

Impact of the real exchange rate on Czech trade

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Abstract. Since the beginning of the transformation process in 1990, the Czech crown has operated in several different exchange rate regimes. The Czech currency appreciated in real terms in all of the regimes. The cause was higher inflation in the Czech economy compared to inflation rates in the trading partners' economies during the periods of the fixed regimes. Later on, the main cause was in nominal appreciation of the crown. It is surprising that in the meantime Czech exports were increasing enormously (in absolute terms as well as percentage of GDP). The goal of the article will be to analyse and explain the seemingly positive impact of real exchange rate on the development of Czech foreign trade. The cointegrating (long-run) relations are estimated using Johansen's multivariate procedure. Estimates of the short-run dynamics are obtained using the error-correction techniques.

Keywords: real exchange rate, foreign trade, Czech economy

JEL Classification: F31, C22

AMS Classification: 91B84

1 Introduction

The development of the Czech economy since the end of the centrally planned period is full of interesting aspects. We would like to concentrate on changes in the real exchange rate and Czech international trade (exports). These two highly important measures of any economy developed against economic intuition in the Czech case. The real exchange was appreciating continuously for nearly the whole period. We would expect that this appreciation should be negative to the growth of Czech exports. The economy opened and from a highly closed economy became a highly open one. Both sides of the trade – exports as well as imports increased in absolute as well as in relative terms. Strong growth of exports is development that we would not expect from the strong appreciation of the real exchange rate. The goal of the article is to explain the seemingly positive impact of real exchange rate on the development of Czech foreign trade.

2 Development of the real exchange rate and trade

Development of the real exchange rate was highly interesting during the whole period. For different reasons the real exchange rate appreciated since 1991. We can see two main periods of development of the nominal exchange rate. The first period of fixed exchange rate lasted till 1997 and it was followed by the second period of (nearly) clean floating. Reasons for real appreciation of the exchange rate were different but the currency appreciated in real terms for the whole period.

Period of fixed exchange rate

The exchange rate system was highly distorted during the communist reign as well as other aspects of the functioning of the economy. Foremost, there was a system of multiple exchange rates. Czechoslovak production was not able to assert itself on the international (western) markets because of the poor quality of production. The multiple exchange rates were used to maximize chances to get hard (convertible) currencies into the country. There was an additional system of surcharges with the same intention (Jirges and Plchová [6]). Winiecki [11] shows that the official exchange rate was far from the unofficial exchange rate on the black market. This situation changed already in the first year of the transformation – in 1990. The government realized that the nominal exchange rate was crucial for the whole transformation process. Several important decisions were made. It was decided to unify the system of multiple exchange rates first of all. At the same time, there were three large devaluations during the year and the crown lost 100 % in total against the dollar. The government decided that the crown should be functioning in the fix exchange rate regime. And it was decided that the exchange rate was to be fixed to a basket of five currencies. The exchange rate was supposed to be an anchor of the whole system – one stable value in the volatile transformation environment. It meant at the same time that the setting of the exchange

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rate was a highly difficult task – Klaus says that it was the most difficult decision in the whole transformation process. The crown was, at the end of 1990 (after the devaluations), undervalued. It created something that was termed as the first transformation cushion or pillow. Generally, it was a temporary help for Czechoslovak exporters. But it was only temporary precisely because of the following real appreciation of the crown. From the beginning of the year 1991 the crown became internally convertible – as a consequence transactions on the current account were allowed without any restrictions. It had straight consequences for the development of Czechoslovak trade, which we will mention later.

