ASSESSING THE EXCHANGE RATE SENSITIVITY OF CZECH BILATERAL AGRICULTURAL TRADE

Jana Simakova¹, Ing.
¹ Silesian University in Opava, School of Business Administration in Karvina

Abstract. This paper examines the short term and long term effects of exchange rate changes on bilateral trade flows of agricultural products between the Czech Republic and its major trading partners (Austria, Germany, Italy, Poland and Slovakia). In accordance with the J-curve theory, the Johansen cointegration test was employed to analyse the long term relationship and a vector error correction model to explore the short term effects of Czech koruna exchange rate level. The dataset used in this study covers period from 1999:Q1 to 2013:Q4. Agricultural product groups are based on the SITC classification. Results show that if the Czech foreign trade in agricultural sector is disaggregated into particular product categories, there can be found only some sectors significantly connected with exchange rate movements in the long term. The effects of currency depreciation are less than ambiguous and cannot be generalized across the analysed product categories but increasing in particular trade balances after currency depreciation dominates its decreasing. Theoretical short term and long term assumptions were confirmed only in trade of meat and meat preparations with Slovakia.

Key words: exchange rate, agricultural sector, trade balance, cointegration.

JEL code: F1, F31

Introduction

Agricultural and food production is one of the traditional industries of the Czech economy and despite the volume of this whole production was significantly reduced in recent years, the volume and value of trade activities had been constantly growing (Bielik et al., 2010). During the last two decades, agricultural trade in the Czech Republic passed through a series of changes that influenced its shape and character. The Czech agricultural trade development was influenced especially by successful transformation from centrally planned economy to market economy; by entrance of Czechia to the EU; and according to Horska et al. (2011) globalization and integration processes has played the important role as well. The transition
process and membership in the EU caused changes in the commodity and especially territorial structure of agricultural trade. The Czech Republic changed its trade orientation especially towards the trade with other member states, which means an EU share of over 75% of its total trade (Svatos and Smutka, 2012). Agri-food foreign trade turnover of the Czech Republic in last decade, with exception of the year 2009, has been continuously growing, thanks to increased exports as well as imports. A greater dynamics in the monitored period was shown by exports, which is a very positive feature with regard to long-term trend. One of the characteristics of agricultural foreign trade of the Czech Republic is a continuous negative trade balance. According to Svatos and Smutka (2012), it can be said that the unit prices of Czech agricultural imports have over the long term exceeded the unit prices of Czech agricultural exports, resulting in negative balance of agricultural trade. This indicator has been gradually increasing in its absolute values; however, as a result of faster dynamics of increasing exports, its share in the volume of exports shows a declining tendency.

After joining the EU and the trade liberalization, the Czech agriculture also faced an inflow of cheaper agri-food production from abroad. Insufficient domestic sales and low, respectively unstable purchase prices are solved many times by decreasing or complete termination of unprofitable agricultural production. One of the macroeconomic policy instruments is exchange rate, which can influence the price competitiveness of international traded products. According to Abeysinghe and Yeak (1998) policies prescriptions have generally assumed that currency depreciation stimulates exports and curtail imports, while currency appreciation is detrimental to exports and encourage imports. Domestic currency depreciation (devaluation in fixed currency regimes) increases the price of imports in domestic currency terms, which means more expensive imports. Simultaneously it decreases the price of exports in foreign currency terms, in other words, exports become cheaper. Given the above, price effect of currency depreciation can increase the volume of exports and decrease the volume of imports (Gupta-Kapoor and Ramakrishnan, 1999). Based on this presumption, this paper considers exchange rate as an instrument which plays a critical role in profitability of both export-oriented and import-competing agriculture and can affect the agricultural trade balance.

