VYSOKÁ ŠKOLA EKONOMICKÁ V PRAZE
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The Impact of Exchange Rate Volatility on Czech Real Export: Theory and Empirical Investigation Extended for Bilateral Trade Flows with Euro Zone Countries

Diploma Thesis

Author: Bc. Peter Jurečka, M.A.

Supervisor: Prof. Ing. Antonín Brůžek, DrSc.

VYSOKÁ ŠKOLA EKONOMICKÁ V PRAZE

Fakulta mezinárodních vztahů

Hlavní specializace: Komerční právo

Vliv volatility směnného kurzu na reální export České republiky: teorie a empirická studie rozšířena o obchod se zeměmi eurozóny

Diplomová práce

Vypracoval: Bc. Peter Jurečka, M.A.

Vedoucí diplomové práce: Prof. Ing. Antonín Brůžek, DrSc.

Prohlášení

Prohlašuji, že jsem diplomovou práci na téma „Vliv volatility směnného kurzu na reální export České republiky: teorie a empirická studie rozšířena o obchod se zeměmi eurozóny " vypracoval samostatně. Veškerou použitou literaturu a podkladové materiály uvádím v přiloženém seznamu literatury.

V Praze dne ……….. …………………..

Podpis

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Abstract

This diploma thesis deals with the impact of real exchange rate volatility on real export of the Czech Republic. In the first part, theoretical aspects of this relationship are examined, explaining both - positive and negative – effects on bilateral and aggregate trade flows, as there is still no clear-cut conclusion about this impact. Furthermore, the issues of measuring exchange rate variability are discussed and the overview of different empirical results is provided as well. Further on, empirical data and econometric tools are employed to capture the relationship between real export and its main determinants for the case of Czech Republic in the past decade. After the brief theoretical introduction to time series econometrics, the particular export demand model is proposed and various cointegration techniques are explained and applied to examine the long-run equilibrium but also short-run dynamics. Some adjustments of the standard export demand model are made to capture specific conditions of the transforming economy of Czech Republic, such as monetary crisis in late nineties or change of exchange rate regime. In the last part of the work, estimation of the parameters of bilateral real export demand model for the case of Czech main trading partners from Euro zone such as Germany, France, Italy, Spain and Netherlands is provided to explain the differences using effective exchange rate comparing to bilateral exchange rates.

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Introduction

Since the collapse of Bretton-Woods system in 1973, the effects of exchange rate volatility on exports have been examined in a great deal of literature. The extent to which this volatility affects the volume of trade is an empirical question and there is no clear-cut conclusion on its impact. In this thesis, the attention will be focused on theoretical explanations of both - positive and negative - effects of real exchange rate variability on bilateral and aggregate trade flows. The issues of measuring this variability are discussed and the overview of different empirical results is provided as well.

Further on, empirical data and econometric tools are employed to capture the relationship between real export and its main determinants for the case of Czech Republic in the past decade. After the brief theoretical introduction to time series econometrics, the particular aggregate export demand model is proposed and various cointegration techniques are explained and applied to examine the long-run equilibrium but also short-run dynamics. In the initial part, the aggregate model capturing overall export volumes that works with effective exchange rate will be used. The following part deals with the estimation of the parameters of the adjusted bilateral export demand model for the trade flows from Czech republic to its main trading partners, which are using Euro as their national currency. Finally, model using effective exchange rate will be compared with models using bilateral exchange rate to capture the effects of exchange rate volatility on aggregate and partial level.

1. Theoretical Part

1.2. Theoretical Aspects of the Relationship between Exchange Rate Volatility[1] and Trade

1.2.1. Types of Exchange Rate Variability

Substantial increase of the degree of variability of exchange rate movements since the beginning of the generalized floating in 1973 have led policymakers and economists to investigate the nature and extend of the impacts of such movements on the volumes of trade. Theoretical analysis suggests that uncertainty generated by greater exchange rate variability may induce risk averse agents to reduce trade volumes or increase trade prices[2]. Two types of exchange rate variability can be distinguished: volatility and misalignment.

Volatility refers rather to short-term (day-to-day or month-to-month) fluctuations of nominal or real exchange rates[3]. Since the collapse of Bretton-Woods system, volatility has increased substantially.

Many economists have attempted to analyze whether the increase of exchange rate volatility in post Bretton-Woods era has led to a decline in the growth of trade but no clear evidence of a significant adverse effect of volatility on trade has emerged from empirical analysis and studies dealing with exchange rate volatility yielded mixed results. Two main reasons may contribute to explanation of the failure to establish a significant link: measurement problems and the development of hedging instruments.

Even the studies that detect a significant link show that sensitivity of trade to volatility is relatively low. On the other hand, despite this low sensitivity, the impact might be large due to the high magnitude of volatility which was the case after the collapse of Bretton Woods system. Various studies estimated the direct impact of this break-down to be the reduction of world trade by roughly 3%. By contrast, as the exchange rate volatility within EMS was already very low, its approximate doubling that occurred in 1992 could have only decreased

[1] In this study, the terms exchange rate volatility and exchange rate variability are used as synonyms.
[2] This is the case if the risk is borne by exporters. If the risk is borne by importers, increased risk caused by higher variability of exchange rates, depress import demand and causes market prices to fall.
[3] Real exchange rate is nominal exchange rate corrected for inflation.

intra-EU trade by less than 1% according to some authors[4]. However, the conclusion that international trade flows are only marginally affected by a rise in exchange rate volatility does not imply that such rise has no harmful effects. Among others, it might contribute to a decline in consumer and business confidence and bring about a slowdown of economic growth.

Another type of exchange rate variability mentioned above is so called misalignment. Contrary to volatility which is a short-term phenomena, misalignment refers to persistent departures (under- or overvaluation) of real exchange rates from their equilibrium values, i.e. values consistent with their macroeconomic fundamentals. By contrast to the link between volatility and trade, here is a consensus in the empirical literature on the negative impact of misalignment on trade. Persistent misalignments may have several adverse effects. They may distort trade and thus indirectly lead to increase of protectionist measures. They may also negatively affect investment and lead to a worldwide misallocation of resources, which retards growth. At world level, it is regarded that misalignment effects contributed significantly to the decline on volumes of trade after 1973 although this effect was lower than the trade policy and income effects.

1.2.2. Impact of Exchange Rate Variability on Trade

Basically, there are two underlying theories explaining opposite effects, that bilateral exchange rate volatility, nominal or real, might have on trade. On the one hand, there are studies supporting the hypothesis that exchange rate volatility hampers trade. It might seem self evident, that for risk averse market participants, exchange risk is implicitly a cost, or is avoidable at an explicit cost, and that this risk in a given transaction is proportional to the prospective variability of the bilateral exchange rate applicable for that transaction. Market participants will thus by growing exchange rate volatility favor domestic to foreign trade at the margin. The argument thus views trading parties as facing undiversified exchange risk; if hedging is impossible or costly, traders are risk-averse and risk-adjusted expected profits from trade will fall when exchange risk increases. Akhtar and Hilton (1984), Cushman (1983), Kenen and Rodrik (1986), Koray and Lastrapes (1989), Thursby and Thursby (1987) provide evidence to support this view.

[4] European Commission, Directorate-General for Economic and Financial Affairs: "The Impact of Exchange Rate Movements on Trade within the Single Market", Reports and Studies, No. 4, 1995

The usual analysis goes as follows. We assume two countries, A and B, where a firm located in country A selling its entire product in country B produces only one commodity, has no market power and does not import any intermediate goods. The firm is paid in foreign currency and converts the proceeds of its exports at the current exchange rate, which varies in an unpredictable fashion because there are by assumption no hedging possibilities as future contracts for fixed exchange rates. In addition, because of costs involved in adjusting the scale of production, the firm must make timely decisions in advance of any subsequent exchange rate movements. It therefore cannot alter its output in response to favorable or unfavorable shifts in the profitability of its exports arising from these movements. In such situation, change of profitability of the firm is solely dependent on the exchange rate. Assuming managers of our firm to be risk averse, greater volatility in the exchange rate will lead to an output and thus also export reductions in order to reduce the exposure to risk. Explaining it in another way, if the firm is risk averse, it would be willing to incur additional costs to avoid risk, so than the risk if not hedged is an implicit cost. This cost increase will ceteris paribus lead to an increase of the supply price for each quantity of export. The overall decline of output might therefore be strongly dependent on the price elasticity of imports in country B[5].

Another reason explaining why trade may be adversely affected by exchange rate volatility stems from the assumption that the firm cannot alter factor inputs in order to adjust optimally to movements in exchange rates. However, when this assumption is relaxed and firms can adjust one or more factors of production in response to movements in exchange rates, increased variability can in fact create profit opportunities. The effect of such volatility depends on the interaction of two forces at work. Firstly, if the firm can adjust inputs to both high and low prices, its expected or average profits will be larger with greater exchange rate variability because it will sell more when price is high and vice versa. Secondly, considering the risk aversion, the higher variance of profits has an adverse effect on the firm and constitutes a disincentive to produce and to export. If risk aversion is relatively low, the positive effect of greater price variability on expected profits outweighs the negative impacts of the higher variability of profits, and the firm will raise the average capital stock and the level of output and exports.

There is one more aspect of the relationship between trade and exchange rate volatility which is worth to mention and it is the role of “sunk costs”. Much of the international trade

[5] We further suppose for simplicity, that our firm sells in a forward market in country B so it knows exactly the future price of its product at the time it incurs its cost of production.

consists of differentiated manufactured goods that typically require significant investment by firms to adapt their products to foreign markets, to set up marketing and distribution networks and to set up production facilities specially designed for export markets. This sunk costs will than make firm less responsive to short-run movements in the exchange rate because they will tend to adopt wait-and-see approach, i.e. to stay in the export markets as long as they are able to cover their variable costs and wait for the turnaround in the exchange rate movements to recoup their sunk costs.

In the finance literature on real options, several authors like McDonald and Siegel (1986), Krugman (1989), Dixit (1989) explored the implications of sunk costs in the context of an “options” approach that has been further applied by Franke (1991) and Sercu and Vanhulle (1992). The key idea is that the exporting firm can be regarded as owing an option to leave the export market, and a firm not currently exporting can be viewed as owing an option to enter the market in the future. Exporting is an option which is exercised if profitable. The decision to enter or exit the export market involves considering explicit fixed and variable costs as well as the costs of exercising the option to enter or leave the market summarily named as transaction costs. If the firm starts exporting, it incurs the costs of entering the foreign market. A firm which stops exporting incurs exit costs.

Similar to the value of stock option, the value of this export strategy depends on exchange rate volatility. The greater the volatility, the greater the value of keeping the option, hence the larger the range of exchange rates within which the firm delays action by staying in the export markets or staying out if it has not yet entered. This suggests that increased exchange rate volatility would increase the inertia in entry and exit decisions.

So far I have mentioned only the situations, when the only variable changes with the change of the volatility of the exchange rate, i.e. the partial equilibrium. All other developments that might have possible effects on the level of trade remained unchanged. However, the factors which are generating the exchange rate movements are very likely to have an impact also on the other aspects of the economic environment which will in turn have an effect on trade flows. Therefore, in general equilibrium framework it is important to take into account of the interaction of all major macroeconomic variables to get a more complete picture of the relationship between exchange rate variability and trade.

Analysis of that kind has been provided by Bacchetta and Van Wincoop (2000) where they developed a simple, two country general equilibrium model. Uncertainty in such model arises primarily from monetary, fiscal and technology shocks and they compared the level of trade and welfare for fixed and floating exchange rate arrangements. Two main conclusions were reached. Firstly, there is ambiguous relationship between level of trade and the type of exchange rate arrangement. Trade can be higher or lower under either exchange rate arrangement depending on preferences of consumers regarding the tradeoff between consumption and leisure. A monetary expansion in a country would depreciate its exchange rate causing it to reduce its imports. On the other hand increased demand resulting from monetary expansion could partly or fully offset the exchange rate effect. The second conclusion is that the level of trade does not necessarily have to serve as a good index of welfare in a country and therefore there is not clear cut relationship between levels of trade and welfare in comparing exchange rate systems. The welfare of the country is determined by the volatility of consumption and leisure.

Koren and Szeidl (2003) developed a model that brings out clearly the interactions among the most important macroeconomic variables. They showed, that what matters is not the unconditional variability of the exchange rate as a proxy for risk, as used in most of empirical works in literature, but rather that the exchange rate uncertainty could influence trade levels and prices through covariances of the exchange rate with the other key variables in the model. In their general equilibrium context, they pointed out that it is not uncertainty in the exchange rate per se that matters, but rather whether risk uncertainty multiplies or reduces firm's other risk on the supply and demand side and ultimately whether it exacerbates the risk faced by consumers.

Another analysis of the impact of exchange rate volatility on the welfare costs was provided by Obsfeld and Rogoff (1998) where they extended the "new open-economy macroeconomic model" to an explicitly stochastic environment. The risk has an impact on the price-setting decisions of firms and hence on output and international trade flows. Providing an illustrative example they came up to the result that the reduction of the variance of exchange rate to zero by pegging the exchange rate could result in a welfare gain of up to one percent of GDP.

Finally, Bergin and Tchakarov (2003) provided an extension of the above mentioned model by applying it to more realistic conditions including incomplete asset market and investment by firms. They calculated that the welfare costs of exchange rate uncertainty are generally quite small, on the order of one tenth of the percent of consumption, thus significantly lower than those of Obsfeld and Rogoff (1998).

1.3. Empirical Results on the Relationship between Exchange Rate Volatility and Trade

The early empirical works on the effect of exchange rate volatility on the volumes of trade provided by IMF study in 1984 did not yield consistent results, with much of the work showing little or no support for negative effect. One of he first works by Hooper and Kohlhagen (1978) used the model of Ethier (1973) for traded goods and derived equations for export prices and quantities in terms of the costs of production, reflecting both imported and domestic inputs, other domestic prices, domestic income and capacity utilization. Nominal exchange rate risk was measured by the average absolute difference between the current period spot exchange rate and past forward exchange rate. The authors examined the effects of exchange rate volatility on aggregate an bilateral trade flows and export prices in 1965-75 and their regression analysis covered the bilateral trade of Germany and United States with other industrialized countries (G-7 except Italy). They could not find any significant evidence of impact on the volumes of trade, although import and export prices appeared to be affected. This findings has been widely cited and was not challenged until recently.

Cushman (1983) followed the methodology adopted by Hooper and Kohlhagen (1978) extended the sample size and studied the effects of volatility in real exchange rates. He measured volatility by standard deviations of quarterly changes in real rates. Of 14 sets of bilateral trade flows in 1965-1977, he found that volatility had significant negative effects on six flows (U.S. exports to Canada, France and Japan and U.S. imports from Canada and Japan and German exports to UK).

Finally IMF (1984) used a simplified version of Cushman's model to estimate bilateral exports between the G-7 countries from the first quarter of 1969 to the end of 1982, with real GNP, the real bilateral exchange rate, relative capacity utilization, and the variability measured as the standard deviation of the percentage changes in the exchange rate over the preceding five quarters. The variability had a significantly negative coefficient in only two cases, while positive coefficients were significant in several cases. There are several factors that might explain the lack of robustness in this early work. Firstly, as mentioned above, theoretical considerations do not provide clear support for the conventional assumption that the exchange rate volatility has a negative impact on the volume of trade. Secondly, the sample period was relatively short and finally the specification of estimating equations was typically rather crude, consisting of a few macro variables from standard trade equations used at that time.

Akhtar and Hilton (1983) estimated volume and price equations for German and U.S. multilateral trade in the floating period. The exchange rate risk was represented by measures of nominal and real exchange rate variability (the standard deviations of daily effective exchange rates within each quarter). They found that nominal exchange rate variability had statistically significant effects on both countries' manufactured exports and on German manufactured imports. Their results for real variability were mixed but broadly consistent with those for nominal variability.

McKenzie (1999) stressed the point that at theoretical level, models leading to both positive and negative effects of variability on trade have been constructed, and a priory there is no clear case that one model should be regarded superior to another one. However, he finds that the most recent contributions to the literature have been more successful in obtaining a statistically significant relationship between volatility and trade, which he attributes more careful attention to the specification of estimation technique and the measure of volatility used. There also might be a threat of the "publishing bias" where publishers prefer papers providing significant results, no matter whether there is positive or negative correlation.

Recent work on this topic employing the gravity model has found some significant evidence of a negative relationship between exchange rate variability and trade[6]. The gravity model in its basic form shows bilateral trade flows between countries as depending positively on the product of their GDPs and negatively on the geographical distance from each other.[7] Countries with larger economies tend to trade more in absolute terms while distance can be viewed as a proxy for transportation costs which acts as an impediment to trade. In addition, population is often included as an explanatory variable as an additional measure of country size. In many applications, several dummy variables are added to control for shared characteristics that would increase the likelihood of trade between countries, such as common borders, common language or membership in a free trade association. To these equations, measures of exchange rate variability are added to see if this proxy for exchange rate risk has a separate, identifiable effect on trade flows after all other major factors have been taken into account.

[6] See Frankel and Wei (1993), Wei (1999), Dell' Ariccia (1999), Rose (2000) and Tenreyro (2003)
[7] See McCallum (1995), Coe at al. (2002) or Deardorff (1998)

Dell' Ariccia (1990) provides a systematic analysis of exchange rate volatility on the bilateral trade of the EU 15 plus Switzerland over the 20-year period from 1975-1994 using four different measures of exchange rate uncertainty: the standard deviation of the first difference of the logarithm of the monthly bilateral nominal exchange rate, that of real exchange rate, the sum of squares of forward errors and the percentage difference between the maximum and minimum of the nominal spot rate. In his basic regressions, exchange rate volatility has a small but significantly negative impact on trade: eliminating volatility to zero in 1994 would have increased trade by amount ranging from 10-13 percent, depending on the particular measure of volatility. The results for both nominal and real variability are very close, which is not surprising given that in the sample the two exchange rate measures are highly correlated.[8]

One of the most thorough surveys was made by Rose (2000) where he employed the gravity approach to examined a set of 186 countries for 5 years (1970, 1975,...1990). His main aim was to measure the impact of currency unions on members' trade, but he also uses his model to test for the effects of exchange rate volatility on trade. The measure of volatility he primarily used is the standard deviation of the first difference of the monthly logarithm of the bilateral nominal exchange rate, which was computed over five years preceding the year of estimation. In his benchmark results using the pooled data, he found a small but statistically significant negative effect: the reduction of volatility by one standard deviation (7 percent) around the mean (5 percent) would increase bilateral trade by about 13 percent, which is similar to the conclusion of Dell' Arricia mentioned above. However, when random effects are incorporated into the estimation, the magnitude of the effect of volatility on trade is reduced to about third of the benchmark estimate, or approximately 4 percent.

Finally, a recent paper by Tenreyo (2003) casts some doubts on the robustness of Rose's results. She used similar gravity equation as Rose did, broad sample of countries and annual data set from 1970-97 but slightly different measure of volatility[9]. Tenreyo found that the effect of reduction of volatility from its sample mean of about 5 percent to zero results in an increase of trade of only 2 percent which just highlighted the problems of estimation that will be more thoroughly described in following chapter.

[8] Dell' Arricia goes further on and takes into account of the simultaneity bias that can result from central banks; attempt to stabilize their exchange rates with their main trading partner. If they were successful, there would be a negative association between exchange rate variability and the level of trade, but it would not reflect causation from the former to the latter.

[9] The standard deviation of the log change in monthly exchange rates is measured only over the current year.

1.4. Measuring Exchange Rate Volatility

A great deal of literature has been dedicated to our issue so far and there is still no consensus on the appropriate method for measuring the exchange rate volatility. The lack of agreements is the result of the number of factors. As mentioned in previous chapters, there is no generally accepted model of firm behavior that is subject to risk arising from fluctuations in exchange rates and other variables. As a result, theory cannot provide definitive guidance as to which measure is more proper. Furthermore, the scope of the analysis will dictate to some extend the type of measure used. If advanced countries are being surveyed, we should take into account the effect of forward markets for the assessment of exchange rate volatility on trade, whereas this would not be possible if we extend our analysis also to larger number of developing countries. Another feature of exchange rate volatility that needs to be taken into account is the time horizon, over which the variability is measured as well as whether it is unconditional volatility or rather the unexpected movement in the exchange rate relative to its predicted value that is the relevant measure. Finally, the level of aggregation of trade flows being concerned will also play role in determining the most suitable measure of the exchange rate to be used.

Methodologically, the basic building block in the analysis is the volatility in the exchange rate between the currencies of each pair of countries in the sample because it allows for the best control for a variety of factors other than volatility that could affect the trade. As a result, the change of detecting an impact of the exchange rate volatility on trade improves.

1.4.1. Effective exchange rate volatility

For the descriptive part of my study, which looks at the exchange rate volatility facing Czech Republic as a whole, it is necessary to aggregate the bilateral volatilities using trade shares as weighted to obtain what is referred to as the “effective volatility” of country’s exchange rates. This ensures that the measures of volatility in the descriptive and econometric parts of the study are fully consistent.