The above mentioned points were crucial changes of the exchange rate system that took place at the beginning of the transformation process. Later on, it was decided to apply a small fluctuation zone $\pm 0.5\%$ and the basket was reduced to just two currencies – the dollar and the D-mark in 1993. In 1996, the fluctuation zone was widened to $\pm 7.5\%$. This regime ended abruptly with currency crisis in May of 1997 – we will describe it in the following subsection. What happened meanwhile with the real exchange rate? The very first step in the form of devaluation of the nominal exchange rate led obviously to depreciation of the real exchange rate as well. But since the beginning of 1991 the nominal exchange rate was de facto fixed. At the same time, the price level in Czechoslovakia and later on in the Czech Republic highly increased in comparison to the main trading partners because of price liberalization, following price deregulations, relatively high inflation expectations and the tax reform. All of these steps led to a relatively high inflation that meant continuous strengthening of the real exchange rate. Frait and Kotlán [4] show that both Hungary and Poland devaluated their currencies and used crawling pegs in some periods during the 1990s. As a consequence, their real exchange rates did not appreciate as much as in the Czech Republic.

Period of floating exchange rate

The Czechoslovak economy suffered from currency crisis in the spring of 1997. The central bank tried to defend the fix exchange rate and sell 3 billion dollars from its reserves on it but it had to abandon its efforts in the end. Consequently, it changed its main policy from the fixed exchange rate regime to inflation targeting. Meanwhile, the exchange rate was altered to managed floating. In reality, the central bank intervened only rarely in the following years. It means that the system was close to clean floating. The Czech exchange rate followed the path of continuous nominal appreciation in the following years. At the same time, the central bank was able to decrease the inflation level in the country after applying inflation targeting. Inflation declined to levels comparable to levels in the European Union or even lower after the turn of the century. The consequence was that the process of real appreciation continued but the main cause was different. The engine of the appreciation was the nominal appreciation of the crown instead of increasing of the price level as it had happened in the first transformation decade. To sum it up, the real exchange rate was first of all in 1990 depreciated with deep nominal depreciation of the crown. But then the process of real appreciation was permanent. There was only difference in the main cause of this process. The cause changed from growth of price level to appreciation in the nominal exchange rate after the currency crisis in 1997. The overall development of the real exchange rate after 1994 can be seen in the Figure 1. We should notice the continuous growing trend for the entire period.

3 Development of the international trade (exports)

What happened meanwhile with Czech trade? We could expect that strong and continuous real appreciation should have negative influence on exports. But the reality was entirely different. In this section we analyze the development of Czech trade after 1990 with emphasis on exports. We generally concentrate on trade with Western countries. At the end of the communist regime the economy was relatively closed – exports to GDP can be estimated to 20%. The number is low if we consider the small size of the Czechoslovak economy at that time. Most of the trade was focused on the Eastern markets – 70% (Půlpán, [10]). And exports to the West generally consisted of goods with low added value. The trade was distorted and planned as other aspects of the Czechoslovak economic life at that time. The government after 1990 believed that competition was the only way to improve efficiency of the large monopolies and thus the entire Czechoslovak economy. It was difficult to start a new business from scratch and compete with these large companies. The government for this reason decided to open the inner market for foreign competition already at the beginning of 1991. It applied inner convertibility of the crown and decreased tariffs. Inner convertibility allowed exports of anything by anyone (there was an obligation for importers to sell the hard currency that they obtain to the central bank at the same time). On the other hand, the government was deeply worried about the exchange rate. Understandably, high foreign currency reserves were needed to defend the fixed exchange rate. And the government did not know how the markets would react to the general opening of the economy. For this reason, temporary 20% import surcharge was applied since January of 1991 but it was step by step decreased to zero in the following 2 years. The Czechoslovak economy had generally highly liberalized trade (both exports as well as imports) since the very beginning of the transformation process. We should mention that there were negative circumstances in the outer relationship at the begin-

ning of 1990s. Foremost the Eastern markets quickly and totally disintegrated. The economy lost its main trading partners from the previous decades and Czech exports with these territories slumped to one fifth of the previous level (Jonáš, [7]). On the other hand, the trade quickly re-orientated towards the Western markets. The economy became integrated into the world economy and its trade started to grow.

