was to a large extent outside of enterprises and market signals. The resultant specialisation pattern was not consistent with comparative advantages, efficiency and competitiveness. As a result, there developed a widening gap between the real and the optimal allocation of resources. Once this system collapsed in 1990, an intensive process of trade diversion and product restructuring

was initiated. Negotiations on the preferential trading with the EU (1991-94) and establishment of the Central European Free Trade Agreement (CEFTA) in 1993 even further accelerated these events. Our empirical analysis will concentrate on comparing the developments in Czech trade with two geographical regions: the EU15 (accounting for 68.4% of exports and 60.2% of imports in 2002) and the rest of the world.

Except for the undisputed role of trade as an engine of growth and employment, its dynamics are have a crucial impact on macroeconomic equilibria: external balance based on the sustainability of the balance of payments, exchange rate equilibrium and the price stability. From this point of view, this paper has two objectives:

a) Explanatory – to contribute to the understanding how the Czech trade functions; namely what factors act behind its evolution, including the evolution of trade balance. A special role is given to the policy variables where we attempt to estimate the sensitivity parameters between them and the trade variables.
b) Predictive – to simulate the potential of changes in trade if some economic policies are applied. Alternatively we may simulate the impacts of predicted remaining exogenous variables (outside of the policy-making), such as the economic fundamentals that have quantifiable impacts on the trade structure and dynamics.

Trade re-adjustments due to trade diversion and the diversified intensity of trade creation with alternative trading partners associated with continued restructuring of enterprises and the inflows of FDI will long remain a sensitive issue in all transition economies. The balance of trade can both diverge or be brought back to equilibrium by various mechanisms and policies, and we should be aware which factors are active behind the dynamics of exports and imports. The analysis of these factors will be based on econometric hypothesis testing using export and import functions applied to Czech data for 1993-2002 in the sectoral breakdown into 29 industries of material production.

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

It is of a paramount importance in econometric hypothesis testing that the specification of the model involves a full set of real causal influences – that is, that there is not a single substantial variable left out that would be non-random. The current state of the art of economic theory helps us approach this objective. The present microeconomic theories of trade are able to "explain" the specialization pattern quite well, but unfortunately they are not so good at explaining trade intensities. Combining them with macroeconomic theories (open economy absorption, real exchange rates and the elasticities approach to the balance of trade) is unavoidable.

Econometric studies dealing with the estimation of factors influencing the commodity structure of international trade have had to tackle this problem by combining 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, so that they can be assumed autonomous and non-collinear.

The theoretical background of this empirical paper commences with the core model of specialisation – with the neoclassical Heckscher-Ohlin factor proportions theory. Its basic assumption is that the production factors are distributed among countries unevenly and their movement across borders is limited. The traded commodities are actually bundles of factors (capital, labour, human capital) that are moved across boarders indirectly – via the commodity trade. It is not logical to "export" that factor which is scarce in the given country. The trade is thus an arbitrage of factors from countries where they are relatively abundant to countries where they are scarce. The problem can be explained by Lerner-Pearce diagram (see Leamer

(1995 b)). We will distinguish between at least two traded commodities (one labour-intensive and one capital intensive) and there will be one labour-intensive non-traded commodity.

The initial equilibrium (in period 1) has certain initial structure of exports, imports and domestic production where all domestic resources are used optimally under perfect competition. In our case it is the year 1993. Then our economy is subjected to various shocks, both internal and external, what will wield pressure on the structure and dynamics of trade. For example, the changes (considered as "determining factors of trade") can be expected in the following:

- endowments of factors,
- internal prices,
- prices of exports or imports,
- quality /image, goodwill/ of traded products,
- prices of factors,
- nominal and various real exchange rates,
- aggregate demand (represented by GDP),
- tariffs,
- economies to scale,
- money supply, and
- productivity.

By estimating the coefficients of such determining (exogenous) variables we can study how they may influence the evolution of exports, imports and the trade balance.

It is of a paramount importance in econometric testing of complex social systems that the specification of the model involves the dominant causal influences. Although the present microeconomic theories of trade are able to explain the specialisation pattern quite well, explaining trade intensities requires to combine them with macroeconomic theories, such as open economy absorption, real exchange rates and the elasticities approach to the balance of trade. In our specification we commenced by placing the Heckscher–Ohlin hypothesis to the forefront. It is assumed that the relative factor inputs to the production of exports and domestic import replacements reflect the country's relative position in endowments. Thus the factor requirements (K_i/L_i) and FDI_i stocks (a proxy for human capital in industry i) became our core variables, defining the **structure of the potential for trade** on the Czech supply side.

The Ricardian comparative advantages are a part of alternative theory that explains the structure of trade. Ricardian comparative advantages are explained by the variable of productivities (such as total factor productivity or labour productivity). Even though the Heckscher-Ohlin comparative advantages in factors and Ricardian comparative advantages in costs are traditionally treated as separate theories, the more recent empirical studies tests them simultaneously and there were calls for designing an integrated theory (Leamer, 1995b).

The structural determining factors should be distinguished from the factors influencing globally the potential for real **intensities of trade.** They are then determined by the parameters of the demand side: aggregate demand (GDP) and the pricing policies of enterprises (PX, PM). In addition there are policy instruments that include the effective real exchange rate (RER) and tariffs (TM, TX). Since the RER is a global parameter common to the whole economy, sectoral price changes (PC) were added as an industry-specific variable. is another instrument specific for the national bank. Last but not least, monetary policy (MP) of the national bank was taken as the policy variable that may modify the "natural" trade flows.

4. Theoretical Background of the Explanatory Variables

The following eleven explanatory variables will be discussed here: capital per labour requirements of industries, productivity of labour, FDI, GDP, changes in domestic prices, real exchange rate, unit export and import prices, material inputs, tariffs and stock of real money.

Relative industrial factor endowments of production, measured by **capital-per-labour (K_i/L_i)** ratios in industries ***i***, are the determining factors in the Heckscher–Ohlin models of trade specialisation based on supply-side characteristics. If a country becomes relatively better endowed with labour (than with capital or natural resources), then according to the Rybczynski theorem and the Stolper-Samuelson theorem, it is assumed that the domestic labour cost/capital cost ratio is lower than that abroad and the country has comparative advantage in labour-intensive products. It is traditionally concluded that Czechia was and remains a country relatively better endowed with labour (Drabek, 1984, Benacek, 1988 or Stolze, 1997), relative to its natural geographic partners (located in the EU). It is therefore expected that Czech exports to the EU should be biased toward labour-intensive products. Our study is therefore also a test of the relevance of how the K_i/L_i ratios of specific factor requirements by industries are important for determining trade patterns.

Unfortunately, the variable of K/L requirements alone will not give complete information on the position of the isoquants of the production functions in the production space if we do not know how the individual isoquants may shift over time by changes in the relative efficiency of production in industries. We could think here about total factor productivities, or (as in our case) about relative **productivities of labour (Y_{it}/L_{it})**, as it was defined in the comparative advantage in labour costs.[5] This is the autonomous "Ricardian" parameter of specialisation based on different gaps in productivities (relative to the unit-value isocost line). Such "gaps" can originate due to most varied reasons: asymmetric changes in the physical productivities, price change due to opening-up of trade, a change in the tastes of consumers, introduction of a tariff, nominal exchange rate depreciation or an increase in quality.

Indirectly the presence of foreign direct investment (**FDI_{it}**), as a proxy for human capital) and the optimal composition of factors in production for exports (reflecting relative scarcities and/or endowments) can become the background source of such changes. Czech economy was one of the most important hosts of FDI in the last 6 years and definitely a leader among the post-communist economies (see Table xxx for the structure of FDI inflows).

In accordance with Keynesian theory, the current values of Czech imports (M_{it}) were considered a function of Czech **gross domestic product (GDP_t)** in real terms (constant CZK of 1995) and the variable of **industrial price changes (PC_{it})**. The combination of these two variables reflects the potential purchasing absorption of aggregate domestic demand in nominal terms. The coefficient of the variable of price changes has an additional interpretation: if it is statistically significant and negative then (under the assumption of one market price) we can treat it as a standard demand factor. An autonomous price increase in an industry discourages consumers to purchase the given product, irrespective of its origin. If the sign is positive, then we should look more at the supply side: the products were either improving in quality or the industry was subject to evolving oligopolistic pricing. In that case it is also a measure of **nominal convergence** in given industries.