Such a measure of effective volatility presupposes that the exchange rate uncertainty facing an individual firm is the average of the variability of individual bilateral exchange rates (Lanyi and Suss, 1982). However, if a trading firm engages in international transactions with a wide range of countries, any tendency for exchange rates to move in opposite directions would offset the overall exposure of the firm to exchange rate risk. This would argue for using the volatility of a country's effective exchange rate as the measure of exchange rate uncertainty facing the country. This method seems particularly suitable for developed economies, where much trade is undertaken by multinational corporations.

It is also important to realize, that the degree of exchange rate variability to which a country is exposed is not necessarily closely related to the type of exchange rate regime it has adopted. A country may peg its currency to an anchor currency but will float against the other currencies if the anchor does as well. Therefore, as with effective exchange rates, the effective volatility is a multidimensional concept (Polak, 1988). Pegging can reduce nominal exchange rate volatility vis-à-vis one trading partner, but it can by no means eliminate overall exchange rate variability.

1.4.2. Nominal vs. Real Exchange Rate Volatility

The choice between nominal and real exchange rates depends in part on the time dimension that is relevant for the economic decision being taken. In the short-run, where costs of production are known and import and export price have already been set, the exchange rate exposure of a firm is a function of the nominal exchange rate. However, the decision to engage in international transactions stretches over a longer time period, during which import and export prices in foreign currency as well as costs of production will vary. From this point of view, exchange rates measured in real terms are more appropriate. Nevertheless, as real and nominal exchange rates tends to move closely together, given the stickiness of domestic prices, the choice of which one to use is theoretically not likely to affect significantly the econometric results.

There has been conflicting argument as to whether exchange rate uncertainty is better measured by nominal or real exchange rate volatility. Studies by Hooper and Kohlgarten (1978), Akhtar and Hilton (1984), among others, have found significant trade flows effects of nominal exchange rate volatility, while Cushman (1983), Kenen and Rodrik (1986) and Thursby and Thursby (1985) have found significant trade flows effects of real exchange rate volatility. Consequently, the models have been constructed using the nominal and real exchange rate volatility but the results were quantitatively similar[10]. Anyway, real rates are considered preferable to nominal ones on theoretical grounds and will be used as a benchmark in the empirical part later. Consumer prices are used to construct the real rates because they are the most widely available measures of domestic prices[11].

While exchange rates are often highly volatile, the extent to which they are a source of uncertainty and risk depends on the degree to which exchange rate movements are foreseen. When hedging instruments are available, the predicted part of exchange rate volatility can be hedged away and hence may not have much effect on trade. This suggests that the appropriate measure of risk should be related do deviations between actual and predicted exchange rates. One of the possibilities along these lines would be to use the forward rate as the prediction of the future spot rate and to use the difference between the current and previous period forward rate as an indicator of exchange rate risk. The major problem of this approach is that the forward rate is not always a good predictor of future exchange rates. In addition, the quotations are available only for the main currencies.

More generally, there is a wide range of methods – ranging from structural models to time series equations using autoregressive conditional heteroscedasticity (ARCH)/ generalized ARCH (GARCH) approaches[12], for example – that could be used to generate predicted values of exchange rates (McKenzie, 1999)[13]. However as pointed out by Meese and Rogoff (1983), there are inherent difficulties in prediction of exchange rates. Therefore my study adopts the approach followed in much of the work on the topic and uses a measure of the observed volatility of exchange rates as the benchmark. A time varying measure of exchange rate volatility is included in my model in order to account for the periods of high and low exchange rate uncertainty[14]. The variable is constructed by the moving sample standard deviation of the first difference of logarithms of the exchange rates. This measure is

[10] Chowdhury , A.R.: "Does the Exchange Rate Volatility Depress Trade Flows? Evidence from Error-Correction Models"; The Review of Economics and Statistics, vol. 75, No. 4 (Nov. 1993), 700 - 706

[11] Results from regressions using nominal exchange rates could be obtained from author upon request.

[12] ARCH and GARCH models are especially useful in analyzing financial time series such as stock prices, inflation rates and exchange rates. A distinguishing feature of these models is that the error variance may be correlated over time because of the phenomenon of volatility clustering.

[13] For more information of ARCH/ GARCH models see: R.Engle, "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation", *Econometrica*, vol. 50. no. 1, 1982, pp. 987-1007 or also A. Bera and M. Higgins, "ARCH models: Properties, Estimation and Testing", *Journal of Economic Surveys*, vol. 7, 1993, pp. 305-366.

[14] Since there is no unique way to measure the exchange rate uncertainty, empirical research on its effects has generally used some measure of exchange rate variability as a proxy for uncertainty. See Akhtar and Hilton (1984) for a discussion on this issue.

similar to those used in much of the literature (for example, Kenen and Rodrik (1986), Koray and Lastrapes (1989), Lastrapes and Koray (1990), Chowdhury (1993)). This measure has the property of being equal to zero if the exchange rate follows a constant trend, which presumably could be anticipated and therefore would not be a source of uncertainty. Moreover, Koray and Lastrapes (1989) have shown, that this measure captures the temporal variation in the absolute magnitude of changes in real exchange rates, and therefore exchange risk over time.

Finally, it is also useful to mention the role of the currency invoicing. Very often, trade between a pair of countries, especially between two developing countries, is not invoiced in the currency of either country. Instead, a major currency – especially the U.S. dollar – is often used as an invoicing currency. It might appear that the volatility of exchange rate between the currencies of the two trading partners is not relevant to consider at all. For example if Chinese exports to India are invoiced in U.S. dollars, it might seem that the Chinese exporters would care only about the fluctuations between U.S. dollar and the Chinese Yuan, but not between the Indian rupee and the Chinese Yuan. However, this view is not correct. Any fluctuations between the Chinese Yuan and the Indian rupee, holding constant the Chinese Yuan/U.S.Dollar rate, must reflect fluctuations in the Indian rupee/U.S. dollar rate. As the latter could have an impact on the Indian demand for Chinese exports, fluctuations in the Chinese Yuan/Indian rupee exchange rate would also affect Chinese exports to India even if the trade is invoiced in U.S. dollars. In general, the choice of invoicing currency does not alter the effect of exchange rate volatility on trade.

2. Empirical Part

2.1. Introduction

As mentioned in theoretical part above, the impact of exchange rate volatility on trade and export itself has been reported in a great deal of literature but no clear-cut results have been achieved so far. Many previously examined export demand models were often very restrictive, forcing the effects of the regressors to be felt fully contemporaneously, or, as in the case of, for example, stock adjustment models, they implicitly force the coefficient of regressors to have the same lag pattern. One way or another, the regressions are very likely to be misspecified and the resulting parameter estimates therefore biased. This problem is obvious especially in the case of exchange rate variability and relative price estimates, because the effects of these variables are believed to be built slowly and trade flows with statistically significant lags[15]. Forcing these effects to be felt instantly, or with the same velocity as changes in activity may have contributed to the mixed or statistically insignificant estimates that have been obtained[16].

As a benchmark for the investigation of the impact of exchange rate volatility on Czech exports, the export demand model proposed by Arize (1995) was chosen.

There are at least three aspects that distinguish his analysis from most previous studies. First, his dynamic modeling of export demand does not follow the restrictive simple stock adjustment mechanism that has been commonly used in several studies. Instead of that, less binding process based on modified error-correction model is used[17]. Second, the level of specification used in previous studies has not recognized that real exports and some of its proposed determinants such as world real income are, a priory, potentially non stationary integrated variables. Previously mentioned mixed results of the impacts of exchange rate variability on trade could be partly explained by neglecting the consideration of nonstationarity[18]. That is why the properties of individual time-series in this study are

[15] Arize, G.: "The Effects of Exchange-rate Volatility on U.S. Exports: An Empirical Investigation", Southern Economic Journal 62, 34-43, 1995
[16] These mixed results have been discussed in detail in Pozo (1992) or Bailey, Tavlas and Ulan (1986)
[17] For more information see: Johansen, S.: "Statistical Analysis of Cointegrating Vectors"; *Journal of Economic Dynamics and Control*, June-September 1988, 708-712 and Engle, R., and Granger, C.W.J.: "Cointegration and Error Correction: Representation, Estimation and Testing"; *Econometrica* 55, 1987, 251-276
[18] My results shown below suggest that exchange rate volatility is nonstationary as well.

established prior to testing for cointegration. Series that are integrated of different order cannot be cointegrated[19].

Further on, the OLS[20] framework is applied to estimate cointegrating vectors among the integrated time series. In the final step, the estimated error-correction term is incorporated into the error-correction model. Last but not least distinguishing feature of Arize's model concerns the measurement of the exchange rate volatility. In this section, two similar versions of exchange rate volatility were chosen as a proxy for exchange rate uncertainty. The effect of exchange rate volatility on Czech export is estimated using a five- and eight-quarter moving average of the variance of the first difference of exchange rate[21].

The rest of this empirical part is organized as follows. Section 2 includes the brief introduction to the theory of time series econometrics and basic issues of stationarity and possible problems emanating from non-stationarity of time series are discussed as well. Furthermore the process of transformation of non-stationary time series including cointegration and error correction mechanism is explained. Section 3 specifies the particular aggregate export demand model[22]. Possible adjustments of Arize's model emanating mainly from different conditions of Czech economy comparing to U.S. are outlined here as well. The following section describes two cointegration techniques used. Next section of this Part is dedicated to the examination of bilateral trade flows from Czech Republic to main trading partners using Euro as national currency involving Germany, France, Italy, Spain and Netherlands. Part 3 summarizes the results from particular regressions and the main conclusions are revised in Part 4. Quarterly data used in this study were published by International Monetary Fund[23] and cover observations from 1995:1 to 2005:1. Quarterly data generating "EURO" time series for bilateral trade models are from the same source and cover period from 1999:4 to 2006:4.

[19] I will briefly explain the theory of cointegration in separate chapter.
[20] Ordinary Least Squares
[21] The use of this unconditional measure was criticized by Jansen (1989) on the grounds that it lacks a parametric model for the time varying variance of exchange rate. Therefore employing another model as a proxy for exchange rate uncertainty proposed by Engle (1983), which is now well known as ARCH – autoregressive conditional heteroscedasticity model might be appropriate but it is out of scope of this study. It specifies the variance of a variable as a function of the expected squares of the lagged value of the error term from an auxiliary regression determining the mean of the variable of interest.
[22] Proposed in Arize (1995)
[23] International Financial Statistics (CD-ROM), International Monetary Fund, May 2005

2.2. Time Series Econometrics[24]

The main aim of this chapter is to provide the reader with the basic theoretical concepts of forecasting in time series, to outline possible problems and explain suggested solutions.

The first issue to deal with is the problem of non-stationarity, as the work based on time series data assumes that the underlying time series are stationary. So what exactly do we mean under the term stationary stochastic process[25]? Broadly speaking, we consider the stochastic process to be stationary[26] if its mean and variance are constant over time and the value of the covariance between the two time periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed[27]. The assumption of stationarity is important as it simplifies the statements of the large numbers and central limit theorem. In case of nonstationarity, each set of time series data will be for a particular episode and we cannot release generalized statements about the time series as a whole.

There are several tests that reveal non-stationarity in time series. The *graphical analysis*, the *Dickey-Fuller test* and *Augmented Dickey-Fuller test* of stationarity which has become widely popular over past several years are used in this study.

To avoid spurious regression[28] problem that might arise from regressing nonstationary time series on another or more nonstationary time series, we have to transform these nonstationary time-series to make them stationary. It is a priory expected that time series of all relevant variables in export demand model[29] are nonstationary, but individually integrated of order one[30]. That means, they have stochastic trends but their linear combination could be integrated in order zero. In other words, it implies that the linear combination cancels out the

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[24] The theory summary is based mainly on Gujarati, D.N.: “Basic Econometrics”; *McGraw-Hill*, New York, U.S.A, 2003 and Wooldridge, J.M.: “Econometric Analysis of Cross section and Panel Data”; *The MIT Press*, Cambridge, Massachusetts, U.S.A. and London, England, 2001

[25] A stochastic or random process is a collection of random variables ordered in time.

[26] In time series literature, stationary stochastic process is also known as a weakly stationary, covariance stationary or second order stationary or wide sense, stochastic process.

[27] More formally: The stochastic process $\{x_t: t = 1,2, \dots\}$ is *stationary* if for every collection of time indices $1 \leq t_1 < t_2 < \dots < t_m$, the joint distribution of $(x_{t1}, x_{t2}, \dots, x_{tm})$ is the same as the joint distribution of $(x_{t1+h}, x_{t2+h}, \dots, x_{tm+h})$ for all integers $h \geq 1$.

[28] The phenomenon of spurious, or nonsense, regression describes the fact, that sometimes in regressing a time series variable on another, we might obtain very high R^2 even though there is no meaningful relationship between the two variables.

[29] Real Exports, Foreign GDP, Real Effective Exchange Rate, Measure of Exchange Rate Uncertainty

[30] I.e. the expected first difference of the time series over time should be zero.

stochastic trend in time series and the regression is meaningful, not spurious and the variables could be cointegrated. The condition that time series in cointegration analysis are both cointegrated[31] in order one is necessary because their expected difference over time should be zero (the difference is stationary I(0)). This is because of their long-run relationship which prevents them from drifting apart. The *Engle-Granger unit root test* and *ARDL[32] method* are used to test for cointegration. In case it is successfully proved that there is a long-term, or equilibrium, relationship between the variables, the *Error Correction Mechanism[33]* will be proposed to survey the short-run dynamics of the model.

Another topic that is dealt with in the empirical part of the thesis is whether there is a structural change[34] in the relationship between the volume of real export and its explanatory variables. There is an a priory expectation that there might be a structural change in the model in the second half of the year 1997 or in the first half of 1998 resulting from the monetary crisis in Czech republic and changes of the exchange rate regimes that went hand in hand with it. Up to the 26th of May 1997, Czech currency operated within the regime of fixed exchange rates with allowed 5% upper and lower band. As a result of constant weakening of Czech Koruna in the second quarter of 1997 and of its fall under the critical 5% lower band below the central parity, the Czech National Bank had to intervene by rising lombard and REPO rate up to the unprecedented levels[35]. On the 26th of May 1997, Czech Prime Minister Václav Klaus and Governor of Central Bank Josef Tošovský announced the change of exchange rate regime to managed floating. After relative stabilization of fall of the Czech Koruna, the Czech National Bank came to what we call Inflation targeting[36]. *CUSUM* and *CUSUMSQ* tests[37] are employed to identify the potential structural break point. If suspected so, *Chow test* and its Dummy *Variable alternative* will be used to test for structural change in this time period.

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[31] Two variables are cointegrated if there is a long-term or equilibrium relationship between them.
[32] AutoRegressive Distributed Lag
[33] The Granger representation theorem states, that if two variables are cointegrated, then there is the relationship between them that can be expressed as Error Correction Mechanism.
[34] By the term structural change we understand, that the values of the parameters of the model do not remain the same throughout the entire time period.
[35] Lombard rate was risen from 14,5 to 50% and REPO rate to 45% on the 19th of May 1997 and the inter-bank interest rates reached 500% on the 22nd of May 1997.
[36] Inflation targeting may be defined as a framework for policy decisions in which the Central Bank makes an explicit commitment to conduct policy to meet a publicly announced numerical inflation target within a particular period of time.
[37] Methods are similar to Chow test regarding every observation as the potential break point. CUSUMSQ test which revealed the breakpoints is supposed to be slightly more powerful than CUSUM test.

2.3. The Export Demand Model

In the model proposed by Arize (1995), the long-run equilibrium export demand function takes the customary form[38]:

$$XR_t' = \lambda_0 + \lambda_1 * GDPN_t + \lambda_2 * NEER_t + \lambda_3 * VAR_t + e_t \qquad (1)$$

Theory suggests, that as foreign income rises, the demand for domestic exports will rise and λ_1 is thus expected to be positive. On the other hand, the value of λ_2 is a priory assumed to be negative, as the rise in relative prices makes domestic goods relatively more expensive than foreign. However there are no clear-cut a priory expectations about the sign of λ_3, as theories mentioned in the first part of this study can explain both positive and negative impact of the increase of exchange rate uncertainty on trade. The exchange rate uncertainty is in most empirical works regarded as risk: Higher exchange rate uncertainty may thus induce risk averse traders to reduce trade volumes or increase trade prices. There are, however, counter-arguments pointed out by Bailey, Tavlas and Ulan (1987). Their basic assumption is that traders may anticipate future exchange rate movements better than average exchange market participant. Opportunities to profit on specialized trade knowledge of fundamentals affecting foreign exchange rates would than tend to offset the trade-volume effect of the costs of higher exchange rate volatility. Moreover, assuming that the volatility is due to fundamentals, any efforts of the authorities to reduce it by means of exchange controls or other restrictions on trade would be more harmful to trade and could reduce it even more. Hence the effect of exchange rate uncertainty on export is difficult to be determined ex ante. It is rather an empirical matter for each individual country.

Arize tested his model for U.S. where markets are considered to be more flexible than in Czech Republic. That means that Czech exporters are expected to respond relatively slower on rising demand originating from the growth of foreign GDP in comparison with their „western" counterparts. This argument was especially relevant in the transition period in

[38] XR_t' is desired real export of goods and services; $GDPR_t$ is real world income represented by trade weighted real GNP of ten major U.S. trading partners; $NEER_t$ is the nominal trade weighted average value of U.S. dollar against currencies of ten major industrial countries multiplied by U.S. GDP deflator deflated by the trade weighted foreign prices of ten major industrial countries; VAR_t is the measure of exchange rate uncertainty and e_t is the disturbance term

1990's due to lack of experience with foreign trade on developed markets. That means that rising demand for Czech goods resulting from growth of GDP might be possibly reflected in the increasing export with one or even longer period lag. I will try to find the answer to this question by comparing the econometric results from the model using also lagged variable of real foreign GDP:

$$XR_t' = \beta_0 + \beta_1 * \ln GDPR_t + \beta 2 * \ln GDPR_{t-1} + \beta_3 * \ln REER_t + \beta_4 * VAR_t + e_t \qquad (2)$$

where XR_t' denotes logarithm of desired real exports; $\ln GDPR_t$ is the logarithm of real foreign income of major trading partners of the Czech Republic[39] (see Appendix I); $GDPR_{t-1}$ is the lagged value of $GDPR_t$; REER is the shortcut for Real Effective Exchange Rate and $\ln REER_t$ denotes the logarithm of the exchange rate adjusted index of the price of Czech exports relative to trade-weighted foreign prices; VAR_t is the measure of the exchange rate variability and is constructed as the moving sample standard deviation of the growth rate of the real effective exchange rate:

$$VAR_t = \left[(1/m) \sum_{i=1}^{m} \left(\log EER_{t-i+1} + \log EER_{t-i} \right)^2 \right]^{1/2} \qquad (3)$$

where m = 5 is the order of moving average[40]. This measure is similar to those used in much of the literature. Koray and Lastrapes (1989) have shown that it captures the temporal variation in the absolute magnitude of changes in real exchange rates, and therefore exchange risk over time.

Another rationale for incorporating one-period lagged variable to the model is that it usually takes some time from when the contract is signed to when the goods are exported. Therefore the rise of foreign income in one period might have significant effect on export in the following time period.

Further adjustment of the basic export demand model (1) to the conditions of Czech economy could be made to encompass different macroeconomic environment. U.S. economy

[39] I computed the weighted average of real GDP of 20 countries that have the biggest share on the exports of Czech Republic. Countries' weights were chosen according to the methodology of Czech National Bank by computing effective exchange rates. See Table in Appendix I. China was excluded from this list due to lack of data.

[40] I test the model for m = 5 and m=8.

was relatively stable comparing to turmoil in the Czech Republic that was a consequence of monetary crisis and change of exchange rate regimes in 1997/98 (described in Section 2.2.). Incorporating the dummy variable for this time period might be therefore useful. I will then also test the following model:

$$XR_t' = \beta_0 + \beta_1 * lnGDPR_t + \beta 2 * lnGDPR_{t-1} + \beta_3 * lnREER_t + \beta_4 * VAR_t + \beta_5 * DV + e_t \qquad (4)$$

and discuss whether this hypothesis is correct. The exact quarter for which the dummy variable is specified is chosen on the basis of graphical analysis of plotted residuals from regression (2). The Czech national bank announced the change of exchange rate regime to inflation targeting in December 1997 and then by practicing too restrictive monetary policy artificially held REPO rate too high till summer 1998. Considering these facts but also the nature of the methodology of computation of the exchange rate variability[41] and the delays in the reaction of exporters[42], it is assumed that the possible outlier for which the dummy variable is computed is either 1st or 2nd quarter of the year 1998.