The aim of this paper is to examine the relationship between exchange rate depreciation and agricultural bilateral trade balances between the Czech Republic and its major trading partners (Austria, Germany, Italy, Poland and Slovakia). Data used in this study cover period from 1999:Q1 to 2013:Q4 and are based on the SITC classification. To distinguish the long term effects from the short term ones, authors apply the J-curve theory which says that currency depreciation improves the trade balance only from long run perspective; in the short run it even worsens the trade balance before improving it (Bahmani-Oskooee and Ratha, 2004). In the study is employed a Johansen cointegration test to analyse the long term relationship between variables. Short run effects are explored by estimating an error correction model.
Research results and discussion

Review of relevant literature

J-curve theory is the traditional instrument to analyse the dynamic effect of exchange rate changes on trade balance. J-curve theoretical basis comes from the Marshall-Lerner condition, which states that the sum of export and import demand elasticity has to be at least one and then the currency depreciation has a positive impact on the trade balance (Auboin and Ruta, 2012). Usually, Marshall-Lerner condition is not met in the short run, goods tend to be inelastic and depreciation deteriorates the trade balance initially. In long run consumers can adjust to the new prices, volume effect is generally believed to dominate the price effect and trade balance will be improved. Short run effect of currency depreciation and related J-curve phenomenon was first advanced by Magee (1973), who pointed that short run deterioration and long run improvement of trade balance after depreciation resemble the letter J.

Literature concerning the J-curve issue tends to fall into one of the following three categories: studies using aggregate trade data; studies employing disaggregate trade data at bilateral level; and recent studies using disaggregate trade data at commodity level. The first type of studies concentrates on the use of aggregate export and import data between a country and the rest of the world in assessing the effectiveness of currency devaluation (e.g. Felmingham, 1988). These studies have to employ the effective exchange rate, what can be misleading when country’s currency appreciate against one currency and simultaneously depreciate against another currency (Bahmani-Oskooee and Brooks, 1999). The weighted averaging will therefore smooth out the effective exchange rate fluctuations, yielding an insignificant link between the effective exchange rate and the trade balance. Therefore, many other studies employ bilateral exchange rates and bilateral trade balance data between a country and its major trading partners (Bahmani-Oskooee and Ratha, 2004). There has been a growing body of literature arguing that the second-generation study may still suffer from the aggregation bias problem, as significant exchange rate impacts with some commodities could be more than offset by insignificant exchange rate effects with others, thereby resulting in an insignificant exchange rate impact and vice versa. Therefore, the newest studies disaggregate data to industry level (e.g. Bahmani-Oskooee and Hegerty, 2011).

In the agricultural trade literature, most studies have mainly concentrated on the effect of changes in exchange rate on agricultural export volume and/or prices (e.g. Gardner, 1981; Bradshaw and Orden, 1990). Limited studies have been made to investigate the impact of exchange rate on the agricultural trade balance. Among studies applying the newest approach to J-curve estimation can be found paper by Yazici (2006). He investigated whether the J-curve hypothesis holds in Turkish agricultural sector. Based on the data covering the period from 1986 to 1998, the results indicate that, following devaluation, agricultural trade balance initially improves, then worsens, and then improves again. This pattern shows that J-curve
effect does not exist in Turkish agricultural sector. Another important finding is that devaluation worsens the trade balance of the sector in the long run.

Douglaston Godwin (2009) empirically tested the existence of the J-curve hypothesis using Nigerian agricultural data. The hypothesis asserts that adjustment to a disturbance in payments is not instantaneous since a certain period of time would have to elapse before variation in the exchange-rate can restore equilibrium in the trade balance. The analysed model is a multiplier based framework which imposes an Almon lag structure on the exchange rate regimes. The empirical results indicate that the J-curve does not exist in Nigerian agricultural sector precisely in the long-run since the pattern of lag between the exchange rate depreciation and the trade balance resembles more of an asymmetric S-shape of a horizontal S.

Yazdani and Shajari (2009) published study, where the impact of macroeconomic indicators of Iran and its 20 trading partners on Iran’s agricultural trade balance had been investigated. The ARDL approach was applied during the period of 1960 - 2005. They found out that real exchange rate had the positive impact on trade balance indicating that the depreciation improves trade balance.