[5] In the classical Ricardian model the domestic relative productivities (i.e. the inverse of physical unit labour requirements) are "normalised" by exogenously given world prices and their "unit-values". Naturally, our models can work only of the rest of world's prices (or productivities) are not correlated with changes in our productivities. The condition of *mutatis mutandis* is crucial for such estimates. We can expect that Czech economy is a marginal producer that indeed does not have an impact on the world prices.

The **real exchange rate (RER_t)** in another variable that can be partially autonomous, mainly due to the nominal exchange rate changes. Such changes can come from the open market international financial transactions (loans, short-term speculations, FDI financing, etc.). RER serves as a globally acting buffer for relating foreign and domestic price levels in one currency. Having the RER in the list of our exogenous variables can be justified if the individual industry-based domestic price indices are not perfectly correlated with nominal exchange rate changes that are universal for the whole economy. Then the real exchange rate is not a constant and its appreciation (i.e. the higher values of RER) should be associated with globally rising imports and declining exports.

Similarly, **exports** can be tested as a function of the **GDP_t** in the partner countries (in nominal EUR) and of the **real exchange rate (RER_t)**, which transfers aggregate demand abroad into that part of Czech effective aggregate demand, which is related to potential exports. In addition, we could retain here the variable of Czech **price changes (PC_{it})** in industries. It is assumed that the differences in the indices of sectoral price changes reflect a narrowing of the gap between world prices and the former prices under central planning.

If the parameter for PC_{it} is positive, it is a measure of nominal convergence related to the intensity of trading. The sectoral price change index reflects how domestic relative prices changed after the opening-up to the West. We might expect that in sectors open to trade the nominal (price) convergence will proceed faster until all domestic prices of tradables are equal to the prices abroad. This is also closely related to improvements in the export prices, which "pass through" into a higher domestic price level. The higher is the rate of "imported inflation" in the given industry, the higher should be the growth in its exports. The Stolper–Samuelson and Haberler theorems (Kenen, 1995) are consistent with this hypothesis. They explain why after opening-up to free trade export sectors have higher "inflation" than sectors without comparative advantages. We should thus expect a positive coefficient for this variable.

In accordance with the neoclassical theory of trade, imports are considered a function of **relative unit prices –** domestic and foreign. One option is to take internal prices at home relative to internal prices abroad, as is done in the literature describing the evolution of trade from autarchy. Such statistics unfortunately do not exist. The only unit prices practically available are those of exports (**PX_{it}**) and imports (**PM_{it}**) measured in values per kilogram of the given product bundle. It is assumed that these two prices represent competing products. If the model of exports as a function of these relative prices is non-linear (e.g. it is a power function), 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).

Unit prices based on values per kilogram 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 the case of vertical differentiation the products belong to "vertically" different consumer baskets due to different quality (e.g. up-market and down-market products). The problem of relative price competitiveness can be even better revealed if the differentiation is horizontal. There, the products belong to a similar quality category, but otherwise they may be identical neither in their prices nor in their costs. Another reason for using prices of exports and imports in trade models is that they are variables indicating sectoral terms of trade. The condition of homogeneity and perfect substitutability between compared exports and imports does not have to be valid here because for each industry we compare two bundles (vectors) of products subject to an unpredictable degree of variety. Although such relative prices have hardly any meaning in the given year, we can at least interpret their **changes over time**, thus converting

this variable it into an **index of the sectoral terms of trade** – and that is a concept that definitely has its economic relevance.

In order to simplify the analysis, we separate the relative prices after taking natural logarithms of their relative definition and get $Ln(PX_{it})$ and $Ln(PM_{it})$. Now we work actually with the rates of price changes. The estimated coefficients of these two variables can be positive or negative, depending whether the trade (exports or imports) on given territory is dominated by competition in prices (costs) or in quality. A review of the basic hypothetical cases for the economic interpretation of coefficients is given in Table 2.

Table 2: Relationship between unit prices (P), quality (Q) and export intensities

Case	Characteristics	Export intensity	Sign of coefficient	Implication	Type of competition
1a	P é	ê	minus	Q é less proportional	in prices
1b	P ê	é	minus	Q ê less proportional	in prices
2a	P é	é	plus	Q é more proportional	in quality
2b	P ê	ê	plus	Q é more proportional	in quality
3a	P é & Q ê	ê	minus	paradox of P	in prices (Q ignored)
3b	P ê & Q é	é	minus	paradox of P	in prices (Q ignored)
4a	P é & Q ê	é	plus	irrational case	false inference about Q competitiveness
4b	P ê & Q é	ê	plus	irrational case	false inference about Q competitiveness

We are analysing here the export case where we test the dependence of the export intensity (X_{it}) on the unit price PX_{it}. The characteristics of the standard **price (cost) competition** are indicated in rows 1a and 1b. It is signalled by the price coefficient's negative sign. Export sales then decrease as the price increases. The product quality may move in the direction of price changes but it impact on sales in not dominant. On the other hand, if the price coefficient had a positive sign for PX, that would indicate the dominance of Czech **quality competition** (see cases 2a and 2b). Higher exports are compatible only with improvements in quality, which are reflected in price increases. There are two strategies for achieving this. First, the quality of all existing products could be increased (on average). Second, the quality of products may remain unchanged but we export more from the vertically differentiated commodity groups that have higher kilogram prices – i.e. where value added in the given unit is higher, which is interpreted as products of higher quality.

However, complications may arise in some of the paradox situations (or behavioural irrationality of consumers) illustrated in the last four rows. In case 3a, a price increase is implicitly associated with a quality decrease, which naturally leads to a loss of exports. Though our inference on price competition is correct, we fail to recognise the parallel existence of competition in quality. In cases 4a and 4b we even may come to false conclusions about quality. For example, in case 4a we ascribe the gains in exports to improved quality, while in reality the quality decreased. Even though we would fail in cases 3a through 4b (partially or fully), we can assume that the probability of such cases must be extremely low and thus the impact of their bias in all exports or imports can be disregarded.

Additional information about interaction can be derived from the results when we compare both coefficients (i.e. PX versus PM) for their value, sign and significance. For

example, if we compare their significance we can see the strength of prevailing **global** tendencies valid both in space (29 industries) and over time (10 years) and what was the balance of power in competition between domestic and foreign products. We will often find different signs in these two coefficients indicating, for example, that domestic exporters out-competed the foreign high quality products by low (and even further falling) prices. The latter then implies that at home there must have taken place large gains in productivity, along with some (but not so dominant) gains in quality. An insignificance of one of the price coefficients (e.g. of PM in the export function) indicates either that foreign products are not an explicit threat to our exports or that foreign price and quality competition existed but none of them was dominant. A further structural analysis (e.g. by robust methods of estimation) would be required to find out what was undergoing beneath the dominating trends.

The rising importance of economies to scale in explaining the intensity of trade (Krugman and Obstfeld, 2003, pp. 120-159) should be a part of our tests. We can test if the growth in the "size of industry" is positively correlated with the growth in its exports and if their elasticity is greater than unity. This variable can be represented by material inputs (MAT_{it}). Another reason why this variable is selected (and not total output) is that exports contain not only the value added of given industry *i* but they also depend on inputs. The sources of export expansion or import substitution need not always rest in the given industry.

The last two of our explanatory variables represent the policy instruments – **tariffs (TAR_{it})** and the real money supply representing monetary policy (MP_t). The former represent an important barrier impeding the penetration of imports onto the domestic market. It is our task to find out how Czech trade behaved as the tariffs with the EU were gradually lifted during 1992–1999 while being kept with the majority of the non-EU countries. We will estimate this influence with the coefficient of elasticity, which should have a negative sign.

Monetary policy (MP_t) of the national bank can be represented by the stock of real M2 in given years or by interest rate (such as PRIBOR). The effect of this variable is described by Mundell-Fleming model. But here we must distinguish between its alternative impacts on nominal exchange rates that are partially present in the variable of RER. The interaction between imports and exports (and the effects of substitution versus complementarity between them) may also differ among countries. Thus the expected impact of monetary expansion on exports need not be always positive.