To make equation (2) estimable, we need to replace the desired export demand XR_t' with actual (observable) levels (XR_t). There are several methods dealing with adjustments of export demand to changes in regressors. Some works have employed the simple stock adjustment mechanism, where the entire adjustment is represented by adding a lagged dependent variable as a regressor:

$$XR_t = \beta_0 + \theta * XR_{t-1} + \beta_1 * GDPR_t + \beta_3 * NEER_t + \beta_4 * VAR_t + e_t \qquad (5)$$

However, several researchers have criticized this stock adjustment structure because of its restrictive assumptions[43]. Moreover, such an equation (5) might subject to estimation problems due to correlation between the errors and lagged dependent variable (even when

[41] Formula (3) works with EER data from preceding 5 – 8 time periods.
[42] It is assumed that big export contracts are usually signed few weeks or months before the transaction itself will be realized and traders cannot simply change or cancel them instantly according to rapidly changing conditions on the domestic markets.
[43] Hendry and Ericsson (1991)

adjusted for serial correlation), and due to "spurious regression phenomenon"[44]. I will use stock adjustment mechanism just for comparison of the results with cointegrating equations.

2.4. Cointegration

The concept of cointegration is associated with the long-run equilibrium relationship between two or more variables. The economic interpretation of cointegration is that if two or more variables are linked to form an equilibrium relationship spanning the long-run, even though the series themselves in the short-run may deviate from the equilibrium, they will move closer together in the long-run equilibrium[45]. A non-stationary variable might have a long-run relationship with other non-stationary variables and this does not create a spurious regression if the deviation of this long-run relationship is stationary. It implies that these variables are cointegrated.

The following two non-graphical methods are employed to decide whether the time series in the proposed export demand model are cointegrated:

2.4.1. Engle-Granger Test

As mentioned above, to avoid producing a spurious regression resulting from regressing a nonstationary time series on another nonstationary time series, we need to check if all time series are individually integrated in order 1, i.e. if they are I(1)[46]. If so, Engle-Granger test could be applied to see whether regressions (1) or (2) are meaningful and whether there is a long-run equilibrium relationship between the variables. According to this approach, in general, a dependent variable Y_t and exogenous variables $X_{i,t}$ form a long-term relationship (6) if all variables are integrated of the same order and the residuals e_t are stationary.

$$Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i X_{i,t} + e_t \qquad (6)$$

[44] Inferences based on OLS parameter estimates in such regressions are invalid because of the usual t- and F-ratio test statistics do not converge to their limiting distribution as the sample size increases. Their use in that case generates spurious inferences if the levels of nonstationary variables included in equation (1) are cointegrated. (Engle and Granger, 1987)

[45] Harris and Sollis (2003), p.34

[46] It is one of the restrictive assumptions of using this test.

Stationarity of the regression residuals e_t is tested by applying the augmented Dickey-Fuller (ADF) unit root test[47]:

$$\Delta \hat{e}_t = a_1 \hat{e}_{t-1} + \sum_{i=1}^{n} a_{i+1} \Delta \hat{e}_{t-i} + \varepsilon_t . \quad (7)$$

Of course, in the short-run there may be disequilibrium. Therefore we can treat error term:

$$e_t = XR_t - \beta_0 - \beta_1 * \ln GDPR_t - \beta_2 * \ln GDPR_{t-1} - \beta_3 * \ln REER_t - \beta_4 * VAR_t \quad (8)$$

as the "equilibrium error" and we can use to tie the short-run behavior of real export to its long-run value.

Further on, the Error Correction Mechanism (ECM)[48] is used to correct for disequilibrium. The important "Granger representation theorem" states, that if two variables integrated of the same order are cointegrated, than the relationship between them can be expressed as ECM. I will consider the following ECM[49]:

$$\Delta XR_t = \beta_0 + \beta_1 * \Delta \ln GDPR_t + [\beta_2 * \Delta \ln GDPR_{t-1}] + \beta_3 * \Delta \ln REER_t + \beta_4 * \Delta VAR_t + \alpha * e_{t-1} + u_t \quad (9)$$

, where Δ denotes the first difference operator, u_t is the random error term and e_{t-1}, the error correction term, is one period lagged value from the cointegration regression (2), i.e.:

$$e_{t-1} = XR_{t-1} - \beta_0 - \beta_1 * \ln GDPR_{t-1} - [\beta_2 * \ln GDPR_{t-2}] - \beta_3 * \ln REER_{t-1} - \beta_4 * VAR_{t-1} \quad (10)$$

ECM equation (9) states that ΔXR_t depends also on the equilibrium error term. If it is nonzero, then the model is out of its equilibrium. Suppose all other regressors to be zero, just e_{t-1} be negative. This would mean that XR_{t-1} is too low to be in equilibrium that is it is below its equilibrium value. Since α is expected to be negative, the term $\alpha * e_{t-1}$ is positive and, therefore, ΔXR_t will be positive to restore the equilibrium. That is, if XR_t is below its

[47] Since the actual distribution of regression residuals $\hat{e}_t$ is not known, special critical values of the ADF statistics should be used to assess stationarity. Critical values are obtained using the following formula: $C_k(p,T) = \beta_\infty + \beta_1 T^{-1} + \beta_2 T^{-2}$ where p and T are the significance level and the sample size respectively, and the betas are parameters of response surface estimates provided in MacKinnon(1991).

[48] ECM was first used by Sargan (1984) and later popularized by Engle and Granger.

[49] I will test both regressions (1) and (2) and discuss whether the inclusion of lagged foreign GDPR is reasonable in the long-run equilibrium model.

equilibrium value, it will start rising in the next period to correct the equilibrium error and vice versa. Thus, the absolute value of α decides how quickly the equilibrium is restored.

2.4.2. Autoregression Distributed Lags (ARDL) Method

There are several advantages favoring this approach. Firstly, it can be applied irrespective of whether the variables are I(0) or I(1)[50]. This enables us to test the cointegration also for the regression (4) that includes dummy variable, which was impossible with Engle-Granger test[51]. Secondly, the model takes sufficient numbers of lags to capture the data generating process in a general-to-specific modeling framework[52] and thirdly, the dynamic error correction model can be derived from ARDL through a simple linear transformation[53]. The ECM integrates the short-run dynamics with the long-run equilibrium without losing long-run information. The error correction form of the ARDL model[54] is in general given by equation:

$$\Delta Y_t = \beta_0 + \rho(Y_{t-1} + \beta_1 X_{t-1}) + \sum_{j=1}^{l_1} \eta_j \Delta Y_{t-j} + \sum_{j=0}^{l_2} \gamma_{i,j} \Delta X_{i,t-j} + e_t \tag{11}$$

Here, the dependent variable in the first difference is regressed on the lagged values of the dependent and independent variables in levels and first differences.

There are also two other different approaches to measuring volatility in financial time series and to cointegration. The first one is so-called Autoregressive Conditional Heteroscedasticity (ARCH) model[55] originally developed by Engle and its main purpose is to

[50] Pesaran and Pesaran (1997)
[51] Engle – Granger test assumes all cointegrating variables to be integrated of the same order. Dummy variable is not I(1).
[52] Laurenceson and Chai (2003), p.28
[53] Banerjee *et al.* (1993), p.51
[54] Pesaran *et al.* (2001) employ a bound testing approach. Using conventional F-tests, the null of $H_0 : \rho = \beta_1 = ... = \beta_n = 0$ is tested against the alternative hypothesis of $H_1 : \rho \neq 0, \beta_1 \neq 0, ..., \beta_n \neq 0$. They tabulated two sets of critical values, one for the case when all variables are I(1), i.e. the upper-bound critical values and another one when all variables are I(0), i.e. the lower-bound critical values. If the test statistic is higher than the upper bound critical value the null of no cointegration is rejected in favor of the presence of cointegration. On the other hand, an F-statistic lower than the lower bound critical value implies the absence of cointegration. In the event that the calculated F-statistic lies between the two critical values there is no clear indication of the absence or existence of a cointegrating relationship
[55] Or its General Autoregressive Conditional Heteroscedasticity (GARCH) alternative.

deal with phenomenon of volatility clustering[56]. The second approach to cointegration uses Vector Autoregressive Model (VAR). The term autoregressive is due to appearance of lagged value of the dependent variable on the right-hand side and the term vector is due to the fact that we are dealing with a vector of two or more variables.

2.5. Effect of exchange rate volatility on bilateral trade flows

So far, effective exchange rate was used in the formula (3) to compute exchange rate volatility and regression (1), eventually its modifications (2) or (4) enabled us to model aggregate Czech real export demand function in time. In this part, the attention will be focused on individual countries and it will be examined, how volatility of bilateral exchange rates affects the volumes of real export. It could be assumed[57], that the significant part of foreign trade is exercised by firms oriented mostly on one specific country or a group of geographically and economically similar countries. For example, there could be manufacturers supplying with their goods just one big automotive company placed in neighborhood country. The study of bilateral export demand models and their comparison with aggregate models might be therefore interesting. Bilateral exchange rate volatilities and their impact on volumes of export of five major Czech foreign trade partners using Euro as their national currency are examined in this study. Additionally, Slovak republic is involved to the comparison as it might seem interesting to compare the results also with the representative of different kind of economy and the hypothesis based on these differences in relation to export demand and exchange rate volatility could be made. I a priory assume higher significance of the variable exchange rate volatility in the bilateral export demand model, as the volatility measured using effective exchange rate could hardly capture individual differences of each country. The empirical results are provided in the end of Chapter 3.

[56] Financial time series such as exchange rates, stock prices, inflation rates often exhibits the periods in which their prices show wide swings for an extended time period followed by the periods in which there is relative calm, i.e. volatility clustering.
[57] And this assumption seems to be especially valid in the earlier phases of economic transition of Czech Republic.

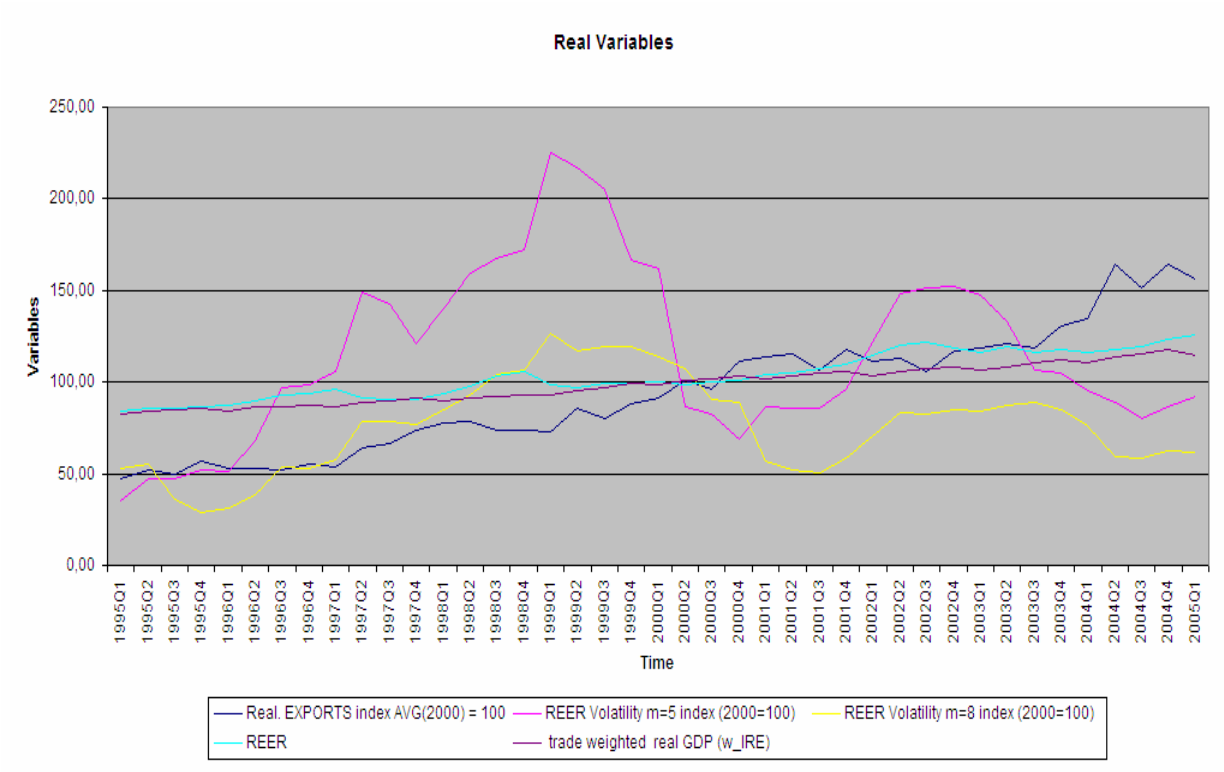
3. Empirical Results

3.1. Tests of stationarity

Statistical inference from time series is usually based on the assumption of stationarity. Therefore, prior to estimating equations defined in section 2.3., i.e. the aggregate export demand model, properties of the individual time series must be tested. Graphical analysis, Dickey-Fuller and Augmented Dickey-Fuller tests are employed to test for the presence of unit root.

Figure 1 exhibits clear upward trend for variables[58] foreign real GDP, real effective exchange rate and also real exports.

Figure 1: Real Variables (index values; 2000=100)



[58] For better illustration, GDP, REER and XR were plotted in their volume form. Their logarithmic transformations used in regressions would not change the results. Variables would still be trended.

Both measures of exchange rate variability does not seem to have equal variance over the whole time period and thus we can expect all variables to be non-stationary which was in accordance with our a priory expectations.

In Figure 2, the first differences of all five variables were plotted. Time series does not seem to be trended. However, there is a potential risk of non-equal variance over the entire time period for the measures of exchange rate variability.

Figure 2: Real Variables – differentiated once (index values, 2000 = 100)

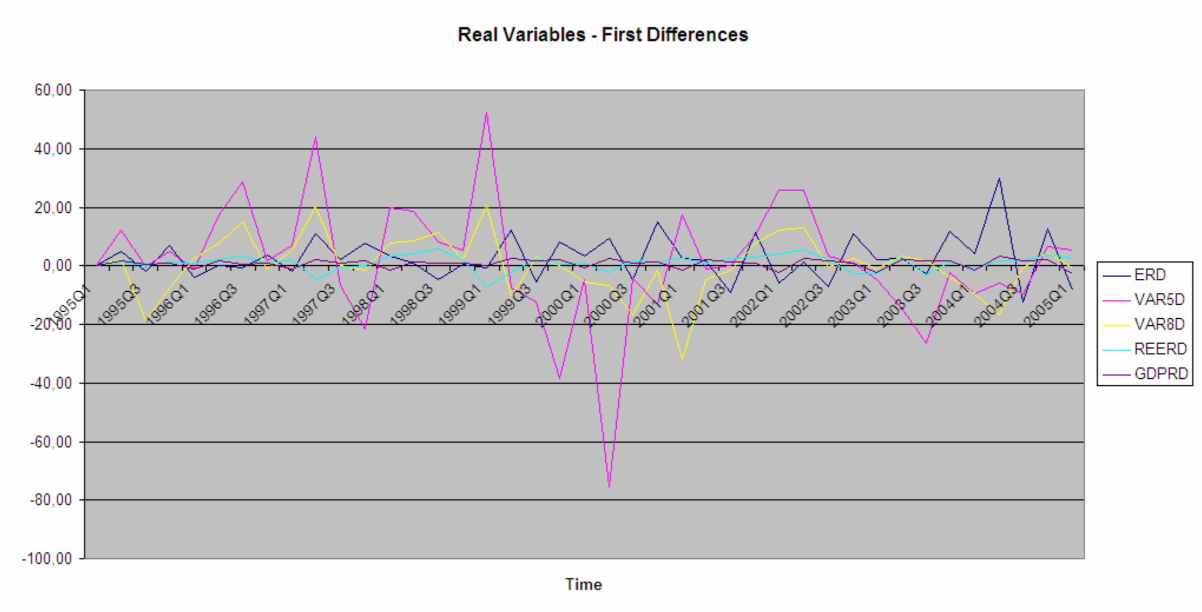


Table 1: Dickey - Fuller and Augmented Dickey Fuller Tests

Variable	The Dickey-Fuller regressions include an intercept but not a trend				The Dickey-Fuller regressions include an intercept and a linear trend				Stationarity
	Actual value			Critical value	Actual value			Critical value	
	DF	ADF(1)	ADF(2)		DF	ADF(1)	ADF(2)		
lnXR	-0.95	-0.52	-0.67	-2.94	-3.11	-2.04	-2.99	-3.54	Not Proved
lnXRD	-9.40	-3.68	-4.21	-2.94	-9.23	-3.62	-4.13	-3.54	Proved
lnGDPR	-0.92	-0.50	-0.34	-2.94	-4.16	-2.93	-2.70	-3.54	Not Proved
lnGDPRD	-8.64	-6.04	-9.74	-2.94	-8.46	-5.87	-9.51	-3.54	Proved
lnGDPR(-1)	-0.19	0.19	0.26	-2.95	-3.80	-2.61	-2.54	-3.54	Not Proved
lnGDPR(-1)D	-8.69	-5.04	-7.12	-2.95	-8.60	-5.00	-7.05	-3.55	Proved
lnREER	-0.70	-0.86	-0.79	-2.94	-2.37	-3.35	-3.42	-3.54	Not Proved
lnREERD	-4.57	-3.99	-4.62	-2.94	-4.50	-3.94	-4.54	-3.54	Proved
VAR5	-1.80	-2.17	-2.7	-2.94	-2.05	-2.33	-2.78	-3.54	Not Proved
VAR5D	-4.91	-3.14	-2.96	-2.94	-4.97	-3.21	-3.05	-3.54	Proved
VAR8	-1.64	-1.93	-2.61	-2.94	-1.73	-1.84	-2.54	-3.54	Not Proved
VAR8D	-4.94	-2.58	-2.27	-2.94	-5.19	-2.75	-2.46	-3.54	Proved

On the basis of results of Dickey–Fuller and Augmented Dickey–Fuller test summarized in Table 1 and Appendix II, we rejected non-stationarity[59] for the time series differentiated once, which was again in accordance with our priory expectations and plot analysis. Therefore, we consider time series of all variables used in the model to be I(1).

After performing the tests of stationarity, we can move onto the estimation of regression coefficients. However, before interpreting the coefficients themselves, it is necessary to check the diagnostic tests to see whether the assumptions of the classical linear regression model are fulfilled[60]. Three models described in Section 2.3. were compared and the results are reported in Table 2 and Appendix III.

Table 2: Diagnostic Tests of Regressions of Proposed Export Demand Models [61]

Test	Model					
	VAR5			VAR8		
	Arize	**Arize + lagGDP**	**Arize + lagGDP + DV**	**Arize**	**Arize + lagGDP**	**Arize + lagGDP + DV**
	p-values			p-values		
Serial Correlation	0.005	0.050	0.648	0.004	0.052	0.564
Functional Form	0.115	0.221	0.236	0.069	0.132	0.134
Normality	0.473	0.329	0.371	0.465	0.328	0.382
Heteroscedasticity	0.895	0.772	0.838	0.959	0.738	0.892

3.2. Capturing the effects of monetary crisis in Czech Republic

As can be clearly seen from the Table 2, the basic export demand model (1) suffers for serial correlation. One of the explanations might be so called “specification bias”. The inclusion of omitted variable might remove the correlation pattern among the residuals. Incorporation of lagged foreign real GDP has the theoretical economic rationale and partially helped to eliminate problems with serial correlation. The plot of residuals, Figure 3(a) and

[59] If the test statistics exceeds the critical value, we reject the null hypothesis of the presence of a unit root on the 5% level of significance.

[60] Given the assumptions of the classical linear regression model, the least squares estimators, in the class of unbiased linear estimators, have minimum variance, that is, they are BLUE – Best Linear Unbiased Estimators. (Gauss-Markov Theorem)

[61] The null hypotheses in these tests are as follows: Serial Correlation: there is no serial correlation; Functional Form: there is a linear relationship between the variables, Normality: residuals are normally distributed; Heteroscedasticity: there is no dependence between residuals and independent variables. We reject null hypothesis on the standard 5% confidence level if p-value is lower than 0,05. In case we cannot reject any of the null hypothesis, we can apply Gauss-Markov Theorem described above.

3(b), exposed, that another possible omitted variable might the dummy capturing the impact of the outlying observation connected with monetary crisis and changes of exchange rate regimes which were discussed in previous sections. After the inclusion of dummy variable for the second quarter of 1998[62], serial correlation disappeared.