There were possible boosts for exports in the following years in the forms of membership in international organizations – foremost the WTO and later on the EU and formally in splitting of the Czechoslovakia. This probably helped to endure the growth process of Czech. But generally, the impact of these changes was relatively small. The growth was enormous. The level of exports to GDP increased from 25 % at the end of the 1980s to close to 70 % before the economic crisis twenty years later. The Czech economy deeply integrated into the world economy in a relatively short time period. At the same time, other characteristics of the trade show that territorial orientation switched from the Easter to the demanding Western markets (foremost the EU). And commodity structure of exports returned to machinery and vehicles – (goods with a relatively higher added value) after a short run slump in exports of more sophisticated goods at the beginning of the first transformation decade. From these points of views we can see the development of Czech exports as one of the greatest achievements of the whole transformation process. The consequence is that the quality and efficiency of the Czech production had to strikingly increase during the period. And in the context of our article we should emphasize that it was achieved under the conditions of ever growing real exchange rate.

4 Econometric models and estimation results

The main goal of this contribution is to analyse and explain the seemingly positive impact of real exchange rate on the development of Czech foreign trade. The lack of plausible and consistent data sets allows us to analyse only two exchange rate regimes: a pegging system with a band (in 1996 and 1997) and the regime of managed floating (since 1997). Our econometric approach is straightforward. We carry out tests of cointegration (Johansen's approach) and we estimate long-run relationships among cointegrated variables and short-term dynamics using error correction approach. Finally, we determine relative importance of all relevant explanatory variables on the foreign trade. But, before doing that we need to obtain operational measures of all these variables. The data set used for estimation is from the first quarter 1996 to the fourth quarter 2011. The data comes from the OECD database, from the database ARAD of the Czech National Bank and from the Eurostat. The observed variables (for the Czech Republic and EU27) are as follows: real effective exchange rate (Czech crown): deflated by CPI, foreign trade weights of 2010, index 2010=100 (ARAD); Export and import prices: index 2000=100 (OECD); Real consumption, government spending, investment, exports, and imports: millions of national currency, chained volume estimates, national reference year, quarterly levels, s.a. (OECD). Using these data sets, we have constructed appropriate model variables which are presented in Table 2 (including their stationarity properties). All variables are in logarithms. In addition, we created three dummy variables for periods of pegging system with a band (1996-1997), for periods of EU membership of Czech Republic (3rd quarter 2004 and later) and for periods of the last economic slowdown (from the 4th quarter 2008 to 4th quarter 2011). But, these variables do not influence our results (the corresponding model variables prove to be statistically insignificant in both the cointegration relationships and the corresponding error-correction representations).

In our contribution we use a time varying measure of real exchange rate volatility. This proxy variable is constructed by the moving-sample standard deviation which is similar to those employed in the international trade literature (see Arize et al. [1]):

$$J_{t,m} = \left[\frac{1}{m} \sum_{i=1}^m (R_{t+i-1} - R_{t+i-2})^2 \right]^{1/2}, \quad (1)$$

where R is the natural logarithm of real effective exchange rate and $m = 7$ is the order of the moving average. In our case, we use a centered moving average, i.e. $i = -(m-1)/2, \dots, (m-1)/2$. We have computed real exchange rate volatility using a standard GARCH in mean model applied on differenced real exchange rate variables (using Bayesian information criteria, a GARCH(1,1) model was selected) as well (this approach may be found in Omojmite and Akpokodje [9]). It may be shown that the resulting trajectories have similar dynamic (only the levels of these variables differ).