The relationship between our exogenous (explanatory) variables and the trade variable is explained on the next graphs.

(a) Variables K/L and FDI:

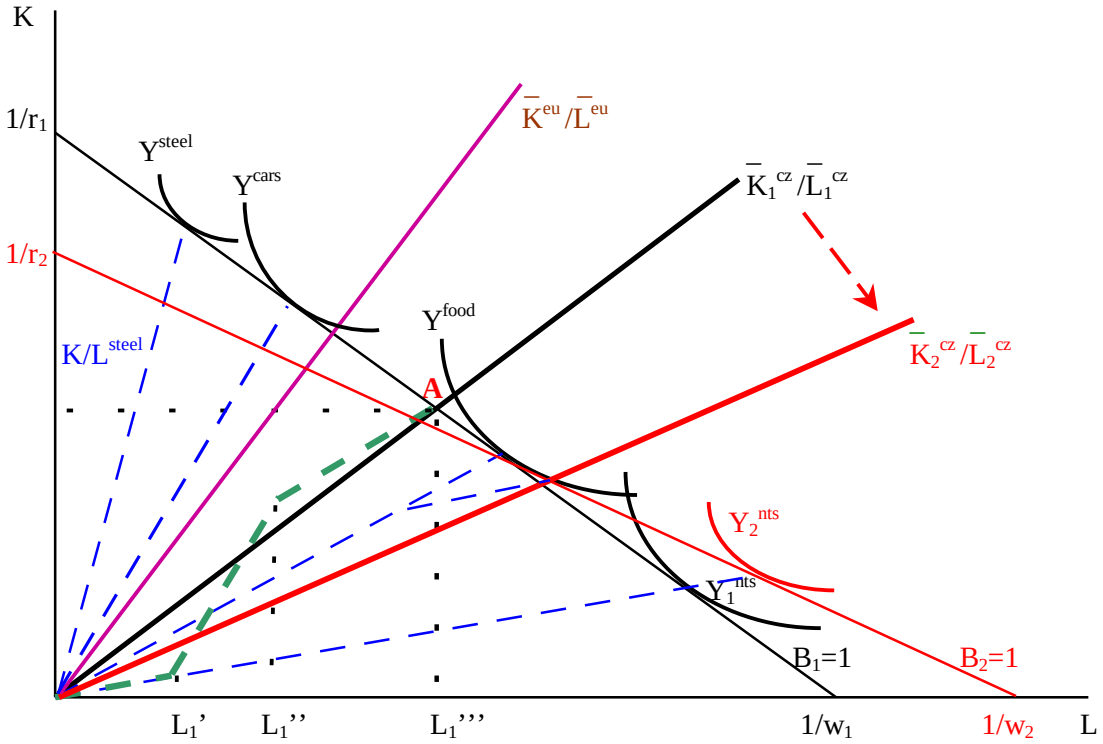

Figure 2: Basic pattern of specialisation according to Heckscher-Ohlin-Rybczynski relative endowments and factor intensities hypotheses

The isoquants and budget (isocost) lines are depicted here as unit-value benchmarks in domestic currency (e.g. 1 million CZK) representing revenues and costs. Point A defines the domestic structure of production and the specialisation pattern (X_i /GDP, M_i /GDP). In the initial period 1 the relative endowments are given as K_1^{cz}/L_1^{cz}. Food is the export article with highest comparative advantage (due to its labour-intensity), but also the cars are exported (in order to employ fully the given stock of capital in point A). The structure of employment (for each 1 million CZK of production) is the following: L_1' workers are employed in the non-traded sector, L_1''– L_1' produce cars and L_1''– L_1''' produce food. The majority of imports come from the capital-intensive industries. Steel is exclusively imported. The quantity of exports and imports cannot be estimated from the supply side. We can make only the assignment of commodities into the groups of comparative advantages and disadvantages and assess the potential for their trade if the endowments change. The true dynamics of trade is incomplete without considering the effects on the demand side.

If the **domestic endowments change** in time, the specialisation of trade is sensitive more than proportionally to such changes. The relative prices of factors reflect the changes in endowments. In case that country loses a part of its endowment of capital (e.g. due to transition), the domestic relative endowments shift to K_2^{cz}/L_2^{cz}. Labour becomes relatively more abundant and its marginal products falls. Wages decline as a result. On the other hand, the interest (rental rate) on capital rises. In this case **more** labour-intensive commodities (food) are both produced and exported in period 2. Domestic production of cars sharply declines and is replaced by more car imports. At the end only food is exported. In our models this situation is tested by the statistical significance of parameters for $\mathbf{K_i/L_i}$ and their elasticity towards export (or import) flows. A similar theoretical explanation can be given to the

evolving endowments of the human capital, represented in our models by the **FDI$_i$** stocks, respectively.

(b) Variable of price changes - PC:

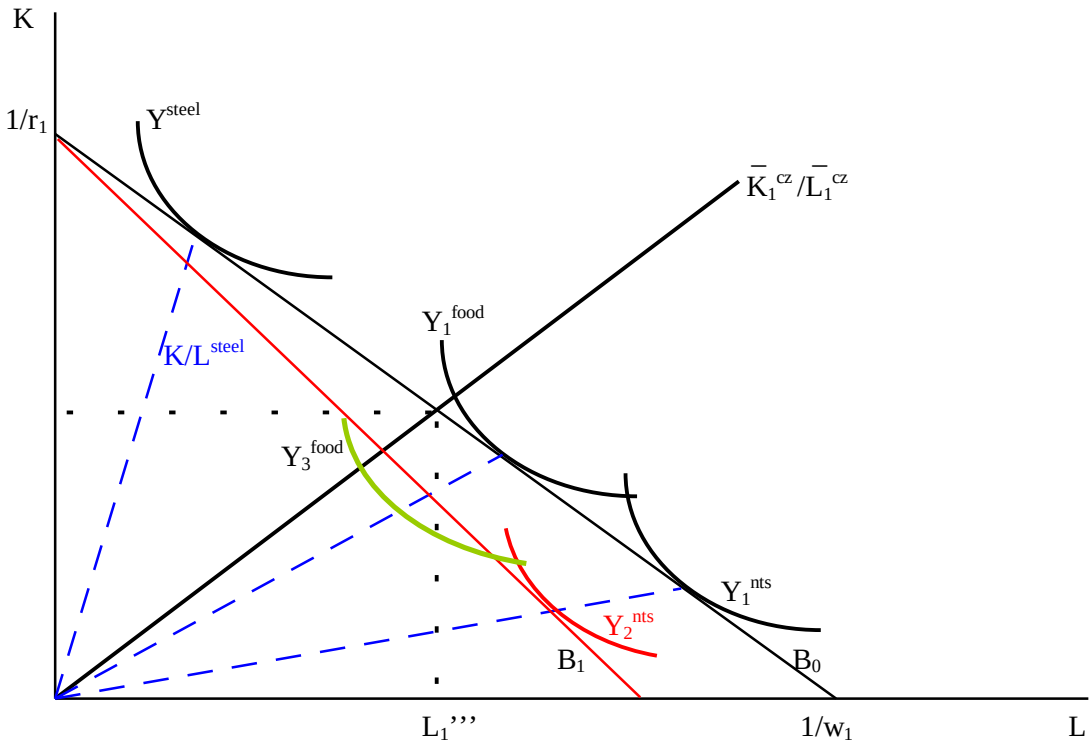

Figure 3: Change in prices generated domestically (without a change in the product quality)

An exogenous price change can happen in the first place in the non-traded sector (nts). An autonomous increase in prices of non-tradables (e.g. by 20%) first shifts proportionally its **unit-value** isoquant (Y_1^{nts}), making its production at Y_2^{nts} very profitable. This pushes the wages in the non-traded sector up, what unfortunately spreads with some lag into the whole economy. The higher wage costs per physical output lead to higher unit prices in the traded sector, what is reflected in rising indices PC_i. In addition, the RER (defined as P^{ts}/P^{nts}, or as w^{home}/w^{abroad}, or by means of relative CPIs) appreciates, what hits exports – especially in the more labour-intensive industries. The cost-push inflation in the sectors of food and steel undermine their competitiveness what decreases their exports and encourages imports.