Figure 3(a) – Plot of residuals from regression model (1) using VAR5[63]

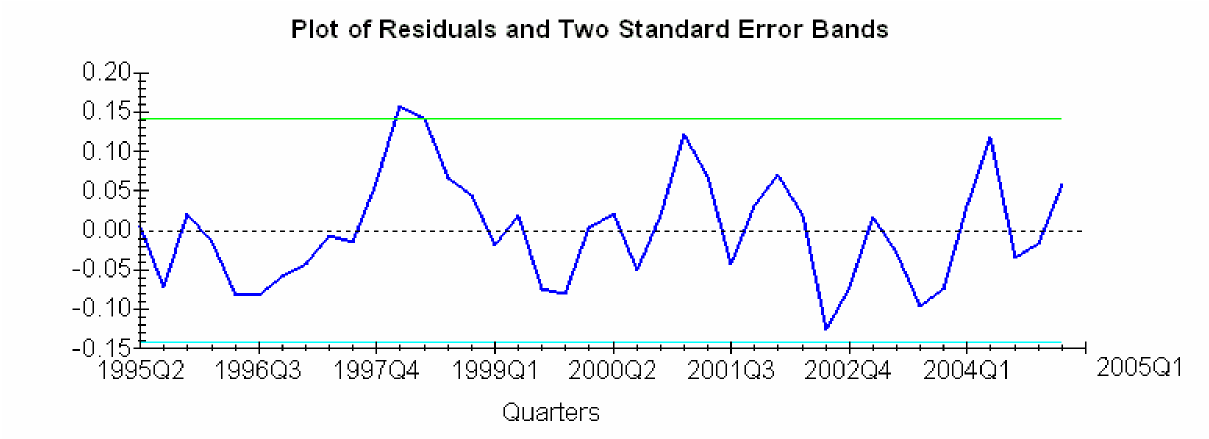
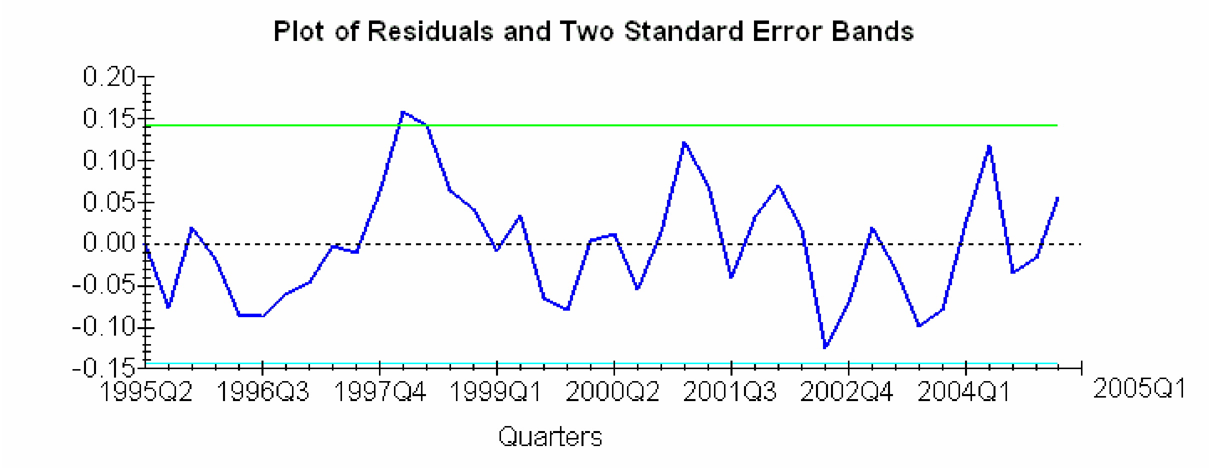


Figure 3(b) – Plot of residuals from regression model (1) using VAR8



Furthermore, the validity of incorporation of both additional variables to the model is supported by the high significance of individual t-tests. The coefficients of all variables are

[62] Similar results in terms of values and significance of OLS coefficients and of impact on serial correlation were obtained after the inclusion of dummy variable for 1998:1 or both.

[63] VAR5/VAR8 means that five- or eight-quarter moving average of the variance of the first difference of exchange rate was used as a measure of exchange rate volatility.

reported in Table 3 and Appendix III. Table 4 and Appendix III provide the overview of the values and signs of coefficients of all three models. P-values are stated in brackets[64].

Table 3: OLS estimations - Model with lagged foreign GDP and DV

Coeff.	Variable	Expected sign	Actual sign	Value (VAR5)	p-value (VAR5)	Value (VAR8)	p-value (VAR8)	Note
β_0	-	Not relevant	-	-11,65	0,000	-11,58	0,000	Highly significant
β_1	lnGDPR	+	+	2,70	0,000	2,67	0,000	Highly significant
β_2	lnGDPR(-1)	+	+	1,48	0,043	1,42	0,052	Significant
β_3	lnREER	-	-	-0,65	0,023	-0,58	0,035	Significant
β_4	VAR	?	-	0,00	0,352	0,00	0,575	Non-significant
β_5	DV2Q98	+	+	0,16	0,024	0,16	0,024	Significant

As can be seen from Table 4, the values of basic three coefficients ($\beta_{1,}$ $\beta_{3,}$ β_4) and their significance do not change a lot after including another one or both additional variables. Further interesting result from this comparison is that the effect of foreign real GDP seems to divide between current and previous period after adding $GDPR_{t-1}$ to the model. Moreover, the impact of the growth of foreign real GDP in current period is approximately twice as strong as in the previous period.

Table 4: OLS Estimators - Comparison of Models

Coeff.	Model					
	VAR5			VAR8		
	Arize	Arize + lagGDP	Arize + lagGDP + DV	Arize	Arize + lagGDP	Arize + lagGDP + DV
β_0	-11.47 (.000)	-11.50 (.000)	-11.65 (.000)	-11.42 (.000)	-11.40 (.000)	-11.58 (.000)
β_1	3.89 (.000)	2.68 (.001)	2.70 (.000)	3.82 (.000)	2.67 (.001)	2.67 (.000)
β_2	-	1.41 (.067)	1.68 (.043)	-	1.34 (.080)	1.42 (.052)
β_3	-0.41 (.153)	-0.60 (.049)	-0.45 (.023)	-0.35 (.207)	-0.51 (.078)	0.58 (.035)
β_4	0.00 (.420)	0.00 (.285)	0.00 (.352)	0.00 (.616)	0.00 (.464)	0.00 (.575)
β_5	-	-	0.16 (.024)	-	-	0.16 (.024)

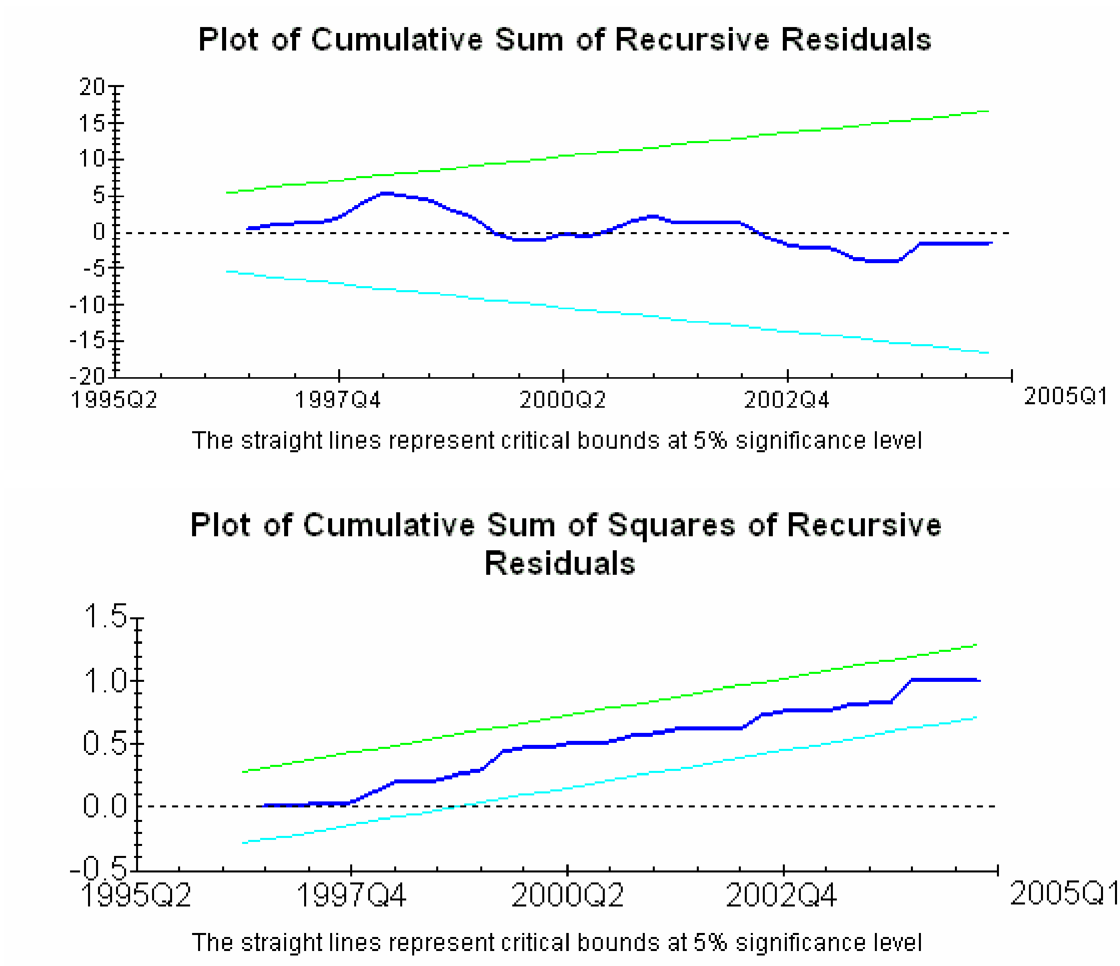
Signs of all coefficients are in accordance with our ex ante expectations. The sign of the coefficient at the dummy variable is positive as the devaluation of the Czech Crown caused by monetary crisis has the positive effect on the volumes of real export. Further

[64] Overall F-tests are highly significant at all regressions. (see Appendixes)

attractive feature of this model[65] is that the slope coefficients measure the elasticity of real export with respect to the explanatory variables. That is, the percentage changes in the volume of export, for a given small percentage change in GDP, effective exchange rate, etc.

There is a strong, statistically significant dependence of real export on changes in foreign real GDP not only in current period, but also in the previous one. The same but with negative sign holds also for the changes in real effective exchange rate. It does not seem that the exchange rate variability would have any clear-cut effect on real exports. One of the explanations for this might be the impact of antagonistic effects of higher exchange rate risk mentioned in previous sections or simply the development of hedging instruments such as future contracts for fixed exchange rates.

Figure 3: CUSUM and CUSUMSQ tests



[65] Log-log, double-log, log-linear or constant elasticity model.

As mentioned in Section 2.2., from theoretical point of view, there is a possibility of structural difference between the periods when the currency was pegged and when the managed floating was used.

However, the CUSUM and CUSUMSQ tests[66], Figure 3, did not reveal any structural break points in our export demand model (2)[67] and it is therefore assumed that the regression coefficients in the model are a good representation of the relationship between regressand and regressors over the entire sample period.

3.3. Stock adjustment model

As mentioned in section 2.3., there are several methods that deal with adjustments of export demand to changes in the regressors and one of them used in several studies is the simple stock adjustment mechanism where the entire adjustment is represented by adding a lagged dependent variable as a regressor. As this approach was criticized by several authors, I present the results from this model in Table 5 and Appendix IV just for comparison.

Table 5: Stock Adjustment Model

Coeff.	Variable	Model			
		VAR5		VAR8	
		Value	p-value	Value	p-value
β_0	-	-6.00	0.000	-5.91	0.000
θ	XR(-1)	0.48	0.000	0.48	0.000
β_1	lnGDPR	2.45	0.000	2.34	0.000
β_3	lnREER	-0.64	0.012	-0.55	0.022
β_4	VAR	0.16	0.205	0.14	0.283

The coefficients of basic variables do not change too much from those obtained using standard export demand models presented in Table 4 but their significance has improved. However, as already mentioned, this type of models using lagged value of regressand as

[66]CUSUSM and CUSUMSQ tests presented were used for the model using VAR5. The similar results could be obtained also for the regression with VAR8.
[67] We cannot identify any structural break (for the period for which the DV was included) in the model with dummy variables. Since the CUSUM and CUSUMSQ tests provide Chow's first test for every possible observation, it is assumed that the model is the same throughout, which is not the case when dummy variables are implemented. We can apply the CUSUM and CUSUMSQ tests also on the regression (4) that includes dummy variables, but they will reveal only possible structural changes for the period starting with 1999:2 where we theoretically do not expect them.

regressor often have problems with serial correlation which was partly proved also in this case (see Appendix IV). As a results the usual OLS estimators, although linear, unbiased and normally distributed (in large samples) are no longer minimum variance among all linear unbiased estimators, i.e. they are not efficient relative to other linear and unbiased estimators which may consequently lead to invalidity of the usual t- and F-tests.

3.4. Long-run equilibrium

The long-run equilibrium relationship between export and its main determinants is examined in cointegration analysis. It is a priory assumed, that inclusion of dummy variables for outliers to the model is meaningful to capture short-to-medium run inequalities, but do not have much sense in investigation of long-run relations. I also try to find the answer to the question, whether the effects of lagged real foreign GDP are significant in the long-run. It might be the case that its significance in the model was mainly due to lower flexibility of the markets in the transition period. It is anticipated, that nowadays, Czech exporters are able to respond to the rise of foreign income faster than decade ago and thus the significance of this variable is expected to decline in the long-run perspective.

Engle-Granger Test

Methodology used in Gujarati (2003) was employed to test for stationarity of residuals from regressions (1) and (2). Due to restrictive requirements of this test on the same integration order of all variables, we cannot test the model (4) which includes dummy variable as this is not I(1).

The test works as follows: we perform unit root test on the residuals obtained from regressions (1) and (2) and compare obtained T-ratios with 1% critical τ value computed by Engle and Granger (1987). The results for particular models are presented in Table 6 and Appendix V. If t-ratios are higher than τ value[68], we conclude that residuals from regression are I(0), that is, they are stationary. Hence, (1) or (2) is a cointegrating regression and it is not spurious, even though individually all variables are nonstationary and we can consider slope coefficients as long-run, equilibrium, elasticities.

[68] In absolute value.

As seen from Table 6, there seems to be the equilibrium relationship among the variables.

Table 6. - Engle-Granger Test

	Model			
	VAR5		VAR8	
	Arize	Arize + lagGDP	Arize	Arize + lagGDP
T-ratio	3.09	2.44	3.11	2.53
1% critical value	2.63	2.63	2.63	2.63
5% critical value	1.95	1.95	1.95	1.95

The significance of the model containing variable lagged foreign real GDP declines in the long-run which supports our hypothesis of growing responsiveness of Czech traders in time.

3.5. Short-run dynamics

Error Correction Mechanism described in section 2.4.1. for regressions (1) and (3) is specified in Table 7 and full results are provided in Appendix VI. Negative sign for the variable lagged real foreign income might be misleading, because one should bear in mind that now we regress first differences of particular variables, not their volume logarithmic values.

Table 7: Error Correction Models

Coeff.	Variable	Model			
		VAR5		VAR8	
		Arize	Arize + lagGDP	Arize	Arize + lagGDP
β_0	-	0.01 (.374)	0.03 (.031)	0.01 (.368)	0.03 (.032)
β_1	lnGDPRD	2.44 (.002)	1.54 (.030)	2.44 (.002)	1.57 (.029)
β_2	lnGDPR(-1)D	-	-1.39 (.047)	-	-1.39 (.048)
β_3	lnREERD	-0.34 (.429)	-0.33 (.371)	-0.35 (.414)	-0.34 (.352)
β_4	VARD	0.00 (.625)	0.00 (.639)	0.00 (.686)	0.00 (.768)
α	RES(-1)	-0.54 (.003)	-0.66 (.000)	-0.53 (.003)	-0.64 (.000)

Numbers in the brackets represent the p-values of individual t-tests.

Coefficient α is of our main interest here and its interpretation is as follows: for example, in the model with lagged value of foreign GDP, the magnitude -0.66 suggests, that on average, 66% of the „variance from equilibrium“ from previous period will be corrected in current period. Remaining 34% is still to be corrected since the variables tend to their equilibrium state over time as they are cointegrated.

3.6. ARDL method

The advantages of this approach were discussed in section 2.4.2. Results from the estimation of long-run coefficients are presented in Table 8 and Appendix VII. The number of lags – four – was chosen according to Akaike Information Criteria. It is interesting to compare these outputs with those presented in Table 4. There are two important aspects to be mentioned. Firstly, in the long-run, the significance of incorporation of the variable lagged foreign GDP and dummy variable capturing the effect of monetary crisis noticeably diminishes. The possible reasons were discussed above. Dummy captured the short-run deviation from usual behavior with negligible effect in the long-run and inclusion of lagged value of foreign real GDP was important to describe slower responsiveness of Czech exporters to changes in foreign income in transition period. The importance of this variable declines in the long-run perspective as well.

Secondly, the change of the impact of particular variables is evident[69]. Looking at the basic "Arize's" model, the effect of the changes of real foreign GDP on exports almost doubles and the impact of change of relative prices is approximately six times higher in the long-run leaving approximately the same levels of significance.

Table 8: Estimated Long-Run Coefficients using ARDL Approach

Coeff.	Model					
	VAR5			VAR8		
	Arize	Arize + lagGDP	Arize + lagGDP + DV	Arize	Arize + lagGDP	Arize + lagGDP + DV
β_0	-12.45 (.000)	-12.09 (.000)	-12.13 (.000)	-11.73 (.000)	-11.74 (.000)	-11.86 (.000)
β_1	6.30 (.002)	2.10 (.285)	2.18 (.241)	5.64 (.001)	2.13 (.402)	2.25 (.338)
β_2	-	3.14 (.115)	2.99 (.112)	-	3.28 (.207)	3.08 (.193)
β_3	-2.64 (.126)	-1.66 (.103)	-0.45 (.094)	-2.11 (.132)	-1.88 (.207)	1.77 (.182)
β_4	0.07 (.236)	0.07 (.104)	0.06 (.466)	0.05 (.314)	0.06 (.255)	0.05 (.440)
β_5	-	-	0.09 (.127)	-	-	0.12 (.295)

Numbers in the brackets represent the p-values of individual t-tests.

[69] Comparing the values of coefficients and the T-statistics.

Again, there is no clear evidence of the impact of growing volatility of effective exchange rate on real exports. The conclusion is, that the empirical results corresponds with the theory – the real export is much more price and foreign income elastic in long-run that in the short-run. It is much easier to change the behavior of the exporters as a response of changing economic conditions in the long-run, than in the short-run when the contracts have already been signed.

Finally, the error correction model is proposed. The values of the coefficients of the ECM are presented in Table 9 and Appendix VII.

Table 9: Error Correction Model - ARDL approach

Coeff.	Variable	Model			
		VAR5		VAR8	
		Value	p-value	Value	p-value
θ	XR(-1)	-0.30	0.069	-0.29	0.088
β_0	-	-3.81	0.026	-3.78	0.030
β_1	lnGDPR	1.93	0.000	1.81	0.001
β_3	lnREER	-0.81	0.003	-0.68	0.007
β_4	VAR	0.02	0.124	0.02	0.245
α	RES(-1)	-0.31	0.040	-0.32	0.033

One should bear in mind that this ECM is slightly different[70] from that proposed in Chapter 2.4.1. and which results are summarized in Table 7. Anyway, it gives comparable perspective about the short-run dynamics. The coefficient α here states, that approximately one third of the "variance from equilibrium" from previous period will be corrected in current period. The mixed results from previous ECM are due to its different form within ARDL approach.

3.7. Bilateral trade flows – Case of Germany, France, Italy, Spain and Netherlands

The analysis described in previous chapters was based on aggregate export demand model using effective exchange rate for the computation of exchange rate volatility. In the

[70] Apart from differentiated values of all explanatory variables and Error-Correction Term, it contains also differentiated value of lagged export.

next two sub-chapters, the attention will be focused on estimating bilateral trade flows between particular countries. The following analyses will be slightly restricted comparing to previous parts as far as adjustments of the basic model are concerned, but on the other hand more thorough in terms of individual countries involved. The data for each particular country are tested on the basic model (1) proposed in Chapter 2.3. Similar to Chapter 3.1., prior to estimating regression coefficients of particular export demand models, it is necessary to test for stationarity of time series. Graphical analysis again precedes Dickey-Fuller and Augmented Dickey Fuller tests. Figures 4 to 8 exhibit upward trends in variables capturing the development of GDP, export as well as of exchange rate EUR/CZK in time.