There are many approaches (models) to estimate equilibrium real exchange rate, e.g. behavioural equilibrium exchange rate mode (BEER) or permanent equilibrium exchange rate model (PEER). Both model frameworks involve estimating of the equilibrium exchange rate using cointegration analysis. Beza-Bojanowska and MacDonald [2] estimates real Polish zloty/euro equilibrium rate using these approaches. Frait and Komárek [5] presented and estimated real equilibrium exchange rate for the Czech crown. Both papers are focused on the driving

forces standing behind the evolution of the real exchange rate and its equilibrium trajectory. Our contribution is intended to be focused on analysis of the determinants of the Czech foreign trade (in particular of the exports). To estimate real equilibrium exchange rate, we use Hodrick-Prescott filter with the standard smoothing parameter (1600) for the quarterly data. This filter is applied on the real exchange rate time series. This approach is sufficient to approximate the development of the equilibrium real exchange rate. We are aware of the fact that we are not able to fully understand the set of factors that possibly caused the real appreciation in the past. But, these factors are explained by Frait and Komárek [5]. It should be noted that this variable was used especially for robustness checking (i.e. alternative models specifications).

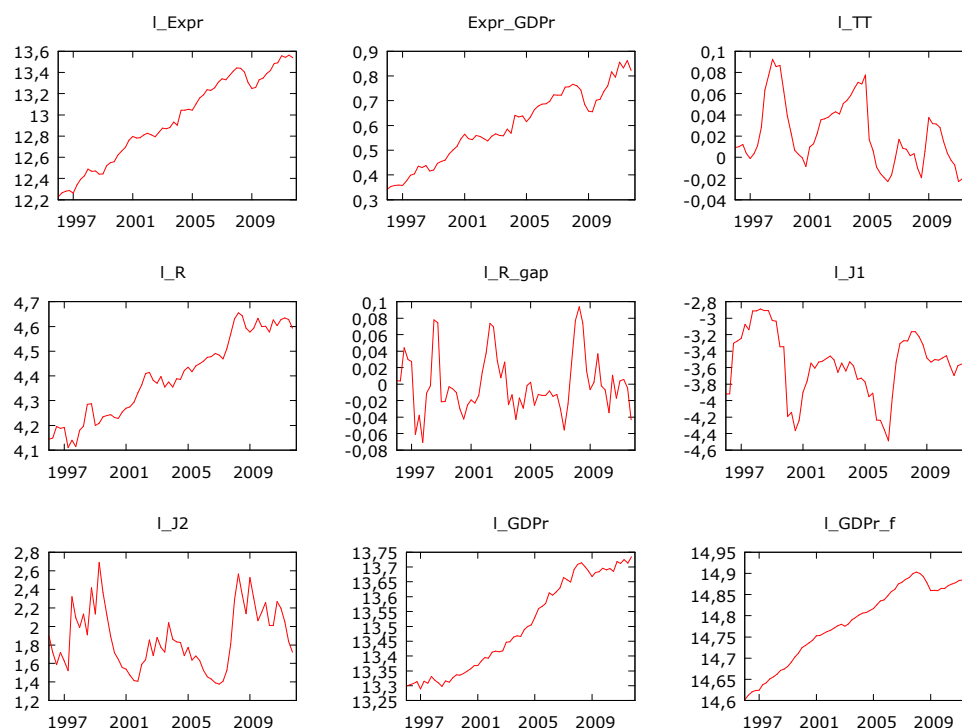


Figure 1 Model data

Determining the importance of explanatory variables is of practical relevance. This topic is a controversial one and there is no a unique measure. Commonly used measures are: zero-order correlations, partial correlations, semiparametrical correlation, standardized regression coefficients, Akaike weights and independent effects (see Murray and Conner [8] for further details and Monte Carlo simulations). In our evaluation of relative importance we use the concept of standardized coefficients and reduction in R^2 statistics (see Bing [3]). Standardized regression coefficients are identical to the estimates obtained from the regression on the standardized variables.