Alternatively there can be a price increase caused purely by the demand-pull inflation in the traded sector. It can happen if the price is caused by higher demand (at home or abroad) in the traded sector. Alternatively it can be a reflection of certain market rigidities, such as the rise in market power. If the increased prices originate at home, this hits exports and stimulates imports in a similar way like the appreciated RER (defined by the impact of relative CPI on nominal exchange rate) does for the whole economy.

However, if the price increase comes from abroad (i.e. as a terms of trade improvement in exports of food that spill-over to higher domestic food prices), the exports expand. The isoquant of food shifts to Y_3^{food} , while the unit-value isocost line remains in B_0, what boosts the profitability in the food sector. This latter case would be an example of nominal convergence where higher internal prices are compatible with higher exports.

In our model these mechanisms are captured in the variables $\mathbf{PC}_i$ (price changes), provided the prices of competitors abroad did not change.

(c) Variables of unit export and import prices and changes in productivity – PX, PM, Y/L:

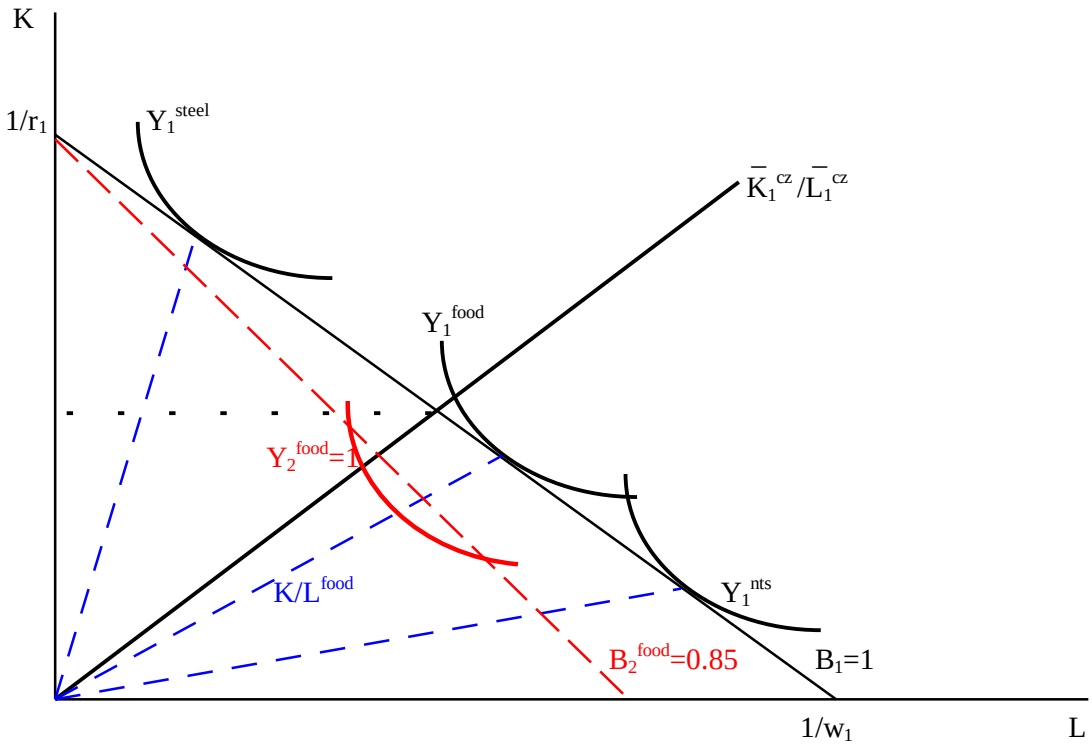

Figure 4: Change in prices generated by a change in quality or by an improvement in productivity – Stolper-Samuelson implications

A price gain in the traded sector (mutatis mutandis) can be caused by a general shift in consumer preferences, or by a unilateral increase in quality (goodwill, image) of the given commodity. We will distinguish between the export and the import sectors. If the price push coming exogenously from the world markets is by 25% in food (export industry), it will shift the respective unit-value isoquant of food closer to the origin along its K/L factor intensity line, offering the producer a rent from exports. The export price gain need not spill over to the domestic price changes. (If yes, that might be erroneously interpreted and measured as "inflation".) This is a very similar process like in the Figure 3, but its causes are slightly different.

As a result, the production of exports of food will rise and the production (and exports) of other commodities may get under contraction. In addition, there will be an impact on wages (food is more labour intensive than the average) that will rise slightly. The tangent (red) isocost line will therefore have a higher value than 0.85 mil CZK. One million CZK of exported food is therefore produced at a cost of 0.85 million CZK, what boosts exports.

If the price increase occurs in an import industry – this will discourage our demand for imports due to Marshall-Lerner price response. It may be an incentive to expand domestic import replacement production and even to start exporting its products.

In our model these mechanisms are relevant for tests involving variables $\mathbf{PX}_i$ and $\mathbf{PM}_i$, which can be interpreted either as a change in quality or a change in price marketing policies (see Table 2). Indirectly we may test additional (secondary) effects of trade pricing by the

variable **PC_i** (domestic price changes) where the questioned hypothesis is: how active is the export or the import price pass-though is in penetrating into domestic prices. We may interpret some cases (e.g. where PC is positively correlated with exports or imports) as the nominal price convergence.

This analysis can be further extended into the supply-side conditions. A change in **productivity** (caused for example by a total factor productivity improvement – what is measured also in our variable of **labour productivity Y_{it}/L_{it}**) can be depicted in the same way as a change in quality, although, taken strictly from the "productive" point of view, it is a rather different phenomenon than a mere price change. While the higher export price is often confused with inflation, the gain in mere physical productivity is presumed to be the "desired" economic development. Unfortunately, it is a source of a deep misunderstanding from our point of view. Both gains, either via the productivity improvement or via the price increase, have identical impacts on exports and therefore they should be treated equally – as exogenous improvements in export competitiveness.

(d) Variables of exchange rate and tariff changes – RER, TX, TM

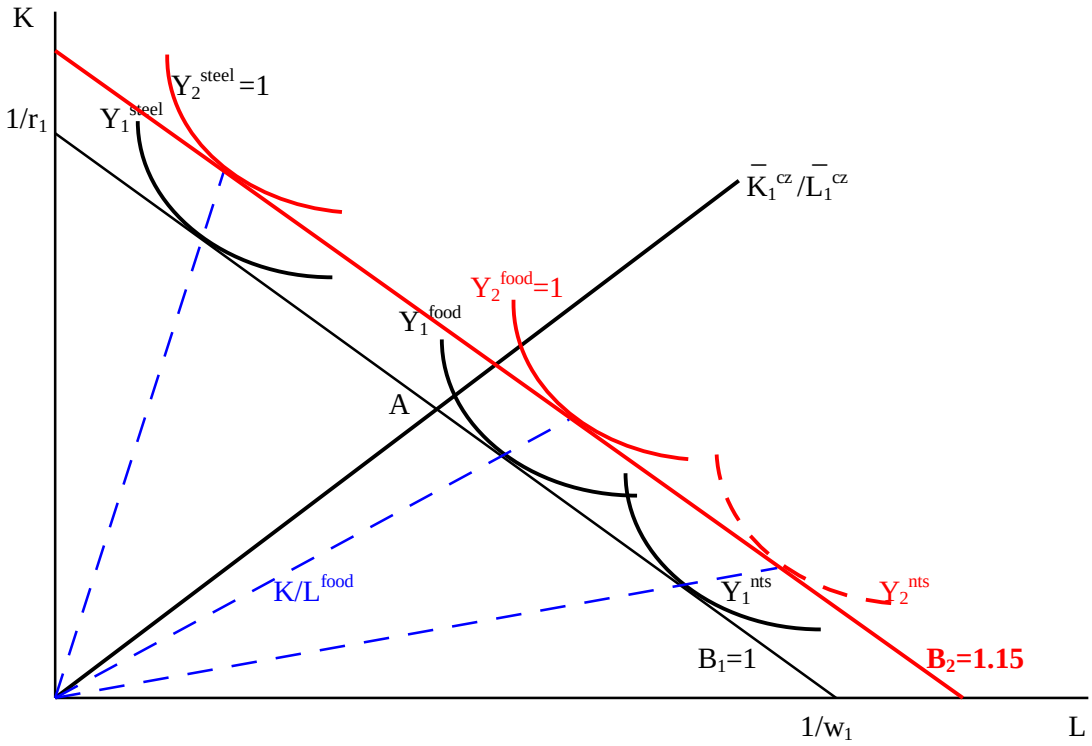

Figure 5: Nominal and real appreciation of exchange rates

There is a series of impacts of a nominal appreciation (e.g. of 15%) on a small domestic economy that is a price taker. First we can see the decline of unit prices (in domestic currency) in both exports and imports. It is because all exports are subject to an implicit "tax" of 15% and all imports are subject to an implicit "subsidy" of 15%. The exports generally decrease and imports get a rise.