Figure 4: Variables – Germany (index values, 2000 = 100, dif = 1st difference)

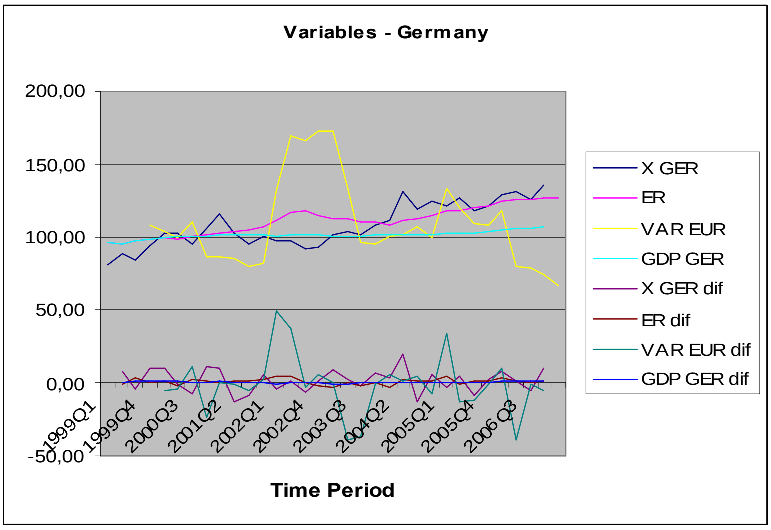


Figure 5: Variables – France (index values, 2000 = 100, dif = 1st difference)

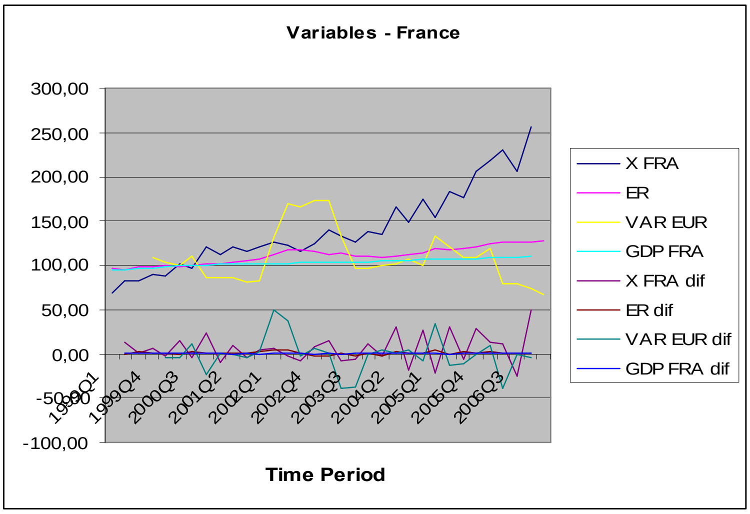


Figure 6: Variables – Italy (index values, 2000 = 100, dif = 1st difference)

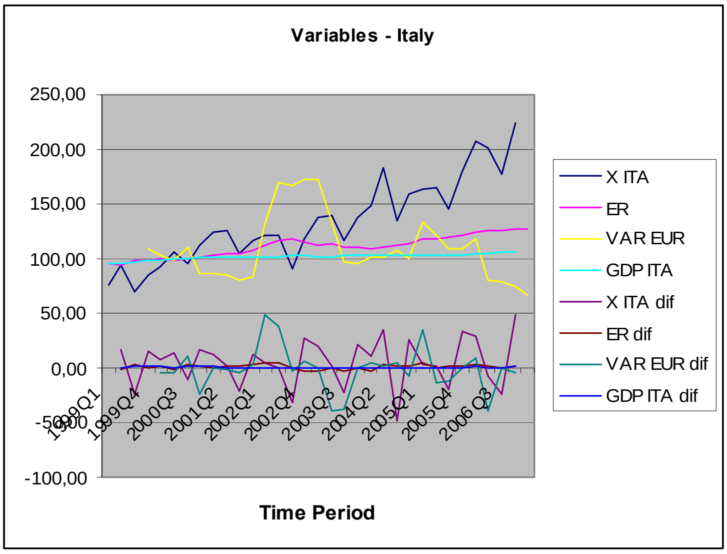


Figure 7: Variables – Spain (index values, 2000 = 100, dif = 1st difference)

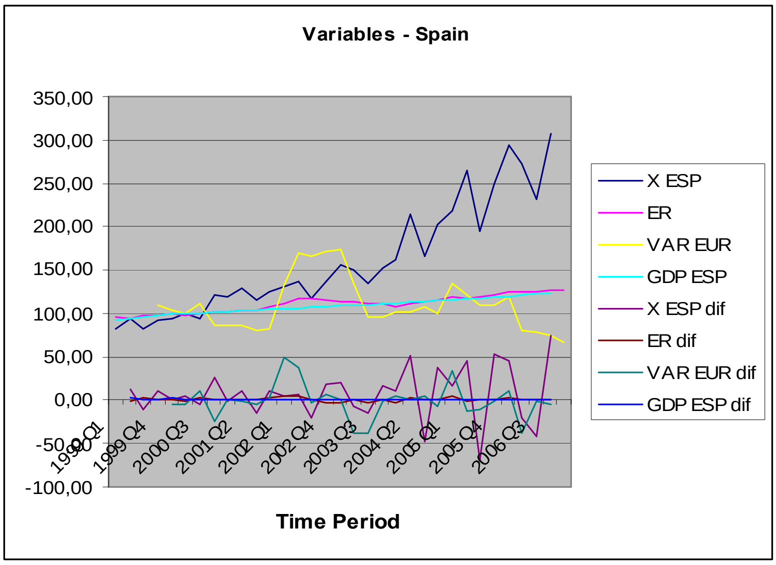
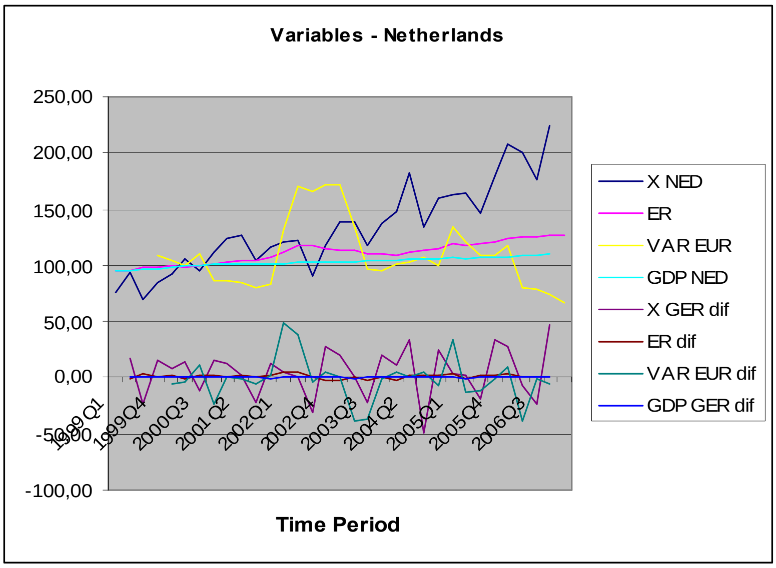


Figure 8: Variables – Netherlands (index values, 2000 = 100, dif = 1st difference)



All variables seem to be non-stationary either due to presence of upward trend or due to non equal variance over time[71]. Tables 10 to 14 summarize the results of Dickey-Fuller and Augmented Dickey-Fuller tests of stationarity[72].

Table 10: Dickey-Fuller and Augmented Dickey Fuller tests – Germany

Variable	The Dickey-Fuller regressions include an intercept but not a trend				The Dickey-Fuller regressions include an intercept and a linear trend				Stationarity
	Actual value			Critical value	Actual value			Critical value	
	DF	ADF(1)	ADF(2)		DF	ADF(1)	ADF(2)		
lnXde	-0,935	-0,675	-0,294	-2,991	-2,641	-2,355	-1,908	-3,612	Not Proved
lnXdeD	-5,912	-4,697	-3,936	-2,991	-5,831	-4,732	-4,088	-3,612	Proved
lnEReur	-0,837	-1,043	-1,120	-2,991	-1,450	-2,116	-2,616	-3,612	Not Proved
lnEReurD	-3,383	-2,428	-2,648	-2,991	-3,302	-2,363	-2,577	-3,612	Proved
VAReur	-1,537	-2,271	-2,300	-2,991	-1,666	-2,333	-2,259	-3,612	Not Proved
VAReurD	-3,844	-3,204	-2,442	-2,991	-3,933	-3,351	-2,562	-3,612	Proved
lnGDPde	2,816	1,556	2,284	-2,991	1,034	0,201	1,027	-3,612	Not Proved
lnGDPdeD	-2,675	-2,383	-1,028	-2,991	-3,330	-3,198	-1,858	-3,612	Proved

As can be seen from Table 10, variable measuring growth of GDP in Germany is not I(1), so it is not possible to use Engle-Granger test to test for long-run equilibrium[73]. The

[71] Measures of volatility does not seem to be equal over time, all other variables are trended.
[72] Full results and outcomes from econometric SW could be found on http://jurecka.webz.cz/ or be send upon request.
[73] For more information see Chapter 3.4. – Engle-Granger test.

graphical analysis (Figure 4) suggests that the growth of GDP in Germany was much lower than the growth of real export to this country. Regression results summarized in Table 15 also support our previous statements that the development of German GDP does not seem to be much correlated with Czech exports to this country[74]. It could be assumed, that the growing export to Germany could be better explained by other explanatory variables. It might also be the case, that the export demand model for Germany might be much complex including other explanatory variables. The estimates of the regression coefficients from basic bilateral export demand model are summarized in Tables 15 and 19[75].

Table 11: Dickey-Fuller and Augmented Dickey Fuller tests – France

Variable	The Dickey-Fuller regressions include an intercept but not a trend				The Dickey-Fuller regressions include an intercept and a linear trend				Stationarity
	Actual value			Critical value	Actual value			Critical value	
	DF	ADF(1)	ADF(2)		DF	ADF(1)	ADF(2)		
lnXfra	-0,012	0,923	0,932	-2,991	-3,463	-1,386	-1,393	-3,612	Not Proved
lnXfraD	-11,052	-4,336	-4,379	-2,991	-11,256	-4,575	-4,877	-3,612	Proved
lnEReur	-1,941	-2,440	-2,160	-2,991	-1,885	-2,346	-2,012	-3,612	Not Proved
lnEReurD	-3,339	-3,370	-2,305	-2,991	-3,364	-3,476	-2,421	-3,612	Proved
VAReur	-1,263	-1,362	-2,335	-2,991	-1,503	-1,555	-2,364	-3,612	Not Proved
VAReurD	-4,176	-1,940	-2,196	-2,991	-3,976	-1,681	-1,930	-3,612	Proved
lnGDPfra	0,764	0,876	0,914	-2,991	-2,466	-2,094	-2,276	-3,612	Not Proved
lnGDPfraD	-6,363	-4,109	-3,254	-2,991	-6,428	-4,227	-3,282	-3,612	Proved

As can be seen from Tables 11 – 14, for France, Italy, Spain and Netherland, all relevant time series are I(1) and could be therefore cointegrated, e.g. the regression should not be spurious.

Table 12: Dickey-Fuller and Augmented Dickey Fuller tests – Italy

Variable	The Dickey-Fuller regressions include an intercept but not a trend				The Dickey-Fuller regressions include an intercept and a linear trend				Stationarity
	Actual value			Critical value	Actual value			Critical value	
	DF	ADF(1)	ADF(2)		DF	ADF(1)	ADF(2)		
lnXita	-1,409	-0,939	-0,301	-2,991	-4,233	-3,897	-2,896	-3,612	Not Proved
lnXitaD	-6,514	-5,801	-7,990	-2,991	-6,356	-5,714	-8,091	-3,612	Proved
lnEReur	-1,941	-2,440	-2,160	-2,991	-1,885	-2,346	-2,012	-3,612	Not Proved
lnEReurD	-3,339	-3,370	-2,305	-2,991	-3,364	-3,476	-2,421	-3,612	Proved
VAReur	-1,263	-1,362	-2,335	-2,991	-1,503	-1,555	-2,364	-3,612	Not Proved
VAReurD	-4,176	-1,940	-2,196	-2,991	-3,976	-1,681	-1,930	-3,612	Proved
lnGDPita	1,563	1,162	1,368	-2,991	-0,095	-1,014	-0,492	-3,612	Not Proved
lnGDPitaD	-3,115	-3,238	-2,255	-2,991	-3,383	-3,387	-2,189	-3,612	Proved

[74] As can be seen from Table 10, time series for German GDP are not I(1). Regression results stated in Table 15 might be therefore misleading.
[75] For full regression results see Appendix VIII.

Table 13: Dickey-Fuller and Augmented Dickey Fuller tests – Spain

Variable	The Dickey-Fuller regressions include an intercept but not a trend				The Dickey-Fuller regressions include an intercept and a linear trend				Stationarity
	Actual value			Critical value	Actual value			Critical value	
	DF	ADF(1)	ADF(2)		DF	ADF(1)	ADF(2)		
lnXesp	-0,800	-0,439	-0,146	-2,991	-4,654	-3,472	-2,579	-3,612	Not Proved
lnXespD	-7,759	-6,009	-8,767	-2,991	-7,534	-5,858	-8,828	-3,612	Proved
lnEReur	-1,941	-2,440	-2,160	-2,991	-1,885	-2,346	-2,012	-3,612	Not Proved
lnEReurD	-3,339	-3,370	-2,305	-2,991	-3,364	-3,476	-2,421	-3,612	Proved
VAReur	-1,263	-1,362	-2,335	-2,991	-1,503	-1,555	-2,364	-3,612	Not Proved
VAReurD	-4,176	-1,940	-2,196	-2,991	-3,976	-1,681	-1,930	-3,612	Proved
lnGDPesp	1,497	1,462	2,160	-2,991	-0,080	-0,821	0,316	-3,612	Not Proved
lnGDPespD	-3,021	-3,591	-1,633	-2,991	-3,178	-4,189	-2,166	-3,612	Proved

Table 14: Dickey-Fuller and Augmented Dickey Fuller tests – Netherlands

Variable	The Dickey-Fuller regressions include an intercept but not a trend				The Dickey-Fuller regressions include an intercept and a linear trend				Stationarity
	Actual value			Critical value	Actual value			Critical value	
	DF	ADF(1)	ADF(2)		DF	ADF(1)	ADF(2)		
lnXned	-1,409	-0,939	-0,301	-2,991	-4,233	-3,897	-2,896	-3,612	Not Proved
lnXnedD	-6,515	-5,801	-7,990	-2,991	-6,356	-5,714	-8,091	-3,612	Proved
lnEReur	-1,941	-2,440	-2,160	-2,991	-1,885	-2,346	-2,012	-3,612	Not Proved
lnEReurD	-3,339	-3,370	-2,305	-2,991	-3,364	-3,476	-2,421	-3,612	Proved
VAReur	-1,263	-1,362	-2,335	-2,991	-1,503	-1,555	-2,364	-3,612	Not Proved
VAReurD	-4,176	-1,940	-2,196	-2,991	-3,976	-1,681	-1,930	-3,612	Proved
lnGDPned	0,764	0,876	0,914	-2,991	-2,466	-2,094	-2,276	-3,612	Not Proved
lnGDPnedD	-6,363	-4,109	-3,254	-2,991	-6,428	-4,227	-3,282	-3,612	Proved

Tables 15-19[76] suggest, that the significance of variable "exchange rate" measuring the impact of the change of bilateral exchange rate on volumes of real exports declines comparing to aggregate export demand models. On the other hand, the significance of the impact of exchange rate variability improves substantially, at least in case of Germany, France and Italy.

Table 15: Regression estimates – Germany

Coeff.	Variable	Experted sign	Actual sign	Value	p-value	Note
β0	-	Not relevant	-	-3,2702	0,728	Non-signifficant
β1	lnEReur	-	+	0,8853	0,155	Non-signifficant
β3	VAReur	?	-	0,0019	0,035	Signifficant
β4	lnGDPger	+	+	0,8674	0,725	Non-signifficant

[76] For full regression results see Appendix VIII.

Table 16: Regression estimates – France

Coeff.	Variable	Expected sign	Actual sign	Value	p-value	Note
β0	-	Not relevant	-	-26,8809	0,000	Signifficant
β1	lnEReur	-	+	1,1213	0,074	Non-signifficant
β3	VAReur	?	-	-0,0015	0,038	Signifficant
β4	lnGDPfra	+	+	5,7521	0,000	Signifficant

Table 17: Regression estimates – Italy

Coeff.	Variable	Expected sign	Actual sign	Value	p-value	Note
β0	-	Not relevant	-	-36,0123	0,015	Signifficant
β1	lnEReur	-	+	1,1808	0,183	Non-signifficant
β3	VAReur	?	-	-0,0017	0,125	Non-signifficant
β4	lnGDPita	+	+	7,6782	0,052	Signifficant

Table 18: Regression estimates – Spain

Coeff.	Variable	Expected sign	Actual sign	Value	p-value	Note
β0	-	Not relevant	-	-12,7657	0,000	Signifficant
β1	lnEReur	-	-	-0,3902	0,682	Non-signifficant
β3	VAReur	?	-	0,0001	0,934	Non-signifficant
β4	lnGDPesp	+	+	5,4329	0,000	Signifficant

Table 19: Regression estimates – Netherland

Coeff.	Variable	Expected sign	Actual sign	Value	p-value	Note
β0	-	Not relevant	-	-32,0039	0,000	Signifficant
β1	lnEReur	-	-	-0,7177	0,424	Non-signifficant
β3	VAReur	?	-	-0,0002	0,817	Non-signifficant
β4	lnGDPned	+	+	8,6850	0,000	Signifficant

One possible explanation might be, that in case of aggregate export demand model, the impact of volatilities of different currencies comprised in effective exchange rate might mutually cancel out. Another interesting finding is the strong positive relationship between export and the growth of GDP. Expecially in France, Spain and Netherland, extremely strong correlation between these two variables could be identified. Just to reminder, the Log-log regression model assures that the values of particular coefficients measure the foreign income, exchange rate and exchange rate volatility elasticities of Czech real export demand.

3.9. Bilateral trade flows – Case of Slovakia

It the following part, the bilateral export demand model for the case of the second largest Czech export partner – Slovakia, is examined. Considering qualitative aspects, this market is more similar to Czech one than any other above mentioned countries, and the examination of the main determinants of Czech export to Slovakia and its comparison to previous results might be therefore useful.

Figure 9: Variables – Slovakia (index values, 2000 = 100, dif = 1st difference))

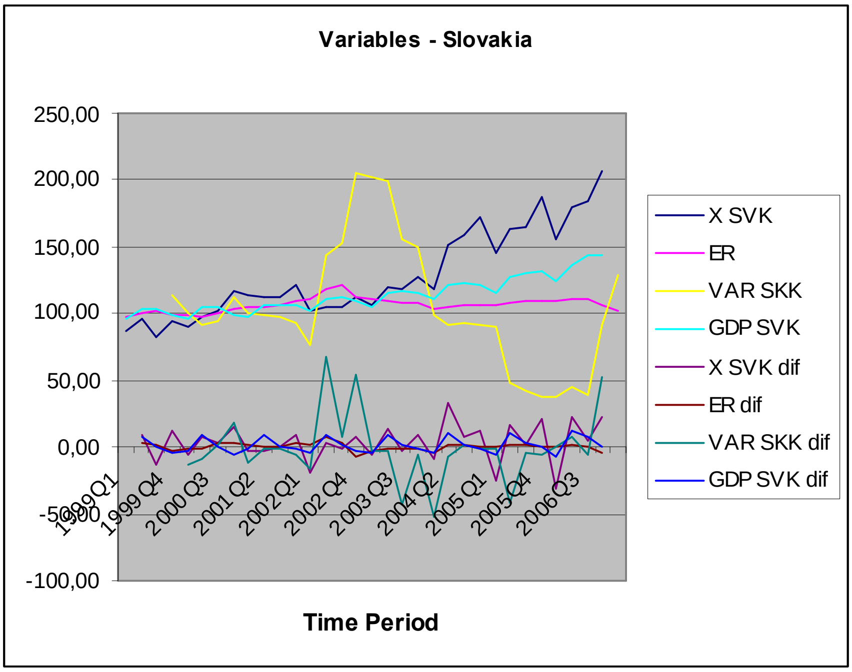


Figure 9, similar to figures related to West-european countries, also exhibits upward trends in variables capturing the development of GDP and export in time. Growth of GDP in Slovak republic was significantly higher comparing to other analyzed countries. Exchange rate CZK/SKK seems to be relatively stable as both currencies strengthen considerably to

Euro in last years. Table 20[77], similarly to previous cases, summarizes the outcomes from Dickey-Fuller and Augmented Dickey-Fuller test of stationarity. It could be concluded, that the first differences of all necessary variables are stationary and the time series could be cointegrated.

Table 20: Dickey-Fuller and Augmented Dickey Fuller tests – Slovakia

Variable	The Dickey-Fuller regressions include an intercept but not a trend				The Dickey-Fuller regressions include an intercept and a linear trend				Stationarity
	Actual value			Critical value	Actual value			Critical value	
	DF	ADF(1)	ADF(2)		DF	ADF(1)	ADF(2)		
lnXsk	-0,413	0,473	0,279	-2,991	-3,060	-1,866	-2,134	-3,612	Not Proved
lnXskD	-8,217	-3,714	-4,974	-2,991	-8,399	-3,869	-5,086	-3,612	Proved
lnERsk	-1,941	-2,440	-2,160	-2,991	-1,885	-2,346	-2,012	-3,612	Not Proved
lnERskD	-3,339	-3,370	-2,305	-2,991	-3,364	-3,476	-2,421	-3,612	Proved
VARskk	-1,263	-1,362	-2,335	-2,991	-1,503	-1,555	-2,364	-3,612	Not Proved
VARskkD	-4,176	-1,940	-2,196	-2,991	-3,976	-1,681	-1,930	-3,612	Proved
lnGDPsk	-0,856	-0,503	0,639	-2,991	-4,116	-5,428	-3,588	-3,612	Not Proved
lnGDPskD	-5,900	-6,751	-16,491	-2,991	-5,784	-6,868	-28,132	-3,612	Proved

Table 21[78] provides us with the results of the regression measuring the parameters of the Czech-Slovak bilateral export demand model.