There was made only few studies concerning the J-curve issue in Czechia, in addition, their results are mixed. Among studies, which do not confirm the J-curve for Czechia is Bahmani-Oskooee and Kutan (2009) who made an extensive study for emerging Europe. Based on data from 12 countries covering the period 1990-2005 they found empirical support for the J-curve effect in Bulgaria, Croatia and Russia. By contrast, no evidence of the J-curve effect was revealed for the Czech Republic. By application a similar methodology, Nusair (2013) tested 17 aggregate trade balances of emerging and transition countries over the period 1991-2012. While the J-curve effect was present in Armenia, Georgia and the Ukraine, the Czech economy still remained free of the J-curve effect. No evidence of this effect can be found also in Hsing (2009), who examined the J-curve for bilateral trade of six CEE countries including Czechia.

Contrary, two studies confirmed existence of some characteristics associated with the J-curve effect on bilateral basis. Hacker and Hatemi (2004) tested the J-curve for Czechia, Hungary and Poland in their bilateral trade with Germany. This study came to the conclusion that trade balance deteriorates within a few months after depreciation and then rises to a long run equilibrium value higher than the initial one. The J-curve effect in bilateral trade between Czechia and Germany was empirically confirmed also in Simakova (2012) by applying a traditional methodology comprising Johansen cointegration and error correction model. Moreover, Simakova (2012) found the J-curve also in the Czechia’s trade with Poland.

The only study made for the Czech Republic in the third-generation way was paper by Simakova and Stavarek (2014). They considered the major trading partners of the Czech Republic (Austria, Germany, France, Italy, Poland and Slovakia) and selected product categories, determined on the basis of SITC classification. They employed the Johansen cointegration test to analyse the long term relationship and a vector error correction model to
explore the short term effects of exchange rate level of Czech koruna. Although their findings suggest that product group of food and live animals is related with exchange rate in the long term, the J-curve effect was not confirmed in this sector.

In summary, the existing empirical literature on the J-curve phenomenon concerning the Czech Republic and its international trade is very limited. Results of the few previously published studies indicate almost no evidence for the J-curve effect, i.e. no effect of the CZK depreciation on the Czech trade balance. In addition, none of them is made in third-generation way for the particular agricultural sector. As compared to other papers, this study uses the most recent available data on international trade on the commodity level to avoid the aggregation bias problem which can influence the results. Therefore, this study substantially contributes to scientific discussion in this field and fills the gap in literature about bilateral agricultural trade.

**Model and data specification**

This study employs a reduced form of trade balance model to analyse the long-run effects of changes in exchange rate on the trade balance. They use a trade model in which trade balance is expressed as a function of exchange rate and the domestic and foreign income. The Johansen cointegration procedure is applied to avoid the main criticism of early studies, whose results could suffer from spurious regression problem because of non-stationary data. For empirical analysis of agricultural trade, the model is specified as follows (1):

$$\ln TB_{p,t} = \alpha + \beta \ln Y_{d,t} + \gamma \ln Y_{f,t} + \lambda \ln ER_{f,t} + \varepsilon_t$$

(1)

where $TB_p$ is a measure of the trade balance in time period $t$ defined as the ratio of exports of the Czech Republic to country $f$ over the Czech imports from country $f$ in a selected product group. $Y_d$ is measure of the Czech income (GDP) set in index form to make it unit free; $Y_f$ is the income of trading partner $f$ and $ER_f$ is the bilateral exchange rate. The exchange rate is defined in a manner that an increase reflects a depreciation of the CZK. $\varepsilon_t$ represents an error term.

Since an increase in foreign income $Y_f$ is expected to increase the Czech exports to respective country, an estimate of $\gamma$ is expected to be positive. Contrary, since an increase in Czech income $Y_d$ is assumed to increase the Czech imports, an estimate of $\beta$ is expected to be negative. Finally, the parameter $\lambda$ is expected to be positive as the trade balance of respective industry should improve due to CZK depreciation.