The explanation is simple: the exchange rate appreciation causes that prices of both exports (i.e. as proceeds from trade in domestic currency) and imports in domestic currency will decline [6]. For example, if the price pass-through in traded goods is perfect, the new unit-value (1 mil CZK) isoquants of steel and food are pushed proportionally upward. The new

[6] The extent of price falls depends on the supply and demand elasticities, what is explained by Marshall-Lerner-Robinson conditions.

isocost line B_2 tangent to these isoquants marks the cost of 1.15 million CZK – what will imply a loss of 0.15 mil CZK per each unit-value, provided the factor prices and factor costs (wages) remain unchanged. The production of non-traded products will grow, as the released domestic resources try to reallocate there – pulling its prices down.

The extreme case – that nominal exchange rate pass-through is perfect in prices but none in the wage changes, what implies constant RER based on CPI – is of an analytical interest here. In such case only the RER based on wages will signal the full pressures on trade. The RER based on CPI gives a correct signal only if the commodity prices respond less than proportionally to the nominal exchange rate changes.

A similar effect, but limited to individual imported commodities, can be found if the **tariff** on imports is decreased. If the import supply is perfectly elastic the price decrease should be equal to the tariff premium. Imports than expand in a similar way like after the exchange rate depreciation. However, the export side is not directly effected in this case.

In our models this mechanism will be reflected in the variables of $\mathbf{RER_t}$ (only if the price pass-through from trade on domestic market is sticky), **and tariffs ($\mathbf{TX_{it}}$, $\mathbf{TM_{it}}$)**.

(e) Variable of the scale of production - MAT

Here we can test a hypothesis coming from the theories of trade dealing with the economies of scale. Exports may have a higher dynamics if certain size of the production is achieved. Thus large industries can be more export dependent than small industries. We have tested material inputs as the proxy variable for the scale of production. This offers another interesting information that can be derived from an analysis of elasticities of trade intensities to a percentage increase in material inputs. Such elasticity of exports gives signals about their input efficiency and how future exports are correlated with imports (that are a part of material inputs). It would be desirable for a sustainable balance of trade to have the export elasticity greater than unity. At the same time it would be advantageous to have the import elasticity less than unity.

(f) Variables of aggregate demand and monetary policy – GDP, MP

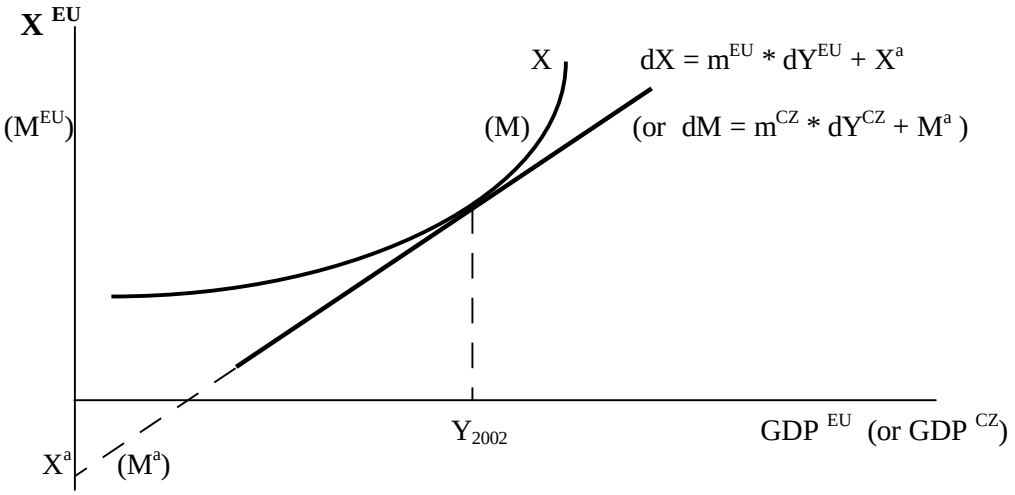

Figure 6: Aggregate demand expenditures, exports and imports

According to Keynesian multiplier approach to GDP in open economies, imports, exports and the trade balance depend not only on the slope of linear marginal propensities of import (domestic m^{CZ}, or m^{EU} for Czech exports to the EU, respectively), but also on various

autonomous (exogenous) factors included in the constants $\{X^a, M^a\}$ that reflect the existence of other factors determining the trade, independent of the $\mathbf{GDP_t}$. Actually these are our remaining exogenous variables in the estimated models. Monetary policy (**MP**) may be considered as one of them. The exchange rate is supposed to be unchanged.

The macroeconomic equation $X = m^{EU} * Y^{EU} + X^a$ can be extended for individual sectors ***i*** in the given year: $\mathbf{X_i = m_i^{EU} * Y^{EU} + X^a_i}$

Its estimation on cross-sectional data of industries looks for a trade-weighted coefficient m^{EU} common for all industries. The estimation on a panel data may even extend over all industries and years.

The role of monetary policy (represented, for example, by the real stock of money M2) is mediated by its effects on the aggregate demand for imports and exports. Namely it is the impact on GDP via induced changes in the savings and investments. The monetary variable is therefore primarily important in the import equation. Its extension to the export model can be justified only if we prove that Czech exports can be stimulated directly not only by the foreign GDP but also by domestic GDP. This is the assumption built into the gravity models of trade, which is supported by empirical evidence (contrary to standard macroeconomic economic theory).

If we are interested in the analysis of changes, our model will be in differences over time. The impact on trade with the EU will be studied on its net change in the trade balance $dN = dX – dM$. For simplification we omit the tax rate among the leakages, considering only the marginal propensities of savings and imports. The functioning of the variables of GDP and monetary policy are explained on Figure 7. In the period 1 the net trade balance (N = X-M) is zero, given the existing income Y_1^{CZ} and Y_1^{EU}, and propensities s^{CZ}, m^{CZ} and m^{EU}.

In the period 2 the EU economy revives. GDP^{EU} is increased, bringing a higher expenditure on Czech exports E_2. This is an exogenous shift. The Czech GDP rises to Y_2^{CZ}, what increases also the imports via a multiplier. The function of Czech net trade N_1 is pushed up by $(N^a_2 – N^a_1) = (E_2 – E_1)$.

Thus $dN = dN^a – m\,dY$, while $dY = [1/(s+m)]\,dE$ and $dE = dN^a$.[7]

Alternatively, in period 3 the net Czech expenditure is boosted by expansionary monetary policy from E_1 to E_3, which increases GDP^{CZ} to Y_3^{CZ} and increases the imports by B_3. The impact on exports is not considered here. The logic of this traditional model can be modified if we expect that the impact of monetary expansion has a spillover effect into exports. For example, an increase in domestic spending offers the exporters to divert their trade internally. We should not treat exports as an entity depending exclusively on the world markets. A monetary expansion thus may decrease exports because they were diverted to the domestic market. A monetary contraction gives incentives to domestic producers to export more abroad.

With this we have concluded the explanation of independent relationships (mutatis mutandis) between our main exogenous variables and the endogenous variables X and M.

[7] See Kenen (1995) for more details.