Table 21: Regression estimates - Slovakia

Coeff.	Variable	Expected sign	Actual sign	Value	p-value	Note
β0	-	Not relevant	-	-2,2302	0,177	Non-signifficant
β1	lnERskk	-	+	-0,3086	0,452	Non-signifficant
β3	VARskk	?	-	-0,0008	0,072	Signifficant
β4	lnGDPsvk	+	+	1,8177	0,000	Signifficant

Similarly to the case of West-European countries, Table 21 suggest, that the significance of variable "exchange rate" declines comparing to aggregate export demand models. On the other hand, the significance of the impact of exchange rate variability improves substantially again. Furthermore, contrary to Germany, the impact of growth of foreign GDP remains highly significant for the case of Slovak republic.

[77] Full results and outcomes from econometric SW could be found on http://jurecka.webz.cz/ or be send upon request
[78] For full regression results see Appendix VII.

4. Summary and Conclusions

In this study, the impact of exchange rate variability on the demand for real exports has been examined. The main conclusions from the theoretical part are as follows. Firstly, there is no definite predictable impact of the growth of exchange rate volatility on real exports and this effect is a matter of ex post empirical investigation for each individual country. Secondly, we have to distinguish the terms exchange rate volatility and misalignment. Volatility refers rather to short-term fluctuations of exchange rates whereas misalignment refers to persistent departures of real exchange rates from their equilibrium values and its impact on trade is indisputably negative.

In the second part, the Czech real export demand was modeled using standard procedures of econometric analysis and the study yielded the following main results. The standard real export demand model had to be adjusted for the conditions of Czech economy by adding a dummy variable capturing the turmoil around monetary crisis in the end of the year 1997 and beginning of 1998 and by adding a variable of lagged foreign real GDP. According to our expectations, both additional variables turned out be insignificant in the long-run what just supported our theory, that inclusion of dummy variables for outliers to the model is meaningful to capture short-to-medium run inequalities, but do not have much sense in investigation of long-run relations.

Furthermore, there seems to be a strong, statistically significant dependence of real export on changes in foreign real GDP not only in current period, but also in the previous one. Moreover, the impact of the growth of foreign real GDP in current period is approximately twice as strong as in the previous period.

The structural stability of the parameters was tested as well but no structural break points were found and it is then assumed, that the regression coefficients in the model are a good representation of the examined relationships.

All variables turned out to be non-stationary, but the cointegration analysis revealed that there is an equilibrium relationship among them and that the regression was not spurious. Additionally, the long-term effects of the particular variables turned out to be significant and much stronger than the short-term ones. The export demand price and income elasticities were again in accordance with theory much higher that in the short-run. The dynamics of the model was outlined using the error correction models. The main conclusion is that there is no clear-cut effect of the real effective exchange rate volatility on Czech real exports neither in the short-run, nor in the long-run. Finally, the examination of bilateral export demand models revealed the growth of signification of the variable capturing exchange rate volatility. Negative sign at coefficients of these variables favor the common theory of negative impact of exchange rate volatility on bilateral exports. Interestingly, the strong positive relationship between export and the growth of GDP was found in the most cases of bilateral export demand model. Especially in France, Spain and Netherland, extremely strong correlation between these two variables could be identified.

The further research could be extended to the examination of this effect to the whole groups of countries, e.g. new EU joiners, CEE countries etc., using the panel data analysis. Another way for further studies could lead to improvement of basic bilateral models by adding country specific variables to capture individual conditions.

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Appendix

For calculations in empirical part of this thesis, MicroFit econometric pack gained legally during studies at Staffordshire University in England was used. Data were obtained from IMF IFS CD-ROM kindly lent by Czech National Bank and public internet sources of Czech Statistical Office and Czech National Bank and can be viewed at http://jurecka.webz.cz/.

Appendix I: **Computation of the Trade Weighted Foreign GDP**

The same trade weights for individual countries are employed by computation of the variable representing the real foreign income as are used in computation of the effective exchange rate by Czech National Bank. The following Table presents the particular weights:

Country	EER_CR (%)
Austria	2,1
Belgium	2,5
Netherlands	4,0
Finland	1,3
France	14,4
Germany	20,6
Ireland	1,0
Italy	11,9
Luxembourg	0,2
Portugal	1,2
Spain	6,3
Slovakia	7,6
Russia	4,5
Poland	5,0
United Kingdom	4,7
United States	4,0
Japan	1,3
Hungary	1,9
Sweden	1,6
Switzerland	1,6
Denmark	0,6
China	1,4

The Czech National Bank currently uses the weight 65.7 % to cover all countries which are the members of the EURO zone. I recalculated the weights for each individual EURO country by using the shares of their GDP within the whole zone in the year 2000 as the weights. The possible differences should have only marginal effects on the whole value of the variable foreign real GDP. The effect of the change of real GDP of Ireland and Greece were left out due to lack of data. As the shares of these 2 countries on overall Czech export are negligible, I do not regard it as an important misspecification of this variable.

Appendix II: Outputs from the analysis of stationarity using DF and ADF tests.

If the value of the test statistic is higher than the critical value stated below the results (in absolute values), the hypothesis of the presence of unit-root is rejected on the 5% level of significance, i.e. the time series are stationary.

Unit root tests for variable **LNXR**
The Dickey-Fuller regressions include an intercept but not a trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-.94787**	43.2892	41.2892	39.7057	40.7365
ADF(1)	-.52021	46.7926	43.7926	41.4173	42.9635
ADF(2)	-.66915	48.2084	44.2084	41.0414	43.1030
ADF(3)	-.39003	49.6642	44.6642	40.7054	43.2825
ADF(4)	-.43406	50.1150	44.1150	39.3645	42.4570

****
95% critical value for the augmented Dickey-Fuller statistic = **-2.9446**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **LNXR**
The Dickey-Fuller regressions include an intercept and a linear trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-3.1060**	47.4788	44.4788	42.1036	43.6498
ADF(1)	-2.0408	48.8540	44.8540	41.6869	43.7486
ADF(2)	-2.9934	52.5377	47.5377	43.5789	46.1560
ADF(3)	-2.3676	52.6595	46.6595	41.9089	45.0014
ADF(4)	-3.1447	55.2842	48.2842	42.7419	46.3498

****
95% critical value for the augmented Dickey-Fuller statistic = **-3.5386**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **LNXRD**
The Dickey-Fuller regressions include an intercept but not a trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-9.4029**	46.2465	44.2465	42.6629	43.6938
ADF(1)	-3.6806	47.6311	44.6311	42.2558	43.8020
ADF(2)	-4.2095	49.4881	45.4881	42.3211	44.3827
ADF(3)	-2.7886	50.0229	45.0229	41.0641	43.6412

ADF(4)	-3.8143	53.3527	47.3527	42.6021	45.6946

****

95% critical value for the augmented Dickey-Fuller statistic = **-2.9446**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **LNXRD**
The Dickey-Fuller regressions include an intercept and a linear trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-9.2341**	46.2511	43.2511	40.8758	42.4221
ADF(1)	-3.6153	47.6384	43.6384	40.4714	42.5330
ADF(2)	-4.1308	49.4886	44.4886	40.5298	43.1068
ADF(3)	-2.7414	50.0241	44.0241	39.2736	42.3661
ADF(4)	-3.7540	53.3847	46.3847	40.8423	44.4502

****

95% critical value for the augmented Dickey-Fuller statistic = **-3.5386**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **LNGDPR**
The Dickey-Fuller regressions include an intercept but not a trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-.91665**	98.4516	96.4516	94.8681	95.8989
ADF(1)	-.49742	101.8445	98.8445	96.4692	98.0155
ADF(2)	-.33621	102.3052	98.3052	95.1381	97.1998
ADF(3)	.11164	112.0905	107.0905	103.1317	105.7088
ADF(4)	-.034433	122.3072	116.3072	111.5566	114.6491

****

95% critical value for the augmented Dickey-Fuller statistic = **-2.9446**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **LNGDPR**
The Dickey-Fuller regressions include an intercept and a linear trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-4.1565**	105.6943	102.6943	100.3190	101.8652
ADF(1)	-2.9275	106.0026	102.0026	98.8356	100.8973
ADF(2)	-2.6971	106.0396	101.0396	97.0808	99.6579
ADF(3)	-1.3358	113.1560	107.1560	102.4054	105.4979
ADF(4)	-3.2342	127.8811	120.8811	115.3388	118.9467

****

95% critical value for the augmented Dickey-Fuller statistic = **-3.5386**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **LNGDPRD**
The Dickey-Fuller regressions include an intercept but not a trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-8.6433**	103.2114	101.2114	99.6278	100.6587
ADF(1)	-6.0350	104.2617	101.2617	98.8864	100.4327
ADF(2)	-9.7403	116.2920	112.2920	109.1250	111.1867
ADF(3)	-1.6816	133.9138	128.9138	124.9550	127.5320
ADF(4)	-2.2290	135.8329	129.8329	125.0824	128.1749

****
95% critical value for the augmented Dickey-Fuller statistic = **-2.9446**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **LNGDPRD**
The Dickey-Fuller regressions include an intercept and a linear trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-8.4655**	103.2784	100.2784	97.9031	99.4493
ADF(1)	-5.8739	104.2923	100.2923	97.1252	99.1869
ADF(2)	-9.5068	116.2962	111.2962	107.3374	109.9145
ADF(3)	-1.6418	133.9157	127.9157	123.1651	126.2576
ADF(4)	-2.1758	135.8696	128.8696	123.3273	126.9352

****
95% critical value for the augmented Dickey-Fuller statistic = **-3.5386**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **LGDPRL**
The Dickey-Fuller regressions include an intercept but not a trend
****
35 observations used in the estimation of all ADF regressions.
Sample period from 1996Q3 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-.18974**	97.9943	95.9943	94.4389	95.4574
ADF(1)	.19389	101.3720	98.3720	96.0390	97.5667
ADF(2)	.25909	101.5687	97.5687	94.4580	96.4949
ADF(3)	.37732	109.1623	104.1623	100.2740	102.8201
ADF(4)	.21955	119.0212	113.0212	108.3552	111.4105

****
95% critical value for the augmented Dickey-Fuller statistic = **-2.9472**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **LGDPRL**
The Dickey-Fuller regressions include an intercept and a linear trend
****

35 observations used in the estimation of all ADF regressions.
Sample period from 1996Q3 to 2005Q1

	Test Statistic	LL	AIC	SBC	HQC
DF	**-3.8039**	104.5409	101.5409	99.2079	100.7356
ADF(1)	-2.6069	104.9446	100.9446	97.8339	99.8708
ADF(2)	-2.5377	105.0814	100.0814	96.1930	98.7391
ADF(3)	-1.3742	110.3361	104.3361	99.6701	102.7254
ADF(4)	-3.2801	124.8287	117.8287	112.3849	115.9495

95% critical value for the augmented Dickey-Fuller statistic = **-3.5426**
LL = Maximized log-likelihood   AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion   HQC = Hannan-Quinn Criterion

Unit root tests for variable **LGDPRLD**
The Dickey-Fuller regressions include an intercept but not a trend

34 observations used in the estimation of all ADF regressions.
Sample period from 1996Q4 to 2005Q1

	Test Statistic	LL	AIC	SBC	HQC
DF	**-8.6923**	97.9878	95.9878	94.4614	95.4673
ADF(1)	-5.0385	98.1526	95.1526	92.8630	94.3718
ADF(2)	-7.1244	105.4934	101.4934	98.4407	100.4523
ADF(3)	-1.8036	115.0996	110.0996	106.2837	108.7983
ADF(4)	-2.2052	116.1744	110.1744	105.5954	108.6128

95% critical value for the augmented Dickey-Fuller statistic = **-2.9499**
LL = Maximized log-likelihood   AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion   HQC = Hannan-Quinn Criterion

Unit root tests for variable **LGDPRLD**
The Dickey-Fuller regressions include an intercept and a linear trend

34 observations used in the estimation of all ADF regressions.
Sample period from 1996Q4 to 2005Q1

	Test Statistic	LL	AIC	SBC	HQC
DF	**-8.6032**	98.1550	95.1550	92.8654	94.3742
ADF(1)	-5.0041	98.3374	94.3374	91.2847	93.2964
ADF(2)	-7.0504	105.6916	100.6916	96.8757	99.3903
ADF(3)	-1.8030	115.2547	109.2547	104.6757	107.6931
ADF(4)	-2.1811	116.2889	109.2889	103.9466	107.4670

95% critical value for the augmented Dickey-Fuller statistic = **-3.5468**
LL = Maximized log-likelihood   AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion   HQC = Hannan-Quinn Criterion

Unit root tests for variable **LNREER**
The Dickey-Fuller regressions include an intercept but not a trend

36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1

	Test Statistic	LL	AIC	SBC	HQC
DF	**-.69894**	79.7237	77.7237	76.1402	77.1710

ADF(1)	-.86223	80.6661	77.6661	75.2908	76.8370
ADF(2)	-.78998	80.8854	76.8854	73.7184	75.7800
ADF(3)	-.62609	82.5860	77.5860	73.6272	76.2043
ADF(4)	-.60711	82.6477	76.6477	71.8972	74.9897

****

95% critical value for the augmented Dickey-Fuller statistic = **-2.9446**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **LNREER**
The Dickey-Fuller regressions include an intercept and a linear trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-2.3698**	82.2973	79.2973	76.9220	78.4683
ADF(1)	-3.3523	85.6852	81.6852	78.5182	80.5798
ADF(2)	-3.4197	86.2994	81.2994	77.3406	79.9177
ADF(3)	-2.7265	86.3460	80.3460	75.5955	78.6880
ADF(4)	-2.8441	86.8593	79.8593	74.3170	77.9249

****

95% critical value for the augmented Dickey-Fuller statistic = **-3.5386**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **LNREERD**
The Dickey-Fuller regressions include an intercept but not a trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-4.5722**	80.5676	78.5676	76.9841	78.0149
ADF(1)	-3.9939	80.8488	77.8488	75.4735	77.0198
ADF(2)	-4.6185	83.1216	79.1216	75.9545	78.0162
ADF(3)	-3.7563	83.2118	78.2118	74.2530	76.8300
ADF(4)	-3.3807	83.3902	77.3902	72.6397	75.7321

****

95% critical value for the augmented Dickey-Fuller statistic = **-2.9446**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **LNREERD**
The Dickey-Fuller regressions include an intercept and a linear trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-4.5041**	80.5722	77.5722	75.1969	76.7431
ADF(1)	-3.9274	80.8502	76.8502	73.6832	75.7448
ADF(2)	-4.5399	83.1219	78.1219	74.1631	76.7402
ADF(3)	-3.6849	83.2135	77.2135	72.4629	75.5554
ADF(4)	-3.3163	83.3932	76.3932	70.8509	74.4588

****

95% critical value for the augmented Dickey-Fuller statistic = **-3.5386**

LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **VAR5**
The Dickey-Fuller regressions include an intercept but not a trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-1.7997**	-194.4803	-196.4803	-198.0638	-197.0330
ADF(1)	-2.1682	-193.1947	-196.1947	-198.5700	-197.0237
ADF(2)	-2.6978	-191.4326	-195.4326	-198.5996	-196.5380
ADF(3)	-2.6685	-191.2634	-196.2634	-200.2222	-197.6451
ADF(4)	-3.2590	-189.3279	-195.3279	-200.0785	-196.9860

****
95% critical value for the augmented Dickey-Fuller statistic = **-2.9446**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **VAR5**
The Dickey-Fuller regressions include an intercept and a linear trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-2.0451**	-193.3953	-196.3953	-198.7705	-197.2243
ADF(1)	-2.3292	-192.3571	-196.3571	-199.5241	-197.4624
ADF(2)	-2.7795	-190.8195	-195.8195	-199.7783	-197.2013
ADF(3)	-2.7019	-190.7053	-196.7053	-201.4559	-198.3634
ADF(4)	-3.2253	-188.9685	-195.9685	-201.5108	-197.9029

****
95% critical value for the augmented Dickey-Fuller statistic = **-3.5386**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **VAR5D**
The Dickey-Fuller regressions include an intercept but not a trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-4.9112**	-195.5918	-197.5918	-199.1753	-198.1445
ADF(1)	-3.1448	-195.1211	-198.1211	-200.4964	-198.9501
ADF(2)	-2.9633	-194.9850	-198.9850	-202.1521	-200.0904
ADF(3)	-2.3235	-194.7831	-199.7831	-203.7419	-201.1648
ADF(4)	-3.7578	-189.0985	-195.0985	-199.8491	-196.7566

****
95% critical value for the augmented Dickey-Fuller statistic = **-2.9446**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **VAR5D**

The Dickey-Fuller regressions include an intercept and a linear trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-4.9728**	-195.1759	-198.1759	-200.5512	-199.0049
ADF(1)	-3.2059	-194.8245	-198.8245	-201.9915	-199.9299
ADF(2)	-3.0499	-194.6254	-199.6254	-203.5842	-201.0071
ADF(3)	-2.4104	-194.4858	-200.4858	-205.2364	-202.1439
ADF(4)	-3.9711	-188.2232	-195.2232	-200.7655	-197.1576

****
95% critical value for the augmented Dickey-Fuller statistic = **-3.5386**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **VAR8**
The Dickey-Fuller regressions include an intercept but not a trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-1.6376**	-150.7696	-152.7696	-154.3532	-153.3223
ADF(1)	-1.8286	-149.9077	-152.9077	-155.2829	-153.7367
ADF(2)	-2.6107	-145.8076	-149.8076	-152.9747	-150.9130
ADF(3)	-2.9512	-144.8157	-149.8157	-153.7745	-151.1975
ADF(4)	-2.7550	-144.7766	-150.7766	-155.5272	-152.4347

****
95% critical value for the augmented Dickey-Fuller statistic = **-2.9446**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **VAR8**
The Dickey-Fuller regressions include an intercept and a linear trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-1.7304**	-149.2683	-152.2683	-154.6436	-153.0974
ADF(1)	-1.8384	-148.8364	-152.8364	-156.0034	-153.9418
ADF(2)	-2.5374	-145.3712	-150.3712	-154.3300	-151.7529
ADF(3)	-2.8274	-144.5144	-150.5144	-155.2650	-152.1725
ADF(4)	-2.6093	-144.4910	-151.4910	-157.0333	-153.4254

****
95% critical value for the augmented Dickey-Fuller statistic = **-3.5386**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **VAR8D**
The Dickey-Fuller regressions include an intercept but not a trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-4.9405**	-151.6449	-153.6449	-155.2284	-154.1976
ADF(1)	-2.5766	-149.2818	-152.2818	-154.6570	-153.1108
ADF(2)	-2.2740	-149.2714	-153.2714	-156.4384	-154.3768
ADF(3)	-2.4273	-148.8349	-153.8349	-157.7937	-155.2166
ADF(4)	-2.4990	-148.5071	-154.5071	-159.2577	-156.1652

****

95% critical value for the augmented Dickey-Fuller statistic = **-2.9446**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable **VAR8D**
The Dickey-Fuller regressions include an intercept and a linear trend
****
36 observations used in the estimation of all ADF regressions.
Sample period from 1996Q2 to 2005Q1
****

	Test Statistic	LL	AIC	SBC	HQC
DF	**-5.1897**	-150.6439	-153.6439	-156.0192	-154.4730
ADF(1)	-2.7481	-148.7670	-152.7670	-155.9341	-153.8724
ADF(2)	-2.4551	-148.7657	-153.7657	-157.7245	-155.1475
ADF(3)	-2.6073	-148.2861	-154.2861	-159.0367	-155.9442
ADF(4)	-2.6805	-147.9179	-154.9179	-160.4602	-156.8523

****

95% critical value for the augmented Dickey-Fuller statistic = **-3.5386**
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Appendix III: **Comparison of Individual Export Demand Models**

ARIZE, VAR5

Ordinary Least Squares Estimation
****
Dependent variable is LNXR
41 observations used for estimation from 1995Q1 to 2005Q1
****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CON	-11.4726	.49310	-23.2662[.000]
LNGDPR	3.8917	.32026	12.1518[.000]
LNREER	-.41075	.28142	-1.4595[.153]
VAR5	.8767E-4	.1075E-3	.81564[.420]