Our analysis of possible cointegration starts with the determination of the stationarity properties of our time series. If the series do not follow the same order of integration, then there can be no meaningful long-term relationships among them and we should concern only on the short-term dynamics. The Augmented Dickey-Fuller (ADF) test has been used to detect unit roots in the data. The results of unit-root tests are presented in Table 1. We can see that only the logarithms of real exports, real GDP of the Czech Republic and real GDP of the EU27 may be treated as integrated of order 1. The lag length is based on the significance of the most lagged variable where the residuals are white noise. One asterisk implies that we can reject the null hypothesis that the time series has a stochastic trend or contains a unit root at 10% significance level, two asterisks implies 5% level of significance and three asterisks 1% significance level. ADF tests have been carried on including constant (c) and constant and trend (c, t) in the corresponding test equations. We are able to reject the null hypothesis that the differenced time series have a stochastic trend or contain unit root at 1 and 5% significance level respectively. Only the variables of real exports, Czech real GDP and real GDP of the EU27 contain the unit root. Real exchange rate seems to be a trend stationary variable. All the model data are depicted in Figure 1. As mentioned previously, the cointegrating (long-run) relations are estimated using Johansen's multivariate procedure. Estimates of the short-run dynamics are then obtained using the error-correction technique. We have constructed many models (including interaction terms with our dummies and various volatility measures) but the number of cointegration vectors and the effects estimated coefficients remained robust. Table 3 presents the results for two models: Model 1 includes four endogenous variables (real exports, real GDP, real exchange rate, foreign GDP),

unrestricted constant, restricted trend and two unrestricted stationary variables in error-correction equation (terms of trade and exchange rate volatility); Model 2 treats the foreign GDP as an exogenous (restricted) variable in the cointegration equation. In both models, only one cointegration relationship has been identified (using 5% level of significance). Optimal lag length (order 2) was selected using the information criteria.

Variable	Notation	ADF (c) Level	ADF (c, t) level	ADF (c) difference	ADF (c, t) Difference
Real exports	l_Expr	-1.14	-2.00	-6.97***	-6.97***
Real exports to GDP ratio	Expr_GDPPr	-0.87	-3.92**	-3.93***	-3.90**
Terms of trade	l_TT	-3.18**	-3.61**	-4.46***	-4.49***
Real exchange rate	l_R	-0.81	-4.21***	-6.29***	-6.24***
Real exchange rate gap	l_R_gap	-5.09***	-5.03***	-6.63***	-6.57***
Real exchange rate volatility (moving average)	l_J1	-3.27**	-3.21*	-4.07***	-4.03***
Real exchange rate volatility (GARCH)	l_J2	-2.81*	-2.8	-9.59***	-9.52***
Real GDP	l_GDPPr	-0.48	-1.68	-3.34**	-3.25*
Real GDP for EU27	l_GDPPr_f	-2.19	-1.04	-4.36***	-4.88***

Table 1 List of model variables (in logarithms) and tests of stationarity

Rank	Trace statistics	Max. eigen. statistics		Trace statistics	Max. eigen. statistics	
	Model 1	Model 1		Model 2	Model 2	
0	77.52 (0.002)	36,63 (0.010)		71.80 (0.000)	42.96 (0.000)	
1	40.90 (0.077)	20.98 (0.198)		28.84 (0.085)	19.11 (0.052)	
2	19.91 (0.235)	14.33 (0.241)		9.727 (0.303)	9.73 (0.143)	
3	5.58 (0.524)	5.58 (0.526)		-	-	

Table 2 Johansen's cointegration test (p-values in parenthesis)

	l_Expr	l_R	l_GDPPr	l_GDPPr_f	Trend
Model 1	1.000	1.620 (0.254)	-0.324 (0.313)	-1.768 (0.370)	-0.024 (0.003)
Model 2	1.000	0.957 (0.187)	-0.123 (0.234)	-2.351 (0.276)	-0.018 (0.003)

Table 3 Long-term cointegration vectors (normalized, standard deviations in parenthesis)