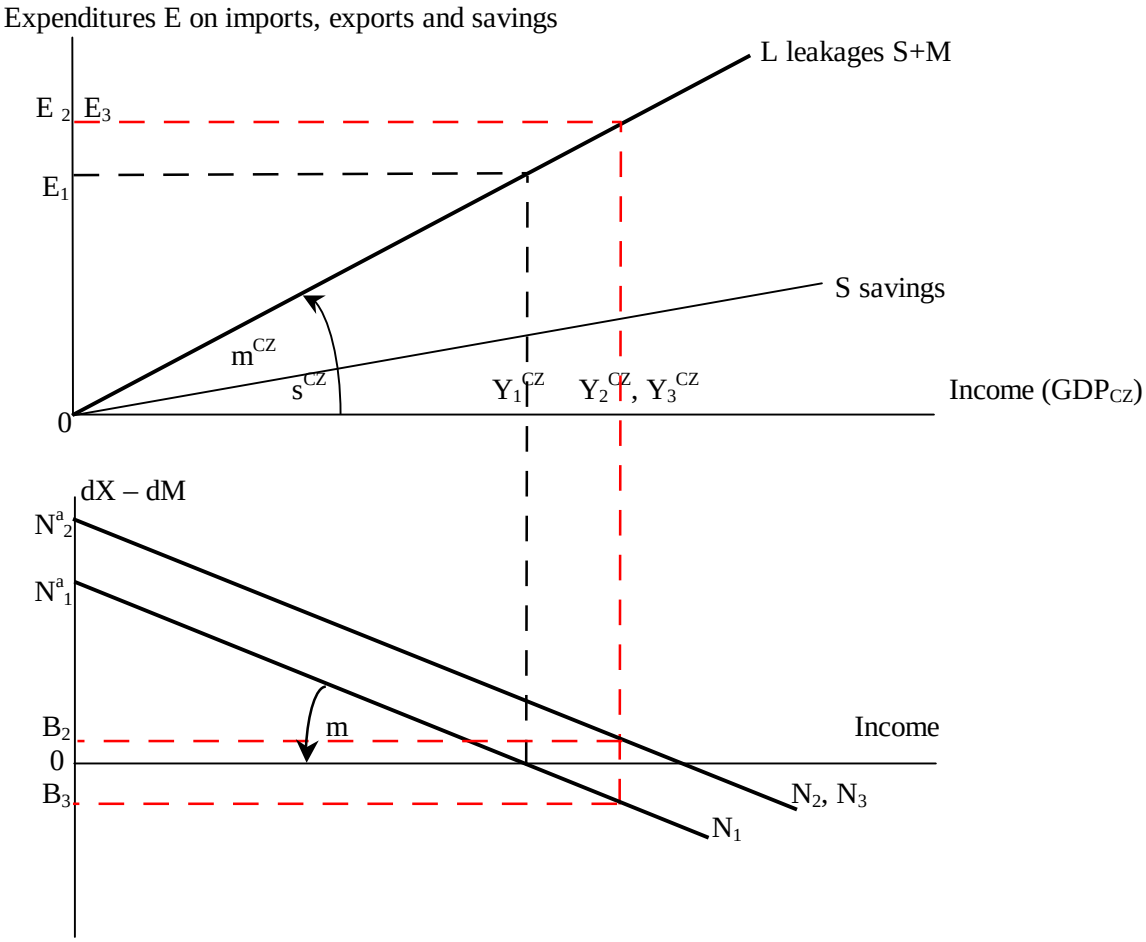

Figure 7: Impacts of autonomous shifts in GDP abroad on domestic X and M and impact of monetary policy on trade balance.

5. Estimation of Trade Models by the Technique of Fixed Effects

The choice of estimation technique for the coefficients in our models is crucial and subject to the nature of our data. In their economic contents, our data are primarily cross-sectional indicators defined for 29 sectors. It addition, they are pooled by years (1993–2001). Panel techniques (Wooldridge, 2002) suit best for the estimation of models based on such data. The problem is explained illustratively in Figure 8, where we limit the whole export function to the core explanatory variable of relative factor requirements:
$X^{EU}_{it} = a + b\, K_{it}/L_{it} + e_i$, where a, b are the estimated coefficients.

The dots in Figure 8 are stylized observations. According to the Heckscher–Ohlin hypothesis, the intensities of exports (representing the specialization) are not indifferent to factor requirements. For example, in a country relatively better endowed with labour relative to capital, the majority of exports should be concentrated in the textile industry, which is labour intensive. The higher is the *K/L* requirement in a given industry, the lower is that sector's engagement in exports. The model should then be estimated as cross-sectional data pooled by time – depicted in Figure 1 as a series of downward-sloping lines (e.g., by the thick intermittent line X_{1997} as one of them).

The complication is that there is also a time dimension for each industry. The *K/L* ratio may then grow in time, what also has an impact on exports. For example, this can be depicted by the upward-sloping thick intermittent green line representing the trade in food. By estimating the model alternatively, in this case in an industrial sequence of time-series, we

may get very different coefficients *a*, *b* that actually represent very different economic hypotheses.

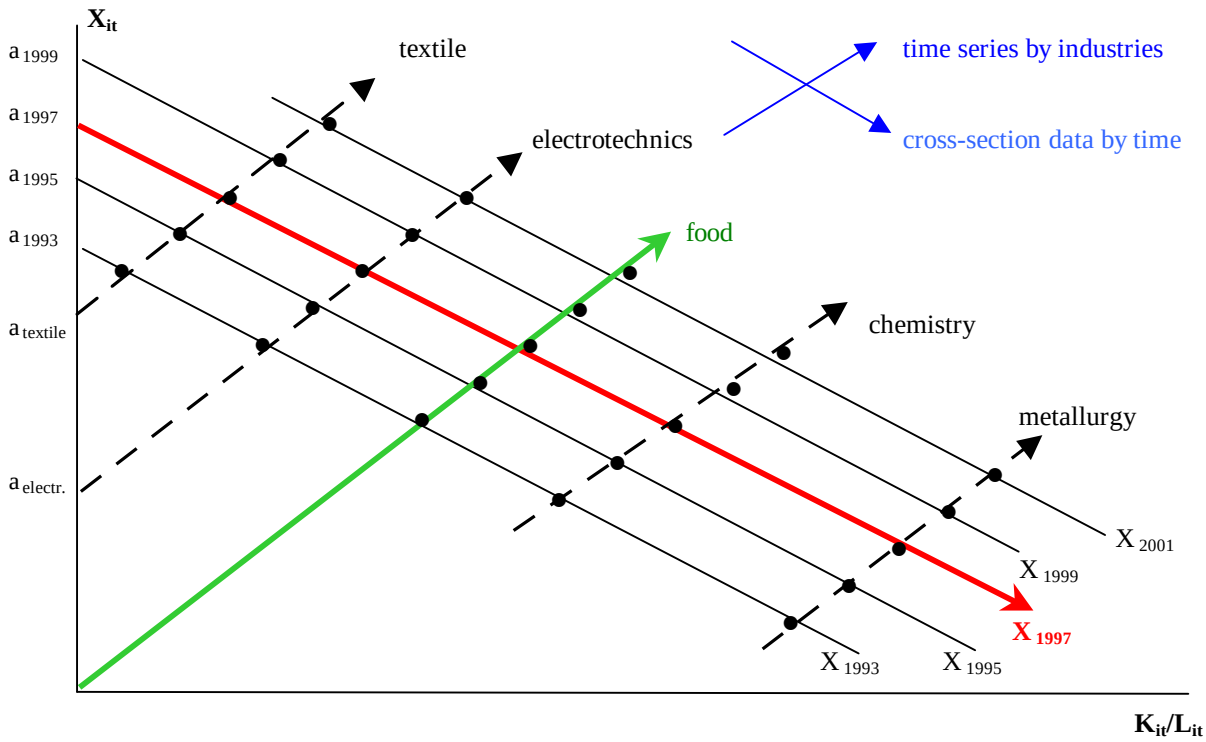

Figure 8: Illustration of dimensions and characteristics of our panel data

Figure 9 illustrates how the data with an exclusive time dimension (such as GDP, RER or the stock of money) cannot have a full interpretation as a structural model (i.e. as vertical intermittent lines). Its main strength in is the analysis of the time dynamics (i.e. as upward-sloping time series of individual industries).