****

R-Squared	.96646	R-Bar-Squared	.96375
S.E. of Regression	.070020	F-stat.	**F(3, 37) 355.4348[.000]**
Mean of Dependent Variable	4.4824	S.D. of Dependent Variable	.36774
Residual Sum of Squares	.18141	Equation Log-likelihood	52.9456
Akaike Info. Criterion	48.9456	Schwarz Bayesian Criterion	45.5185
DW-statistic	1.0984		

****

Diagnostic Tests

```
*******************************************************************************
*   Test Statistics  *       LM Version        *        F Version         *
*******************************************************************************
*                *                      *                        *
* A:Serial Correlation*CHSQ(   4)=  15.0724[.005]*F(   4,  33)=   4.7960[.004]*
*                *                      *                        *
* B:Functional Form   *CHSQ(   1)=   2.4793[.115]*F(   1,  36)=   2.3170[.137]*
*                *                      *                        *
* C:Normality         *CHSQ(   2)=   1.4964[.473]*      Not applicable       *
*                *                      *                        *
* D:Heteroscedasticity*CHSQ(   1)=  .017521[.895]*F(   1,  39)=  .016674[.898]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

ARIZE, VAR8

Ordinary Least Squares Estimation

```
*******************************************************************************
 Dependent variable is LNXR
 41 observations used for estimation from 1995Q1 to 2005Q1
*******************************************************************************
```

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CON	-11.4189	.49598	-23.0227[.000]
LNGDPR	3.8190	.31108	12.2764[.000]
LNREER	-.34971	.27219	-1.2848[.207]
VAR8	.1422E-3	.2814E-3	.50548[.616]

R-Squared	.96610	R-Bar-Squared	.96335
S.E. of Regression	.070404	F-stat.	**F(3, 37) 351.4338[.000]**
Mean of Dependent Variable	4.4824	S.D. of Dependent Variable	.36774
Residual Sum of Squares	.18340	Equation Log-likelihood	52.7214
Akaike Info. Criterion	48.7214	Schwarz Bayesian Criterion	45.2942
DW-statistic	1.0933		

Diagnostic Tests

```
*******************************************************************************
*   Test Statistics  *       LM Version        *        F Version         *
*******************************************************************************
*                *                      *                        *
* A:Serial Correlation*CHSQ(   4)=  15.2283[.004]*F(   4,  33)=   4.8749[.003]*
*                *                      *                        *
* B:Functional Form   *CHSQ(   1)=   3.3163[.069]*F(   1,  36)=   3.1681[.084]*
*                *                      *                        *
* C:Normality         *CHSQ(   2)=   1.5323[.465]*      Not applicable       *
*                *                      *                        *
* D:Heteroscedasticity*CHSQ(   1)= .0026416[.959]*F(   1,  39)= .0025129[.960]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

ARIZE + GDPR(-1), VAR5

```
                         Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LNXR
 40 observations used for estimation from 1995Q2 to 2005Q1
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CON                     -11.4982            .50344             -22.8391[.000]
 LNGDPR                    2.6750            .71089               3.7629[.001]
 LNGDPR(-1)                1.4118            .74558               1.8936[.067]
 LNREER                   -.59661            .29213              -2.0423[.049]
 VAR5                    .1182E-3           .1088E-3              1.0864[.285]
*******************************************************************************
 R-Squared                     .96718    R-Bar-Squared                   .96343
 S.E. of Regression            .068470   F-stat.             F(  4,  35)  257.8503[.000]
 Mean of Dependent Variable    4.4983    S.D. of Dependent Variable      .35804
 Residual Sum of Squares       .16408    Equation Log-likelihood         53.1677
 Akaike Info. Criterion        48.1677   Schwarz Bayesian Criterion      43.9455
 DW-statistic                  1.2613
*******************************************************************************

                                 Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version          *
*******************************************************************************
*                     *                          *                            *
* A:Serial Correlation*CHSQ(   4)=   9.4819[.050]*F(   4,  31)=   2.4079[.071]*
*                     *                          *                            *
* B:Functional Form   *CHSQ(   1)=   1.4954[.221]*F(   1,  34)=   1.3205[.259]*
*                     *                          *                            *
* C:Normality         *CHSQ(   2)=   2.2263[.329]*       Not applicable       *
*                     *                          *                            *
* D:Heteroscedasticity*CHSQ(   1)=  .083977[.772]*F(   1,  38)=  .079946[.779]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

ARIZE + GDPR(-1), VAR8

```
                         Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LNXR
 40 observations used for estimation from 1995Q2 to 2005Q1
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CON                     -11.4049            .50342             -22.6548[.000]
 LNGDPR                    2.6266            .72503               3.6228[.001]
 LNGDPR(-1)                1.3526            .74907               1.8057[.080]
 LNREER                   -.50967            .28068              -1.8159[.078]
 VAR8                    .2085E-3           .2814E-3              .74115[.464]
*******************************************************************************
 R-Squared                     .96660    R-Bar-Squared                   .96278
 S.E. of Regression            .069074   F-stat.             F(  4,  35)  253.2013[.000]
 Mean of Dependent Variable    4.4983    S.D. of Dependent Variable      .35804
 Residual Sum of Squares       .16699    Equation Log-likelihood         52.8159
 Akaike Info. Criterion        47.8159   Schwarz Bayesian Criterion      43.5937
```

```
 DW-statistic                    1.2380
*******************************************************************************


                           Diagnostic Tests
*******************************************************************************
*   Test Statistics  *        LM Version        *       F Version         *
*******************************************************************************
*                    *                          *                         *
* A:Serial Correlation*CHSQ(   4)=   9.4037[.052]*F(   4,  31)=   2.3820[.073]*
*                    *                          *                         *
* B:Functional Form   *CHSQ(   1)=   2.2714[.132]*F(   1,  34)=   2.0470[.162]*
*                    *                          *                         *
* C:Normality         *CHSQ(   2)=   2.2293[.328]*       Not applicable       *
*                    *                          *                         *
* D:Heteroscedasticity*CHSQ(   1)=   .11208[.738]*F(   1,  38)=   .10678[.746]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

ARIZE + GDPR(-1) + DV, VAR5

```
                      Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LNXR
 40 observations used for estimation from 1995Q2 to 2005Q1
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CON                      -11.6503            .47799             -24.3737[.000]
 LNGDPR                     2.7008            .66884               4.0380[.000]
 LNGDPR(-1)                 1.4780            .70195               2.1055[.043]
 LNREER                    -.65497            .27593              -2.3737[.023]
 VAR5                      .9694E-4           .1028E-3              .94337[.352]
 DV2Q98                     .15673            .066532              2.3557[.024]
*******************************************************************************
 R-Squared                      .97178   R-Bar-Squared                   .96764
 S.E. of Regression             .064411  F-stat.                    F(  5,  34)  234.2019[.000]
 Mean of Dependent Variable     4.4983   S.D. of Dependent Variable     .35804
 Residual Sum of Squares        .14106   Equation Log-likelihood        56.1914
 Akaike Info. Criterion         50.1914  Schwarz Bayesian Criterion     45.1248
 DW-statistic                   1.6397
*******************************************************************************


                           Diagnostic Tests
*******************************************************************************
*   Test Statistics  *        LM Version        *       F Version         *
*******************************************************************************
*                    *                          *                         *
* A:Serial Correlation*CHSQ(   4)=   2.4793[.648]*F(   4,  30)=   .49559[.739]*
*                    *                          *                         *
* B:Functional Form   *CHSQ(   1)=   1.4047[.236]*F(   1,  33)=   1.2010[.281]*
*                    *                          *                         *
* C:Normality         *CHSQ(   2)=   1.9806[.371]*       Not applicable       *
*                    *                          *                         *
* D:Heteroscedasticity*CHSQ(   1)=  .041552[.838]*F(   1,  38)=  .039515[.843]*
```

```
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

ARIZE + GDPR(-1) + DV, VAR8

```
                    Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LNXR
 40 observations used for estimation from 1995Q2 to 2005Q1
*******************************************************************************
 Regressor          Coefficient     Standard Error       T-Ratio[Prob]
 CON                 -11.5776            .47891            -24.1749[.000]
 LNGDPR                2.6695            .68191              3.9148[.000]
 LNGDPR(-1)            1.4220            .70488              2.0174[.052]
 LNREER               -.58355            .26573             -2.1960[.035]
 VAR8                 .1505E-3          .2657E-3             .56640[.575]
 DV2Q98                .15873           .067109              2.3653[.024]
*******************************************************************************
 R-Squared                     .97132   R-Bar-Squared               .96710
 S.E. of Regression            .064943  F-stat.                     F(  5,  34)  230.2705[.000]
 Mean of Dependent Variable    4.4983   S.D. of Dependent Variable  .35804
 Residual Sum of Squares       .14340   Equation Log-likelihood     55.8625
 Akaike Info. Criterion        49.8625  Schwarz Bayesian Criterion  44.7958
 DW-statistic                  1.6042
*******************************************************************************

                           Diagnostic Tests
*******************************************************************************
*   Test Statistics  *       LM Version        *        F Version         *
*******************************************************************************
*                    *                         *                          *
* A:Serial Correlation*CHSQ(   4)=   2.9649[.564]*F(   4,  30)=   .60042[.665]*
*                    *                         *                          *
* B:Functional Form   *CHSQ(   1)=   2.2470[.134]*F(   1,  33)=   1.9641[.170]*
*                    *                         *                          *
* C:Normality         *CHSQ(   2)=   1.9262[.382]*      Not applicable      *
*                    *                         *                          *
* D:Heteroscedasticity*CHSQ(   1)=  .018330[.892]*F(   1,  38)=  .017422[.896]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

```
                    Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LNXR
 40 observations used for estimation from 1995Q2 to 2005Q1
*******************************************************************************
 Regressor          Coefficient     Standard Error       T-Ratio[Prob]
 CON                 -11.4049            .50342            -22.6548[.000]
 LNGDPR                2.6266            .72503              3.6228[.001]
 LNGDPR(-1)            1.3526            .74907              1.8057[.080]
```

LNREER	-.50967	.28068	-1.8159[.078]
VAR8	.2085E-3	.2814E-3	.74115[.464]

****

R-Squared	.96660	R-Bar-Squared	.96278
S.E. of Regression	.069074	F-stat.	**F(4, 35) 253.2013[.000]**
Mean of Dependent Variable	4.4983	S.D. of Dependent Variable	.35804
Residual Sum of Squares	.16699	Equation Log-likelihood	52.8159
Akaike Info. Criterion	47.8159	Schwarz Bayesian Criterion	43.5937
DW-statistic	1.2380		

****

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	**CHSQ(4)= 9.4037[.052]**	F(4, 31)= 2.3820[.073]
B:Functional Form	CHSQ(1)= 2.2714[.132]	F(1, 34)= 2.0470[.162]
C:Normality	CHSQ(2)= 2.2293[.328]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .11208[.738]	F(1, 38)= .10678[.746]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Appendix IV**: Stock Adjustment Mechanism**

SAM, VAR5

Ordinary Least Squares Estimation

****

Dependent variable is LNER
40 observations used for estimation from 1995Q2 to 2005Q1

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CON	-6.0084	1.3023	-4.6138[.000]
LNER(-1)	.48152	.11005	4.3756[.000]
LNGDPR	2.4498	.42934	5.7060[.000]
LNREER	-.63888	.24244	-2.6352[.012]
LNVAR5	.015782	.012217	1.2919[.205]

****

R-Squared	.97695	R-Bar-Squared	.97432
S.E. of Regression	.057376	F-stat.	F(4, 35) 370.9160[.000]
Mean of Dependent Variable	4.4983	S.D. of Dependent Variable	.35804
Residual Sum of Squares	.11522	Equation Log-likelihood	60.2385
Akaike Info. Criterion	55.2385	Schwarz Bayesian Criterion	51.0163
DW-statistic	2.2981	Durbin's h-statistic	-1.3129[.189]

****

Diagnostic Tests

****
* Test Statistics * LM Version * F Version *
****
* * * *
*** A:Serial Correlation*CHSQ(4)= 8.3953[.078]***F(4, 31)= 2.0587[.110]*
* * * *
* B:Functional Form *CHSQ(1)= .092459[.761]*F(1, 34)= .078772[.781]*
* * * *
* C:Normality *CHSQ(2)= .14733[.929]* Not applicable *
* * * *
* D:Heteroscedasticity*CHSQ(1)= .67551[.411]*F(1, 38)= .65276[.424]*
****

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

SAM, VAR8

Ordinary Least Squares Estimation

****

Dependent variable is LNER
40 observations used for estimation from 1995Q2 to 2005Q1

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CON	-5.9056	1.3129	-4.4981[.000]
LNER(-1)	.48203	.11078	4.3513[.000]
LNGDPR	2.3370	.42454	5.5047[.000]
LNREER	-.54615	.22790	-2.3965[.022]
LNVAR8	.014261	.013082	1.0902[.283]

****

R-Squared	.97665	R-Bar-Squared	.97398
S.E. of Regression	.057755	F-stat.	F(4, 35) 365.9410[.000]
Mean of Dependent Variable	4.4983	S.D. of Dependent Variable	.35804
Residual Sum of Squares	.11675	Equation Log-likelihood	59.9747
Akaike Info. Criterion	54.9747	Schwarz Bayesian Criterion	50.7525
DW-statistic	2.3117	Durbin's h-statistic	-1.3813[.167]

****

Diagnostic Tests

****
* Test Statistics * LM Version * F Version *
****
* * * *
*** A:Serial Correlation*CHSQ(4)= 8.9308[.063]***F(4, 31)= 2.2277[.089]*
* * * *
* B:Functional Form *CHSQ(1)= .30891[.578]*F(1, 34)= .26462[.610]*
* * * *
* C:Normality *CHSQ(2)= .16994[.919]* Not applicable *
* * * *
* D:Heteroscedasticity*CHSQ(1)= .64425[.422]*F(1, 38)= .62206[.435]*
****

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Appendix V: **Engle – Granger Cointegration Test**

ARIZE, VAR5

```
                         Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is RES5
 39 observations used for estimation from 1995Q3 to 2005Q1
*******************************************************************************
 Regressor          Coefficient      Standard Error        T-Ratio[Prob]
 RES5(-1)              .45178            .14642              3.0856[.004]
*******************************************************************************
 R-Squared                        .20035    R-Bar-Squared                .20035
 S.E. of Regression              .061692    F-stat.                     *NONE*
 Mean of Dependent Variable   -.1427E-3     S.D. of Dependent Variable  .068989
 Residual Sum of Squares          .14463    Equation Log-likelihood     53.8062
 Akaike Info. Criterion          52.8062    Schwarz Bayesian Criterion  51.9744
 DW-statistic                     1.6580    Durbin's h-statistic        2.6372[.008]
*******************************************************************************

                              Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *          F Version          *
*******************************************************************************
*                     *                          *                             *
* A:Serial Correlation*CHSQ(   4)=  16.0687[.003]*F(   4,  34)=   5.9563[.001]*
*                     *                          *                             *
* B:Functional Form   *CHSQ(   1)=   .11245[.737]*F(   1,  37)=   .10699[.745]*
*                     *                          *                             *
* C:Normality         *CHSQ(   2)=   .57405[.750]*       Not applicable        *
*                     *                          *                             *
* D:Heteroscedasticity*CHSQ(   1)=   1.2100[.271]*F(   1,  37)=   1.1847[.283]*
*******************************************************************************
  A:Lagrange multiplier test of residual serial correlation
  B:Ramsey's RESET test using the square of the fitted values
  C:Based on a test of skewness and kurtosis of residuals
  D:Based on the regression of squared residuals on squared fitted values
```

ARIZE, VAR8

```
                         Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is RES8
 39 observations used for estimation from 1995Q3 to 2005Q1
*******************************************************************************
 Regressor          Coefficient      Standard Error        T-Ratio[Prob]
 RES8(-1)              .45407            .14607              3.1087[.004]
*******************************************************************************
 R-Squared                     .20275    R-Bar-Squared                .20275
 S.E. of Regression           .061887    F-stat.                     *NONE*
 Mean of Dependent Variable  .9270E-     S.D. of Dependent Variable  .069311
 Residual Sum of Squares       .14554    Equation Log-likelihood     53.6834
 Akaike Info. Criterion       52.6834    Schwarz Bayesian Criterion  51.8517
```

```
 DW-statistic                  1.6681     Durbin's h-statistic          2.5293[.011]
*******************************************************************************

                                Diagnostic Tests
*******************************************************************************
*   Test Statistics  *       LM Version        *        F Version          *
*******************************************************************************
*                    *                         *                           *
* A:Serial Correlation*CHSQ(   4)=  14.9282[.005]*F(   4,  34)=   5.2713[.002]*
*                    *                         *                           *
* B:Functional Form   *CHSQ(   1)=  .099451[.752]*F(   1,  37)=  .094592[.760]*
*                    *                         *                           *
* C:Normality         *CHSQ(   2)=   .59194[.744]*      Not applicable       *
*                    *                         *                           *
* D:Heteroscedasticity*CHSQ(   1)=   1.1570[.282]*F(   1,  37)=   1.1312[.294]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

ARIZE + GDPR(-1), VAR5

```
                         Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is RES5LAG
 39 observations used for estimation from 1995Q3 to 2005Q1
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 RES5LAG(-1)               .36737              .15065              2.4385[.020]
*******************************************************************************
 R-Squared                       .13523     R-Bar-Squared                   .13523
 S.E. of Regression             .060992     F-stat.                         *NONE*
 Mean of Dependent Variable   -.6296E-3     S.D. of Dependent Variable     .065587
 Residual Sum of Squares         .14136     Equation Log-likelihood        54.2517
 Akaike Info. Criterion         53.2517     Schwarz Bayesian Criterion     52.4199
 DW-statistic                    1.9556     Durbin's h-statistic      .40916[.682]
*******************************************************************************

                                Diagnostic Tests
*******************************************************************************
*   Test Statistics  *       LM Version        *        F Version          *
*******************************************************************************
*                    *                         *                           *
* A:Serial Correlation*CHSQ(   4)=   9.1651[.057]*F(   4,  34)=   2.6111[.053]*
*                    *                         *                           *
* B:Functional Form   *CHSQ(   1)= .1609E-3[.990]*F(   1,  37)= .1526E-3[.990]*
*                    *                         *                           *
* C:Normality         *CHSQ(   2)=   .51207[.774]*      Not applicable       *
*                    *                         *                           *
* D:Heteroscedasticity*CHSQ(   1)=   .10287[.748]*F(   1,  37)=  .097856[.756]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

ARIZE + GDPR(-1), VAR8

```
                          Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is RES8LAG
 39 observations used for estimation from 1995Q3 to 2005Q1
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 RES8LAG(-1)              .38017              .14998              2.5347[.015]
*******************************************************************************
 R-Squared                      .14459    R-Bar-Squared                .14459
 S.E. of Regression            .061265    F-stat.                      *NONE*
 Mean of Dependent Variable  -.4071E-3    S.D. of Dependent Variable  .066240
 Residual Sum of Squares        .14263    Equation Log-likelihood     54.0774
 Akaike Info. Criterion        53.0774    Schwarz Bayesian Criterion  52.2456
 DW-statistic                   1.9535    Durbin's h-statistic      .41460[.678]
*******************************************************************************

                               Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version         *
*******************************************************************************
*                     *                          *                           *
* A:Serial Correlation*CHSQ(   4)=  10.8970[.028]*F(   4,  34)=   3.2959[.022]*
*                     *                          *                           *
* B:Functional Form   *CHSQ(   1)= .0036752[.952]*F(   1,  37)= .0034870[.953]*
*                     *                          *                           *
* C:Normality         *CHSQ(   2)=   .57524[.750]*       Not applicable      *
*                     *                          *                           *
* D:Heteroscedasticity*CHSQ(   1)=   .11202[.738]*F(   1,  37)=   .10658[.746]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

Appendix VI: **Error Correction Model (Engle – Granger)**

ARIZE, VAR5

```
                          Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LNERD
 39 observations used for estimation from 1995Q3 to 2005Q1
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CON                     .011371             .012628              .90043[.374]
 LNGDPRD                  2.4351              .71511              3.4052[.002]
 LNREERD                 -.33800              .42229             -.80039[.429]
 VAR5D                   .9796E-4            .1987E-3             .49310[.625]
 RES5(-1)                -.53663              .16702             -3.2129[.003]
*******************************************************************************
 R-Squared                      .42558    R-Bar-Squared                .35801
```

```
 S.E. of Regression              .061650    F-stat.                   F( 4, 34)   6.2977[.001]
 Mean of Dependent Variable  .028308    S.D. of Dependent Variable  .076943
 Residual Sum of Squares       .12922     Equation Log-likelihood     56.0019
 Akaike Info. Criterion          51.0019   Schwarz Bayesian Criterion   46.8430
 DW-statistic                     2.0921
*******************************************************************************