Variable	Model 1				Model 2		
	d_l_Expr	d_l_R	d_l_GDPPr	d_l_GDPPr_f	d_l_Expr	d_l_R	d_l_GDPPr
const	-4.757***	-2.120**	-0.644	-0.570***	-12.6***	-2.700	-2.347***
d_l_Expr (-1)	-0.178	-0.065	0.039	-0.007	0.047	0.044	0.051
d_l_R (-1)	-0.157	0.247	0.180**	0.080***	0.157	0.104	0.211***
d_l_GDPPr (-1)	0.228	0.660*	-0.212	0.044	0.230	0.603*	-0.212
d_l_GDPPr_f (-1)	1.984**	0.635	0.088	0.380***	-	-	-
l_J1	0.009	0.0133	-0.006	0.000	0.025**	0.012	-0.02
l_TT	-0.305**	-0.074	-0.033	-0.010	-0.479***	-0.036	-0.085
EC1	-0.414***	-0.187**	-0.054	-0.049***	-0.632***	-0.136	-0.117***
R ²	0.55	0.17	0.22	0.47	0.60	0.10	0.29

Table 4 VECM models (*, **, *** statistical significance of parameters at 1, 5 and 10% significance level)

We have found only one cointegration vector using Johansen cointegration test (see Table 2). Conditioned by these results, the final VECMs are estimated. Table 4 contains the estimates of cointegration equations. Table 4 contains the estimates of short-term dynamics. Long-term relationship among variables shows that the exports are negatively related to the development of the real exchange rate. But, this negative connection is neglected by the trend behaviour of the exports (average quarterly growth is 2.4%). An important factor for determination of the Czech foreign trade is the foreign demand (long-term elasticity is 1.77%). As for the short-term dynamics, changes in foreign demand a terms of trade play an important role. Error correction term (EC1) is significant and

the adjustment coefficients suggest that the export dynamics is strongly determined by the development of all variables in the cointegration equation. The influence of volatility is ambiguous. Table 5 shows the estimates of VECMs using standardized variables. Unfortunately, it is not possible to standardize the variables in the cointegration regression because all the variables are nonstationary. We are focusing on the export equation only. The row denoted "sign. only" means, that standardized coefficient were computed only using a regression omitting insignificant variables from the original VECM model, the row "R² change" shows the change of R² in the regression omitting the particular variable. It is evident that the most important factors influencing the development of the exports are terms of trade and error correction term. This term contains the real exchange rate variable and the foreign demand variable. We can conclude (regarding the elasticity estimates from the cointegration vector) that the influence of both these variables is similar. But, this conclusion should be interpreted in a way that the permanent changes of real exchange rate and foreign demand matter. Especially in the case of the estimated expected quarterly trend growth of 2.4% influenced by the factors discussed by Frait and Komárek [5].

	d_l_Expr(-1)	d_l_R (-1)	d_l_GDP(-1)	d_l_GDP_f(-1)	l_J1	l_TT	EC1
Model 1	-0.177	0.132	0.086	0.292	0.090	-0.251	-0.753
R ² change	0.02	0.008	0.005	0.059	0.019	0.039	0.250
sign. only	-	-	-	0.259	-	-0.144	-0.632
Model 2	0.106	0.189	0.112	-	0.251	-0.390	-0.916
R ² change	0.008	0.017	0.009	-	0.038	0.082	0.339
sign. only	-	-	-	-	0.131	-0.326	-0.724

Table 5 Relative importance - standardized coefficients, change of R²

5 Conclusion

In our contribution, we have found the long-term relationship among real exports, real exchange rate and the foreign demand. We have shown that the real exchange rate and its dynamics have a negative impact on the real exports and its development. Seemingly positive impact of real exchange rate on the development of Czech foreign trade was not proved. Czech GDP does not affect the exports both in the long-run and in the short-run. In the short-run, the export dynamics is influenced by the terms of trade and by the volatility of real exchange rate (this influence is ambiguous). The most important factor in determining the dynamics of the export are the deviations from the export equilibrium which may be treated as a desired volume of exports.

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