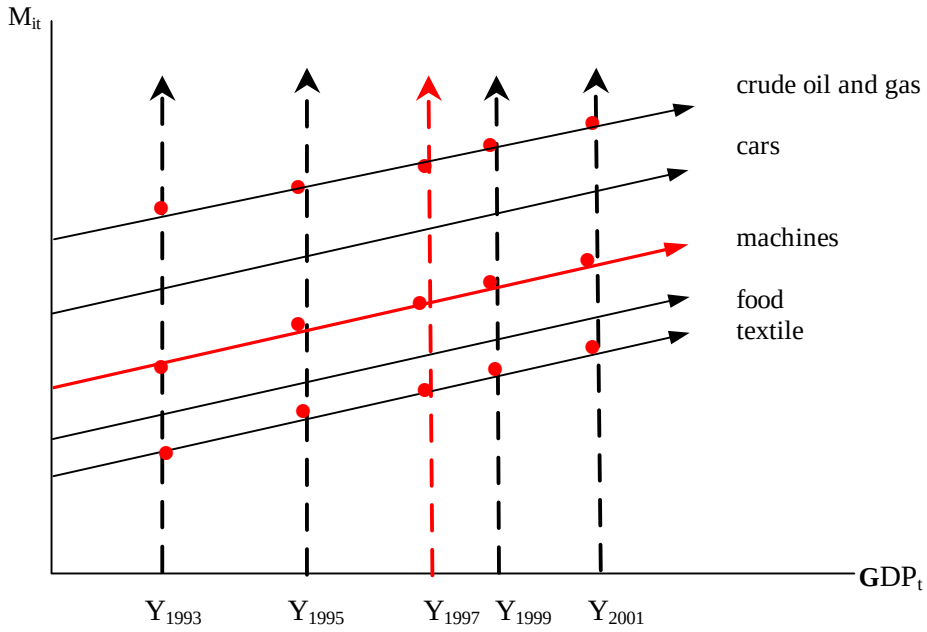

Figure 9: Interpretation of panel data with an exclusive time dimension

The estimation technique of fixed effects eliminates the bias (the shift) from the model caused either by time or by idiosyncrasies of individual industries. In the case of "fixed

effects" of time, it is assumed that the behavioural characteristics are the same for all industries, except for the "vertical shift" in individual years. Thus, by means of time dummies we estimate additional intercepts (a_t) for each year t, aligning the series of cross-sectional data for 1993, 1995, 1999 and 2001 closer to the "average", assumed here to be in the year 1997.

Alternatively, for the proper estimation of variables that have the time dimension (this also includes such variables as GDP_t and RER_t), we must eliminate the "shift" in data caused by behavioural specificities of individual industries. Therefore, we estimate the model with fixed effects by individual industries.[8]

The methodologically different approaches to estimating fixed effects have their own practical outcomes. As Figure 1 shows, structural and time analyses of export behaviour can lead to very different results – for example, the estimated slopes *b* can differ not only in magnitude but also in sign. This may happen if the initial structural characteristics of the studied object (trade flows and specialization) change over time. The analysis of structural patterns offers a static picture that can serve as a benchmark. The complementary analysis of time patterns offers a dynamic outlook that is more appropriate for making predictions. Nevertheless, both analytical views are necessary complements for finding "where we have come from" and "where we are headed".

6. Dynamic Panel Estimation

As suggested in the text, the key identification issue is in the data setup. Whereas the pooled data over all sectors and times leads to inconsistent estimators, the dynamic estimation from the times series across units (similarly to a panel data setup) leads to consistent estimators. This dynamic estimation just concerns the time dependence between dependent, lagged dependent and other determinants. However, the inference about the structural character, for instance about the relation between K/L ratio and exports remain undiscovered in such setup. This could be estimated exclusively on the basis of the cross section data (one data point for each sector) by simple OLS.

The demonstration of the various methods and their inferences is based on the following example (very similar to Figure 8) where we have generated data for K/L ratio in few sectors and we know the true dependence (coefficients values) and we can compare the performance of the various methods. In particular we demonstrate the inconsistency of pooled data by OLS and the consistency of Arellano-Bond (1991) dynamic estimator. In addition, we come with the look at the cross section and at the OLS results applied on pooled data estimator and infer that the OLS on pooled data is biased and the OLS on cross section is not. Thus we study two problems and we have two different inferences about the determinants of exports. The estimation results follow.

The coefficients: in cross section the data was generated as –0.54 in a linear model specification. In the dynamic specification the coefficient should be equal to one. (Standard errors are given in parenthesis and D in front of the variable denotes first differences).

[8] Coefficients estimated by this method are unbiased and consistent. Unfortunately, the trade-off for gains from using fixed effects is that the estimates need not be always efficient. In that case we should know that although the structure of the model is correct, we may not be certain about the "true" variance of the error. Alternatively, the problem can be eliminated by using the GMM method of estimation (Arellano, Bond, 1991) applied on dynamic panels.

OLS on pooled data set

EX = 6.01(0.14) – 0.539(0.0299)K/L
Rsq.=0.99

OLS on pooled data set:
EX = 6.96(0.5) – 0.263(0.079)K/L
Rsq.=0.19

Dynamic (Arellano-Bond) estimator:
DEX = -0.46(0.10)DEX(-1) + 1.048K/L
Tests 1: -1.72 (0.08); Test 2: -0.22(0.82); Test 3: 3.89(0.27)

Fixed effects (within regression)
EX = 0.59(0.08) + 0.81(0.014)K/L
F(7,39) = 1000(0.00)

7. The Alternative Estimations of Our Models of Exports and Imports

The basic models for our empirical testing of the Czech trade flows were defined as the following implicit functions:

$$M_{it}^{w} = \Phi_M^{w}(GDP_{t,} RER_t^{w}, PC_{it}, PM_{it}^{w}, PX_{it}^{w}, K_{it}/L_{it}, Y_{it}/L_{it}, FDI_{it}, MAT_{it}, TM_{it}^{w}, MP_t, e_{it}^{w})$$

$$X_{it}^{w} = \Phi_X^{w}(GDP_t^{w}, RER_t^{w}, PC_{it}, PX_{it}^{w}, PM_{it}^{w}, K_{it}/L_{it}, Y_{it}/L_{it}, FDI_{it}, MAT_{it}, TX_{it}^{w}, MP_t, e_{it}^{w})$$

where:
i ... are commodity groups (e.g., at NACE classification);
t ... the years (e.g., 1993 through 2002);
w ... regions from where the imports originated or to where the exports were directed;
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 CZK at constant prices, 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} ... the effective real exchange rate index based on the CPI and related to the currencies of the given trade partners (increase means appreciation);
PC_{it} ... Czech price changes in industries i (as price deflators, where the base year has index 1.00), measuring the intensity of nominal convergence;
PM_{it}^{w} ... unit prices in EUR per tonne, measuring the type of competition (in prices or in quality);
PX_{it}^{w} ... unit prices in EUR per tonne, measuring the type of competition; [9]
K_{it}/L_{it} ... capital (at constant prices) per unit of labour, characterising the domestic technologies and their relative factor requirements;
Y_{it}/L_{it} … productivity of labour (at constant prices);

[9] In the export equation it is the strategy used by Czech exporters abroad. In the import equation it is a proxy variable for Czech domestic competition to foreign imports.

FDI_{it} ... foreign direct investment stocks (in CZK), serving as a proxy variable for human capital;
MAT_{it} … material input adjusted to price changes;
TM_{it}^{w} … tariff rates levied on Czech imports from w (at home);
TX_{it}^{w} ... tariff rates levied on exports to w (abroad);
MP_t … monetary policy (stock of real M2);
e_{it}^{w} ... random term.

8. Simulation of predictive capacities of the models of exports and imports

There are several scenarios how to make simulative predictions by using the coefficients derived from our model. First we may test the sensitivity of trade to changes in explanatory variables on both the export and the imports parts independently. For example, we can estimate the impact of the expected GDP growth in the EU and at home on Czech exports and imports, provided we also can estimate the investments into domestic sectors. The resultant trade balance with the EU can be estimated. As a follow-up we can test how alternative policy instruments (nominal exchange rate, price evolution or monetary policy) could influence the trade balance. This is a scenario-based testing of hypothetical future situations.

Some trade predictions (for example those dependent too closely on the evolution in technologies and productivities) will be more difficult to estimate since our direct prediction of such variables as TFP or productivities is highly unreliable. However, some basic trends could be relieved if we would be able to predict a structural trajectory in a variable closely related to such changes. FDI could be a variable that might be instrumental in predicting the evolution of trade subject to the stock of human capital or economies to scale. The balance of trade can both diverge or be brought back to equilibrium by various mechanisms and policies, and we should be aware which factors are active behind the dynamics of exports and imports.