In order to test the short run relationship a short term dynamics is incorporated into the long run model. According to Hsing (2009) we apply the following error correction model (2):

$$\Delta \ln TB_{p,t} = \alpha + \sum_{k=1}^n \omega_k \Delta \ln TB_{t-k} + \sum_{k=1}^n \beta_k \Delta \ln Y_{d,t-k} + \sum_{k=1}^n \gamma_k \Delta \ln Y_{f,t-k} + \sum_{k=1}^n \lambda_k \Delta \ln ER_{f,t-k} + \vartheta_k EC_{t-1} + \varepsilon_t$$

(2)

where $EC$ is the disequilibrium term and $\vartheta_k EC_{t-1}$ represents the error correction mechanism.
All time series used for estimation are in the quarterly frequency and cover the period from 1999:1 to 2013:4. Data for GDP and exchange rate are obtained from the OECD iLibrary statistical database in current prices denominated in US dollars. Data for imports and exports flows are obtained from the Czech Statistical Office in US dollars as well. Development of total agricultural trade in the sample period can be seen in Figure 1.

![Graph showing the development of agricultural trade from 1999 to 2013 in USD.](source: authors’ construction based on data from Czech Statistical Office Database)

**Fig. 1. Development of Czech Agricultural Trade (1999 – 2013, USD)**

Estimated product groups representing the commodity structure of trade in agricultural sector are determined on the basis of 2 digit SITC classification:

- 00 Live animals;
- 01 Meat and meat preparations;
- 02 Dairy products and eggs;
- 03 Fish, crustaceans, molluscs etc.;
- 04 Cereals and cereal preparations;
- 05 Vegetables and fruit;
- 06 Sugars, sugar prep. and honey;
- 07 Coffee, tea, cocoa, spices;
- 08 Animal feeds, excl. unmilled cereals;
- 09 Miscellaneous edible products;
- 11 Beverages;
- 12 Tobacco and tobacco manufactures;
- 41 Animal oils and fats;
- 42 Fixed vegetable fats and oils;
- 43 Animal/vegetable fats/oils, processed
**Empirical results**

In empirical estimation we work with five largest trading partners of the Czech Republic (Austria, Germany, Italy, Poland and Slovakia). The selection of trading partners is based on total trade turnover in the Czech agricultural trade. The total share of selected countries is more than 50% on average during the sample period. Logarithmic transformation was performed to reduce skewness and heteroscedasticity and to stabilize variability. Integration of time series was determined using the augmented Dickey-Fuller test. The augmented Dickey-Fuller test for each individual time series confirmed the presence of unit roots, which is the basic precondition of cointegration between variables.

Since the choice of lag orders of the variables in the vector error correction model specification can have a significant effect on the inference drawn from the model, the appropriate lag length for each variable is sequentially determined. The optimal lags for each estimated trading partner within different product groups were determined on the basis of Schwarz information criterion. Results of the cointegration procedure can be seen in Table 1.
As can be seen in Table 1, only some product categories are significantly connected with exchange rate movements in the long term. With respect to data availability, the least number of cointegrated sectors are in trade with Italy (01, 05 and 08). Per contra, in trade flows with Poland can be observe only two product categories not connected in the long run relationship (06 and 09). Sectoral analysis confirmed the long term relationship between analysed variables in product categories of meat, meat preparations and animal feeds. Among products without any cointegration are sugar, sugar preparations, honey, tobacco, tobacco manufactures and fixed vegetable fats and oils. In comparison to results of Simakova and Stavarek (2014), who revealed long term relationship in overall sector of food and animals,
one can see that deeper data disaggregation can help to avoid the bias of different analysed effects and to detect the particular analysed effects.