                               Diagnostic Tests
*******************************************************************************
*    Test Statistics  *       LM Version        *         F Version         *
*******************************************************************************
*                   *                        *                          *
* A:Serial Correlation*CHSQ(   4)=   7.0967[.131]*F(   4,  30)=   1.6683[.183]*
*                   *                        *                          *
* B:Functional Form   *CHSQ(   1)=   5.1674[.023]*F(   1,  33)=   5.0402[.032]*
*                   *                        *                          *
* C:Normality         *CHSQ(   2)=   .42801[.807]*      Not applicable       *
*                   *                        *                          *
* D:Heteroscedasticity*CHSQ(   1)= .3763E-4[.995]*F(   1,  37)= .3570E-4[.995]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

ARIZE, VAR8

```
                        Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LNERD
 39 observations used for estimation from 1995Q3 to 2005Q1
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CON                      .011508            .012616              .91217[.368]
 LNGDPRD                   2.4399             .71546               3.4102[.002]
 LNREERD                  -.34818             .42102              -.82699[.414]
 VAR5D                    .8022E-4           .1970E-3              .40717[.686]
 RES8(-1)                 -.52953             .16478              -3.2135[.003]
*******************************************************************************
 R-Squared                       .42563     R-Bar-Squared                .35806
 S.E. of Regression              .061647    F-stat.                   F( 4, 34)   6.2989[.001]
 Mean of Dependent Variable  .028308    S.D. of Dependent Variable  .076943
 Residual Sum of Squares       .12921     Equation Log-likelihood     56.0036
 Akaike Info. Criterion          51.0036   Schwarz Bayesian Criterion   46.8447
 DW-statistic                     2.0916
*******************************************************************************

                               Diagnostic Tests
*******************************************************************************
*    Test Statistics  *       LM Version        *         F Version         *
*******************************************************************************
*                   *                        *                          *
* A:Serial Correlation*CHSQ(   4)=   7.1487[.128]*F(   4,  30)=   1.6833[.180]*
*                   *                        *                          *
* B:Functional Form   *CHSQ(   1)=   5.2778[.022]*F(   1,  33)=   5.1648[.030]*
*                   *                        *                          *
* C:Normality         *CHSQ(   2)=   .47091[.790]*      Not applicable       *
```

```
*                *                    *                    *
* D:Heteroscedasticity*CHSQ(   1)=  .014933[.903]*F(   1,  37)=  .014172[.906]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

ARIZE + GDPR(-1), VAR5

```
                         Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LNERD
 39 observations used for estimation from 1995Q3 to 2005Q1
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CON                      .031769            .014096              2.2538[.031]
 LNGDPRD                   1.5442             .68147              2.2659[.030]
 LGDPRDL                  -1.3892             .67296             -2.0643[.047]
 LNREERD                  -.32797             .36154             -.90715[.371]
 VAR5D                    .8347E-4           .1764E-3             .47307[.639]
 RES5LAG(-1)              -.66223             .14835             -4.4639[.000]
*******************************************************************************
 R-Squared                     .58572   R-Bar-Squared                   .52295
 S.E. of Regression            .053143  F-stat.    F(  5,  33)    9.3314[.000]
 Mean of Dependent Variable    .028308  S.D. of Dependent Variable      .076943
 Residual Sum of Squares       .093198  Equation Log-likelihood         62.3749
 Akaike Info. Criterion        56.3749  Schwarz Bayesian Criterion      51.3842
 DW-statistic                  1.4059
*******************************************************************************

                                 Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version         *           F Version          *
*******************************************************************************
*                *                    *                    *
* A:Serial Correlation*CHSQ(   4)=  13.0072[.011]*F(   4,  29)=   3.6280[.016]*
*                *                    *                    *
* B:Functional Form   *CHSQ(   1)=   2.3074[.129]*F(   1,  32)=   2.0123[.166]*
*                *                    *                    *
* C:Normality         *CHSQ(   2)=   1.2573[.533]*       Not applicable        *
*                *                    *                    *
* D:Heteroscedasticity*CHSQ(   1)=   .47169[.492]*F(   1,  37)=   .45298[.505]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

ARIZE + GDPR(-1), VAR8

```
                         Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LNERD
 39 observations used for estimation from 1995Q3 to 2005Q1
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
```

CON	.031851	.014208	2.2418[.032]
LNGDPRD	1.5665	.68780	2.2776[.029]
LGDPRDL	-1.3928	.67811	-2.0539[.048]
LNREERD	-.34331	.36364	-.94407[.352]
VAR5D	.5216E-4	.1757E-3	.29682[.768]
RES8LAG(-1)	-.64119	.14660	-4.3738[.000]

****

R-Squared	.57939	R-Bar-Squared	.51566
S.E. of Regression	. 053548	F-stat.	F(5, 33) 9.0916[.000]
Mean of Dependent Variable	.028308	S.D. of Dependent Variable	.076943
Residual Sum of Squares	.094623	Equation Log-likelihood	62.0791
Akaike Info. Criterion	56.0791	Schwarz Bayesian Criterion	51.0884
DW-statistic	1.4312		

****

Diagnostic Tests

```
*******************************************************************************
*   Test Statistics  *       LM Version        *        F Version         *
*******************************************************************************
*                    *                         *                          *
* A:Serial Correlation *CHSQ(   4)=  12.7296[.013]*F(   4,  29)=   3.5131[.019]*
*                    *                         *                          *
* B:Functional Form   *CHSQ(   1)=   2.1808[.140]*F(   1,  32)=   1.8954[.178]*
*                    *                         *                          *
* C:Normality         *CHSQ(   2)=   1.3193[.517]*      Not applicable      *
*                    *                         *                          *
* D:Heteroscedasticity*CHSQ(   1)=   .54045[.462]*F(   1,  37)=   .51994[.475]*
*******************************************************************************
```

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Appendix VII**: ARDL method**

Lags: 4, VAR5

Autoregressive Distributed Lag Estimates
ARDL(2) selected based on Akaike Information Criterion

****

Dependent variable is LNER
37 observations used for estimation from 1996Q1 to 2005Q1

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LNER(-1)	.39222	.12684	3.0922[.004]
LNER(-2)	.30207	.16043	1.8828[.069]
CON	-3.8077	1.6270	-2.3404[.026]
LNGDPR	1.9271	.47627	4.0463[.000]
LNREER	-.80609	.24506	-3.2893[.003]
LNVAR5	.022212	.014056	1.5802[.124]

****

R-Squared	.97714	R-Bar-Squared	97345
S.E. of Regression	.054817	F-stat. F(5, 31)	264.9569 [.000]

Mean of Dependent Variable	4.5414	S.D. of Dependent Variable	.33640
Residual Sum of Squares	.093153	Equation Log-likelihood	58.2113
Akaike Info. Criterion	52.2113	Schwarz Bayesian Criterion	47.3785
DW-statistic	1.9195		

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)= 7.9879[.092]	F(4, 27)= 1.8585[.147]
B:Functional Form	CHSQ(1)= .055484[.814]	F(1, 30)= .045055[.833]
C:Normality	CHSQ(2)= 1.1039[.576]	Not applicable
D:Heteroscedasticity	CHSQ(1)= 1.1696[.279]	F(1, 35)= 1.1425[.292]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Lags: 4, VAR5, Long-run coefficients

Estimated Long Run Coefficients using the ARDL Approach
ARDL(2) selected based on Akaike Information Criterion

Dependent variable is LNER
37 observations used for estimation from 1996Q1 to 2005Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CON	-12.4549	1.6690	-7.4625[.000]
LNGDPR	6.3036	1.8525	3.4028[.002]
LNREER	-2.6367	1.6775	-1.5718[.126]
LNVAR5	.072655	.060155	1.2078[.236]

Lags: 4, VAR5, ECM

Error Correction Representation for the Selected ARDL Model
ARDL(2) selected based on Akaike Information Criterion

Dependent variable is dLNER
37 observations used for estimation from 1996Q1 to 2005Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dLNER1	-.30207	.16043	-1.8828[.069]
dCON	-3.8077	1.6270	-2.3404[.026]
dLNGDPR	1.9271	.47627	4.0463[.000]
dLNREER	-.80609	.24506	-3.2893[.003]
dLNVAR5	.022212	.014056	1.5802[.124]
ecm(-1)	-.30572	.14285	-2.1401[.040]

List of additional temporary variables created:
dLNER = LNER-LNER(-1)
dLNER1 = LNER(-1)-LNER(-2)

dCON = CON-CON(-1)
dLNGDPR = LNGDPR-LNGDPR(-1)
dLNREER = LNREER-LNREER(-1)
dLNVAR5 = LNVAR5-LNVAR5(-1)
ecm = LNER + 12.4549*CON -6.3036*LNGDPR + 2.6367*LNREER -.072655*LNVAR5

R-Squared	.55027	R-Bar-Squared	.47773
S.E. of Regression	.054817	F-stat. F(5, 31)	7.5860[.000]
Mean of Dependent Variable	.027297	S.D. of Dependent Variable	.075853
Residual Sum of Squares	.093153	Equation Log-likelihood	58.2113
Akaike Info. Criterion	52.2113	Schwarz Bayesian Criterion	47.3785
DW-statistic	1.9195		

R-Squared and R-Bar-Squared measures refer to the dependent variable dLNER and in cases where the error correction model is highly restricted, these measures could become negative.

Lags: 4, VAR8

Autoregressive Distributed Lag Estimates
ARDL(2) selected based on Akaike Information Criterion

Dependent variable is LNER
37 observations used for estimation from 1996Q1 to 2005Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LNER(-1)	.39072	.12908	3.0269[.005]
LNER(-2)	.28736	.16297	1.7632[.088]
CON	-3.7771	1.6554	-2.2817[.030]
LNGDPR	1.8146	.48307	3.7565[.001]
LNREER	-.67773	.23442	-2.8911[.007]
LNVAR8	.017012	.014369	1.1839[.245]

R-Squared	.97636	R-Bar-Squared	.97255
S.E. of Regression	.055736	F-stat. F(5, 31)	256.0886[.000]
Mean of Dependent Variable	4.5414	S.D. of Dependent Variable	.33640
Residual Sum of Squares	.096302	Equation Log-likelihood	57.5961
Akaike Info. Criterion	51.5961	Schwarz Bayesian Criterion	46.7634
DW-statistic	1.9215		

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)= 8.0550[.090]	F(4, 27)= 1.8784[.143]
B:Functional Form	CHSQ(1)= .0036029[.952]	F(1, 30)= .0029216[.957]
C:Normality	CHSQ(2)= 1.2631[.532]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .82611[.363]	F(1, 35)= .79930[.377]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Lags: 4, VAR5, Long-run coefficients

Estimated Long Run Coefficients using the ARDL Approach
ARDL(2) selected based on Akaike Information Criterion
****
Dependent variable is LNER
37 observations used for estimation from 1996Q1 to 2005Q1
****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CON	-11.7329	1.4193	-8.2669[.000]
LNGDPR	5.6368	1.4657	3.8457[.001]
LNREER	-2.1053	1.3619	-1.5459[.132]
LNVAR8	.052844	.051671	1.0227[.314]

****

Lags: 4, VAR8, ECM

Error Correction Representation for the Selected ARDL Model
ARDL(2) selected based on Akaike Information Criterion
****
Dependent variable is dLNER
37 observations used for estimation from 1996Q1 to 2005Q1
****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dLNER1	-.28736	.16297	-1.7632[.088]
dCON	-3.7771	1.6554	-2.2817[.030]
dLNGDPR	1.8146	.48307	3.7565[.001]
dLNREER	-.67773	.23442	-2.8911[.007]
dLNVAR8	.017012	.014369	1.1839[.245]
ecm(-1)	-.32192	.14453	-2.2274[.033]

****
List of additional temporary variables created:
dLNER = LNER-LNER(-1)
dLNER1 = LNER(-1)-LNER(-2)
dCON = CON-CON(-1)
dLNGDPR = LNGDPR-LNGDPR(-1)
dLNREER = LNREER-LNREER(-1)
dLNVAR8 = LNVAR8-LNVAR8(-1)
ecm = LNER + 11.7329*CON -5.6368*LNGDPR + 2.1053*LNREER -.052844*LNVAR8
****

R-Squared	.53506	R-Bar-Squared	.46007
S.E. of Regression	.055736	F-stat.	F(5, 31) 7.1351[.000]
Mean of Dependent Variable	.027297	S.D. of Dependent Variable	.075853
Residual Sum of Squares	.096302	Equation Log-likelihood	57.5961
Akaike Info. Criterion	51.5961	Schwarz Bayesian Criterion	46.7634
DW-statistic	1.9215		

****
R-Squared and R-Bar-Squared measures refer to the dependent variable
dLNER and in cases where the error correction model is highly
restricted, these measures could become negative.

Appendix VIII: Regressions – bilateral trade flows[79]

Germany

```
                      Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LNXGER
 29 observations used for estimation from 1999Q4 to 2006Q4
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 C                        -3.2702           8.7135            -.37530[.711]
 LNER                      .88532            .60316             1.4678[.155]
 VAREUR                  -.0019710          .8829E-3           -2.2324[.035]
 LNGDPGER                  .86743           2.4396              .35557[.725]
*******************************************************************************
 R-Squared                    .63389    R-Bar-Squared                   .58996
 S.E. of Regression          .077914    F-stat.    F(  3,  25)   14.4284[.000]
 Mean of Dependent Variable   4.6992    S.D. of Dependent Variable      .12167
 Residual Sum of Squares      .15177    Equation Log-likelihood        35.0152
 Akaike Info. Criterion      31.0152    Schwarz Bayesian Criterion     28.2806
 DW-statistic                 .96171
*******************************************************************************


                    Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version          *
*******************************************************************************
*                    *                          *                            *
* A:Serial Correlation*CHSQ(   4)=  11.5568[.021]*F(   4,  21)=   3.4783[.025]*
*                    *                          *                            *
* B:Functional Form   *CHSQ(   1)=   1.1768[.278]*F(   1,  24)=   1.0151[.324]*
*                    *                          *                            *
* C:Normality         *CHSQ(   2)=   .48028[.787]*       Not applicable       *
*                    *                          *                            *
* D:Heteroscedasticity*CHSQ(   1)= .3817E-3[.984]*F(   1,  27)= .3554E-3[.985]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

[79] Full results from Dickey-Fuller and Augmented Dickey-Fuller test for individual bilateral export demand models can be found at jurecka.webz.cz.

France

```
                 Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LNXFRA
 29 observations used for estimation from 1999Q4 to 2006Q4
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 C                       -26.8809            3.9967            -6.7257[.000]
 LNER                     1.1213             .60145             1.8644[.074]
 VAREUR                  -.0014928          .6827E-3           -2.1865[.038]
 LNGDPFRA                 5.7521             1.4127             4.0717[.000]
*******************************************************************************
 R-Squared                    .94057   R-Bar-Squared                   .93344
 S.E. of Regression           .073094   F-stat.    F(  3,  25)  131.8913[.000]
 Mean of Dependent Variable   4.9466   S.D. of Dependent Variable      .28332
 Residual Sum of Squares      .13357   Equation Log-likelihood        36.8671
 Akaike Info. Criterion      32.8671   Schwarz Bayesian Criterion     30.1325
 DW-statistic                 2.2660
*******************************************************************************


                           Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version          *
*******************************************************************************
*                     *                          *                            *
* A:Serial Correlation*CHSQ(   4)=   6.6327[.157]*F(   4,  21)=   1.5568[.223]*
*                     *                          *                            *
* B:Functional Form   *CHSQ(   1)=   3.1387[.076]*F(   1,  24)=   2.9128[.101]*
*                     *                          *                            *
* C:Normality         *CHSQ(   2)=   1.4984[.473]*       Not applicable       *
*                     *                          *                            *
* D:Heteroscedasticity*CHSQ(   1)=   1.4149[.234]*F(   1,  27)=   1.3849[.250]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

Italy

```
                 Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LNXITA
 29 observations used for estimation from 1999Q4 to 2006Q4
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 C                       -36.0123            13.8427           -2.6015[.015]
 LNER                     1.1808             .86135             1.3708[.183]
 VAREUR                  -.0017633          .0011095           -1.5893[.125]
 LNGDPITA                 7.6782             3.7705             2.0364[.052]
*******************************************************************************
 R-Squared                    .77389   R-Bar-Squared                   .74676
 S.E. of Regression           .12960   F-stat.    F(  3,  25)   28.5216[.000]
 Mean of Dependent Variable   4.9036   S.D. of Dependent Variable      .25754
 Residual Sum of Squares      .41993   Equation Log-likelihood        20.2576
 Akaike Info. Criterion      16.2576   Schwarz Bayesian Criterion     13.5230
 DW-statistic                 1.7770
```

****

Diagnostic Tests

****

* Test Statistics *	LM Version *	F Version *
* A:Serial Correlation	*CHSQ(4)= 14.6537[.005]	*F(4, 21)= 5.3625[.004]*
* B:Functional Form	*CHSQ(1)= .044494[.833]	*F(1, 24)= .036879[.849]*
* C:Normality	*CHSQ(2)= 3.4578[.177]	* Not applicable *
* D:Heteroscedasticity	*CHSQ(1)= .080349[.777]	*F(1, 27)= .075016[.786]*

****

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Spain

Ordinary Least Squares Estimation

****

Dependent variable is LNXESP
29 observations used for estimation from 1999Q4 to 2006Q4

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
C	-18.6263	1.4591	-12.7657[.000]
LNER	-.39016	.93996	-.41508[.682]
VAREUR	.8321E-4	.9989E-3	.083300[.934]
LNGDPESP	5.4329	1.0475	5.1865[.000]

****

R-Squared	.91975	R-Bar-Squared	.91012
S.E. of Regression	.10825	F-stat. F(3, 25)	95.5051[.000]
Mean of Dependent Variable	5.0594	S.D. of Dependent Variable	.36107
Residual Sum of Squares	.29296	Equation Log-likelihood	25.4784
Akaike Info. Criterion	21.4784	Schwarz Bayesian Criterion	18.7438
DW-statistic	2.1988		

****

Diagnostic Tests

****

* Test Statistics *	LM Version *	F Version *
* A:Serial Correlation	*CHSQ(4)= 11.8546[.018]	*F(4, 21)= 3.6299[.021]*
* B:Functional Form	*CHSQ(1)= 2.1179[.146]	*F(1, 24)= 1.8909[.182]*
* C:Normality	*CHSQ(2)= .90988[.634]	* Not applicable *
* D:Heteroscedasticity	*CHSQ(1)= 3.9869[.046]	*F(1, 27)= 4.3036[.048]*

****

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals

D:Based on the regression of squared residuals on squared fitted values

Nederlands

Ordinary Least Squares Estimation

****

Dependent variable is LNXNED
29 observations used for estimation from 1999Q4 to 2006Q4

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
C	-32.0039	5.8653	-5.4565[.000]
LNER	-.71768	.88265	-.81310[.424]
VAREUR	-.2343E-3	.0010019	-.23386[.817]
LNGDPNED	8.6850	2.0732	4.1892[.000]

****

R-Squared	.84511	R-Bar-Squared	.82653
S.E. of Regression	.10727	F-stat. F(3, 25)	45.4692[.000]
Mean of Dependent Variable	4.9036	S.D. of Dependent Variable	.25754
Residual Sum of Squares	.28766	Equation Log-likelihood	25.7434
Akaike Info. Criterion	21.7434	Schwarz Bayesian Criterion	19.0088
DW-statistic	2.3378		

****

Diagnostic Tests

****

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)= 22.0122[.000]	F(4, 21)= 16.5381[.000]
B:Functional Form	CHSQ(1)= .49105[.483]	F(1, 24)= .41338[.526]
C:Normality	CHSQ(2)= 2.5122[.285]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .35464[.551]	F(1, 27)= .33427[.568]

****

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Slovakia

Ordinary Least Squares Estimation

****

Dependent variable is LNXSVK
29 observations used for estimation from 1999Q4 to 2006Q4

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
C	-2.2302	1.6067	-1.3880[.177]
LNER	-.30860	.40348	-.76484[.452]
VARSKK	-.7938E-3	.4230E-3	-1.8766[.072]
LNGDPSVK	1.8177	.18786	9.6758[.000]

****

R-Squared	.87990	R-Bar-Squared	.86549
S.E. of Regression	.086442	F-stat. F(3, 25)	61.0520[.000]

```
 Mean of Dependent Variable    4.8591   S.D. of Dependent Variable      .23569
 Residual Sum of Squares       .18680   Equation Log-likelihood        32.0032
 Akaike Info. Criterion       28.0032   Schwarz Bayesian Criterion     25.2686
 DW-statistic                  1.3791
*******************************************************************************


                           Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version          *
*******************************************************************************
*                     *                          *                            *
* A:Serial Correlation*CHSQ(   4)=   7.4971[.112]*F(   4,  21)=   1.8304[.161]*
*                     *                          *                            *
* B:Functional Form   *CHSQ(   1)=  .021052[.885]*F(   1,  24)=  .017435[.896]*
*                     *                          *                            *
* C:Normality         *CHSQ(   2)=   .75298[.686]*       Not applicable       *
*                     *                          *                            *
* D:Heteroscedasticity*CHSQ(   1)=   1.4588[.227]*F(   1,  27)=   1.4302[.242]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```