… Který dobrovolník se ujme zbytku ???

9. Innovations in our research compared to results in 2002

A. The time series were extended to year 2002, even though some of the data for 2002 were not available at the Czech Statistical Office. In the cases of value added we had to use adjusted provisional data of the Ministry of Industry.
B. The stocks of physical capital are defined differently – as the depreciated market values. Unfortunately the more suitable stocks in purchased accounting values have no support in the statistics after 1998.
C. We have extended the tested explanatory variables by the following:

a/ Variable of monetary policy represented by the stocks of real money M2 (in accordance with the Mundell-Fleming model). We have also tested experimentally the variable of interest rates.

b/ Variable of relative efficiency represented by labour productivity (in value added). The idea here was to test the importance of the comparative costs in the original Ricardian sense.

c/ Material inputs to industries that is a proxy variable for the „economies to scale“ by Krugman.

d/ All of our data were updated, including the years 1993-2001. There were only few real changes that should not have had an impact on estimation. The kilogram prices are now in euros – free from the fluctuation of values due to the exchange rate changes.

D. The functioning of all 11 of our explanatory variables are explained on graphs.
E. Except for the estimation of coefficients by the method of fixed effects, we have used the the methods of random effects and the estimation by GMM dynamic panel.
F. We have used the estimated coefficients for experimental predictions of trade flows and the balance of trade according to a scenario of economic developments in the next couple of years.

10. Policy Relevance of the Models

Taken from the view of the government, national bank and enterprises, the model has the following links to policy relevance:

a) The RER variable is the key variable describing the link between the monetary and real economies. For example, an RER appreciation means decreasing competitiveness of exports or of domestic import substitution. The loss of competitiveness should be compensated for by some of the following: productivity improvements, wage concessions, fiscal support, monetary intervention, attraction of FDI, price/quality improvements, autonomous deflation in industries or by structural adjustments in trade.
b) The variable of aggregate demand is one of the most important mechanisms of international shock transmission. The estimated coefficients of income elasticities reveal the extent to which the trade balance and whole national economy could be hit by such shocks; or how the imports respond to domestic stop-go policies.
c) An expansion of both exports and imports in a small country leads to price convergence, especially if domestic prices are below the price level in the partner countries. A positive sign on the coefficient of price changes could signal the intensity of the nominal convergence in the sectors.
d) The choice of exchange rate system (floating, soft pegging or adopting euro) depends essentially on the sensitivity of trade to income, real exchange rate, expected FDI inflows and the sustainability of trade balance.
e) Since trade intensities, trade structure and trade prices depend significantly on the constraints given by factor endowments (K/L, FDI, human capital) and the sectoral requirements of them, it is crucial for policy-makers to anticipate the long-term development of factors and estimate their impact on the balance of trade and the expected degree of restructuring of trade.
f) Monetary policy has its impacts on growth, savings, investments and the inflows of capital. Indirectly it may influence on the imports, exports and the balance of trade.

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Table 1: Visible exports of eastern Europe and the CIS, 1993-2002

(Billion dollars)

	1993	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	2002/1993	Annual growth 1993-2002
Eastern Europe	66.87	77.26	100.62	107.08	115.90	127.93	125.52	141.89	157.28	178.81	267.4%	10.9%
Albania	0.12	0.14	0.20	0.21	0.14	0.21	0.35	0.26	0.31	0.33	268.3%	11.0%
Bulgaria	3.77	3.94	5.35	4.89	4.94	4.19	4.01	4.83	5.11	5.69	150.9%	4.6%
Croatia	3.71	4.26	4.63	4.51	4.17	4.54	4.30	4.43	4.67	4.90	132.1%	3.1%
Czechia	14.46	15.88	21.27	22.18	22.78	26.35	26.27	29.05	33.40	38.40	265.5%	10.9%
Estonia	0.80	1.31	1.84	2.08	2.93	3.24	2.94	3.18	3.31	3.42	426.8%	16.1%
Hungary	8.92	10.70	12.87	15.70	19.10	23.01	25.01	28.09	30.50	34.34	384.9%	15.0%
Latvia	1.40	0.99	1.30	1.44	1.67	1.81	1.72	1.87	2.00	2.28	162.7%	5.4%
Lithuania	1.99	2.03	2.71	3.36	3.86	3.71	3.00	3.81	4.58	5.52	276.7%	11.3%
Poland	14.20	17.24	22.89	24.44	25.76	28.23	27.41	31.65	36.09	41.01	288.8%	11.8%
Romania	4.89	6.15	7.91	8.09	8.43	8.30	8.49	10.37	11.39	13.87	283.5%	11.6%
Slovakia	5.46	6.71	8.59	8.82	9.64	10.78	10.28	11.91	12.70	14.53	266.3%	10.9%
Slovenia	6.08	6.83	8.32	8.31	8.37	9.05	8.55	8.73	9.25	10.36	170.3%	5.9%
Russia	67.30	67.80	82.42	90.60	86.90	74.44	75.55	105.03	101.62	106.90	158.8%	5.1%
Ukraine	7.82	10.27	13.13	14.40	14.23	12.64	11.58	14.57	16.27	17.96	229.7%	9.2%

Source: UN and WTO World Trade Statistics, 2003

Table xxx: Review of the FDI inflows to the Czech economy in the studied period

Czech Inward Foreign Direct Investment by Industry and Country, 1993–2002

(In millions of EUR)

	1993	1994	1995	1996	1997	1998 *	1999 *	2000 *	2001*	2002* 1)	SUM	%
Non-manufacturing												
Agriculture, hunting, and forestry	2	1	6	0	6	7	6	9	32	12	**81**	0.2
Mining and quarrying	12	18	18	6	0	15	234	83	41	-261	**165**	0.5
Electricity, gas, and water supply	20	73	31	128	332	211	313	223	301	365	**1998**	5.5
Construction	56	91	53	97	34	43	14	109	87	95	**677**	1.9
Trade, hotels and restaurants	34	30	114	226	110	745	1378	595	786	466	**4483**	12.3
Transport, storage and communic.	3	8	1044	147	1	313	185	276	921	4,832	**7730**	21.2
Financial intermediation	120	117	53	26	264	497	1412	1012	1,767	1,956	**7226**	19.9
Real estate and business activities	0	0	0	0	37	303	395	812	509	580	**2636**	7.2
Education	0	0	0	0	0	0	0	1	1	0	**2**	0.0
Health and social work	0	0	0	0	6	19	3	18	2	15	**63**	0.2
Other social and personal services	0	0	0	0	0	18	110	44	4	26	**202**	0.6
Total non-manufacturing	**247**	**339**	**1319**	**629**	**791**	**2172**	**4049**	**3182**	**4,451**	**8,085**	**25263**	69.4
Manufacturing												
Food and tobacco	196	60	94	58	83	113	337	191	275	289	**1697**	4.7
Textiles, wearing apparel, and leather	1	1	2	18	13	88	43	74	115	63	**419**	1.1
Wood, paper and publishing	0	0	0	65	90	76	195	56	167	163	**812**	2.2
Refined petroleum and chemicals	16	37	70	267	45	53	370	323	122	200	**1502**	4.1
Nonmetallic products	42	51	137	49	15	156	296	125	171	102	**1143**	3.1
Basic metals and metal products	0	0	0	0	70	284	173	271	96	286	**1181**	3.2
Machinery and equipment	57	247	360	54	14	300	424	1140	900	682	**4179**	11.5
Recycling and other manufacturing	0	0	0	0	30	76	46	42	-2	15	**207**	0.6
Total manufacturing	**312**	**395**	**663**	**511**	**362**	**1146**	**1884**	**2222**	**1,845**	**1,801**	**11139**	30.6
All FDI	**559**	**734**	**1982**	**1140**	**1152**	**3317**	**5933**	**5404**	**6296**	**9886**	**36402**	**100.0**

Source: Data provided by the Czech National Bank, October, 2003

* Until 1997 data included FDI in equity capital, starting from 1998 data on reinvested earnings and other capital have been included in FDI flows.

1) preliminary data