As regards domestic income, the theoretical assumption of its negative effect on trade balance was confirmed for most of the country-product group models but each bilateral trade flows contains the exemption. In case of foreign income, most of cases met the theoretical assumption and confirm its long term positive relationship with Czech particular trade balances development as well. The results for variable of exchange rate are more less than ambiguous but the positive effect is dominating. The increase in trade balance after depreciation can be observed for trade with Austria in 07; Germany in 02, 04, 08, 43; Italy in 05; Poland in 00, 04, 05 and Slovakia in 01, 02, 07, 08, 09. In summary of long term analysis can be stated that the theoretical assumptions for all variables were revealed only in bilateral trade flows of animal/vegetable fats/oils with Germany; animals, vegetables and fruit with Poland; meat, meat preparations, dairy products and eggs with Slovakia.

The estimations of vector error correction model are realized only for the variables, which are found to cointegrate (parameters are stable). Paper proceed to examine the dynamic responses by generating impulse response functions showing the response of the trade balance to the CZK depreciation. As indicated before, the short run effects of depreciation are reflected in the coefficient estimates obtained for the lagged value of the first differenced exchange rate variable. The J-curve phenomenon should be supported by negative coefficients followed by positive ones reflected into shape of the estimated J-curves. The representatives of estimated responses can be seen in Figure 2.
Fig. 2. Estimated Bilateral J-curves of Czechia in cointegrated product categories

Graphical representations of the impulse response functions present only few typical J-curves. As indicated before, the short run effects of depreciation are reflected in the coefficient estimates obtained for the lagged value of the first differenced exchange rate variable. The traditional J-curve is, thus, confirmed if the estimate of coefficient for exchange rate is significantly negative at lower lags and is followed by a significantly positive coefficient at longer lags. In this study, impulse response functions confirm the theoretical short run assumptions for Italy in trade with vegetables and fruit; Poland in trade with cereals and animal feeds; Slovakia in trade with meat, meat preparations, dairy product, eggs and fish. For
other cases, the J-curve phenomenon is not supported by estimated coefficients of exchange rates. The results are similar to other studies concerned on Czechia (Bahmani-Oskooee & Kutan, 2009; Nusair, 2013) where (despite revealed long term relationship) does not exist almost no support for the J-curve effect. Theoretical short term and long term assumptions were confirmed for the Czechia only in trade of meat and meat preparations with Slovakia.

Conclusions, proposals, recommendations

1. The aim of this study was to examine the short and long run effects of exchange rate development on trade flows in the context of disaggregated agricultural data of bilateral trade between the Czech Republic and its major trading partners (Austria, Germany, Italy, Poland and Slovakia). Special attention was given to assess the characteristics of the J-curve effect in different product groups and empirically identify whether Czech agricultural foreign trade could benefit from depreciation of CZK. The Johansen cointegration test and the vector error correction model were used for this purpose. The dataset used in this paper covers period from 1999:Q1 to 2013:Q4. Agricultural product groups are based on the SITC classification.

2. By relying on a relatively new approach of testing this relationship, this study shows that the long term relationship between analyzed variables can be found for product categories of meat, meat preparations and animal feeds. Among products without any cointegration are sugar, sugar preparations, honey, tobacco, tobacco manufactures and fixed vegetable fats and oils. The supposed indirect relationship of particular trade balances with domestic income and per contra direct relationship with foreign income and currency depreciation were revealed only in bilateral trade flows of animal/vegetable fats/oils with Germany; animals, vegetables and fruit with Poland; meat, meat preparations, dairy products and eggs with Slovakia.

3. The theoretical short run assumptions were confirmed for Italy in trade with vegetables and fruit; Poland in trade with cereals and animal feeds; Slovakia in trade with meat, meat preparations, dairy product, eggs and fish. For other cases, the J-curve phenomenon is not supported by estimated coefficients of exchange rates.

4. The effects of currency depreciation are less than ambiguous and cannot be generalized across the analyzed product categories but in the sample period, increasing in trade balances after currency depreciation dominates its decreasing and exchange rate as a macroeconomic tool can represent an effective instrument of stimulating the agricultural foreign trade.

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