EXCHANGE RATE RISK AND EXPORT FLOWS: FIRM LEVEL EVIDENCE FROM UKRAINE

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Abstract

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The work evaluates the impact of exchange rate fluctuations on the volume and price of export from Ukraine using the data on Ukrainian firms for the period from 2008 to 2011 years. After the careful study of the related literature it was concluded that exchange rate changes influence export volume and prices, once firms import heterogeneity, adjustable price mark-ups and risk-averse behavior is taken into account.

The basic assumption about the importance of the impact of exchange rate changes on Ukrainian firms` export volume and price is confirmed. The empirical evidences that the currency depreciation positively affects the volume and negatively affects the price of exported goods by Ukrainian firms with low portion of imported inputs are founded. On average, the currency depreciation by one unit leads to decrease in export prices by 8,7% and increase in export volumes by 8,9%. According to our estimation the risk-averse hypothesis for Ukrainian exporting companies holds. On average increase in volatility by 1% lead to increasing of price by 0,7% and decreasing of volume by 2,2 %.

TABLE OF CONTENTS

LIST OF TABLES

Chapter 1

INTRODUCTION

One of the main concerns in international trade is that large exchange rate movements have small effect on both the quantity and the prices of traded goods (Obstfeld and Rogoff, 2000). In this paper, it is showed that this fact is mainly associated with large share of import in cost structure of Ukrainian exporting firms. Once firm import heterogeneity is taken into account, significant impact of exchange rate changes on export flow and prices could be estimated.

Most of the developed countries are implementing the policy of floating exchange rate regime. On contrast, National Bank of Ukraine chose the regime of fixed exchange rate. However, national currency of Ukraine was sharply devaluated during financial crises in 1998-1999 and 2008. In view of the 60% hryvnia devaluation four years ago, the polemics on Ukrainian currency collapse arise again in view of unstable political situation and negative trade balance of Ukraine in recent years.

Taking into account the fact that the Ukrainian government and companies have an obligation to repay loans to international creditors, as well as to pay for gas import in foreign currency, there is a risk of significant decrease of the National bank`s foreign currency reserves which would result probably in new exchange rate shock. Reserves of the National Bank declined from 34 billion in 2010 to 15.8 billion dollars in March 2014 (National Bank of Ukraine: http://www.bank.gov.ua). If gold and foreign currency reserves of The National Bank of Ukraine would continue to decline, it would not be able to maintain hryvnia exchange rate any more. As a result, there is a risk of hryvnia devaluation.

From a theoretical point of view, the changes in the exchange rate have ambiguous effect on export flows. However, changes in national currency increase the risk of uncertainty of profits for export contracts in a foreign currency because it leads risk-averse and risk-neutral economic agents to move their activities from foreign markets to the less risky home market, decreasing amount of export. On the other hand, depreciation of national currency represents a greater opportunity for profit and might stimulate trade, because in this case domestic goods become relatively cheaper in foreign markets promoting exports, which also would improve current negative Ukrainian balance of payment.

However, revenue in domestic currency could stay the same or even decrease. The possible reason is that some firms could be inelastic in demand for foreign import. If a share of imported material and components used in production is significant, depreciation could lead to even higher price denominated in foreign currency. Taking into account this fact, analysis with micro-level data could provide more precise results. In addition, changing economic condition could result in different changes from firm to firm due to, for example, their different size, research and development intensity, different substitution effect for their goods in foreign markets. Additional point in favor of micro-level analysis is that aggregate estimations could lead to inconsistency, since aggregate exports may have a reverse effect on exchange rates.

This puzzle initiates vast amount of papers in which data on French, Chinese and Belgium firms is used. To my knowledge this thesis is the first empirical study of the issue on the base of Ukrainian firm-level data. In this paper, the assumption that the low aggregate effect of exchange rate changes on export flows is caused by Ukrainian firm specific factors is tested.

Using detailed Ukrainian firm-level data impact of exchange rate changes and firm specific factors on export flows is estimated. Data analysis shows that the import intensity distribution among exporters is skewed. In other words, import-intensive companies are very often large exporters. Consequently, this firms set high markups for their products and actively adjust them to changes in marginal cost of production limiting the influence of exchange rate changes on export prices. This issue introduces a buffer international prices and local costs for large exporters, playing a main role in limiting the influence of exchange rate changes across export destination countries.

The availability of Ukrainian firm-level data with indication of traded goods, export destination and import source country, currency of payment, implied exchange rate of payment augmented with data on firm productivity provides an opportunity to study the empirical evidences of mentioned issue. The data set is provided by one of the largest corporate bank in Ukraine. A distinctive feature of the constructed dataset is that it contains the firm level information on both export-import statistics and productivity from different sources. The data was matched using the 8-digit company codes. This provides a possibility to calculate a measure of imported inputs in firms` total costs. The predictions of the theory are tested using the data for period from 2008 to 2011.

As a guide for empirical study a theoretical framework developed by Amiti, Itskhoki and Konings (2012) is used. The framework is based on imported inputs choice model (Halpern, Koren, and Szeidl, 2011). Authors assuming the productive structure derive a cost structure and prove that partial elasticity of the firm`s marginal cost with respect to the exchange rate equals the share imported inputs in firm`s cost structure. This finding indicates the necessity of import intensity factor inclusion into empirical model specification.

Developed empirical framework consists from two models. The goal of empirical study is to determine the effect of real exchange rate changes on export volume and price. The first model specification follows traditional gravity approach, controlling for GDP per capital, year and destination fixed effects. From other hand, second model specification additionally includes import weighted real exchange rate variable and controls for import share in cost structure. Comparing results from two models the theoretical prediction of import intensity factor inclusion importance would be tested. Result of empirical study are supposed to be consistent with theoretical prediction that large exporters are less sensitive to exchange rate changes than small non-importing firms.

The remainder of the paper is structured in the following way: Chapter 2 gives a review of the literature about different studies of exchange rate changes impact on export flows in different countries; Chapter 3 provides theoretical and empirical frameworks; Chapter 4 contains data description and finally in the Chapter 5 estimation results and their interpretation are discussed. Conclusions and inferences are provided in the Chapter 6.

Chapter 2

LITERATURE REVIEW

The impact of exchange rate changes on export flows is relatively new topic and is the subject of studies over only past four decades. All studies could be divided into two groups: theoretical works and empirical studies for different countries.

In one of the earliest papers Clark (1973) reaches conclusion that all firms are making their production decision before the realization of exchange rate expectations and hence are restricted in adjusting their exporting decision in response to shifts in the margin of their exports activities. Since not only export but also import decision depend on exchange rate changes, Hooper and Kohlhagen (1978) develop a theoretical model in which they derive export supply and import demand for traded goods of firms to get market equilibrium. They test the model empirically and find that exchange rate uncertainty has high impact on prices for traded goods and low impact on volume of international trade (both import and export are affected).

On the other hand, not all theoretical findings justify the postulate of positive that the trade response to exchange rate shocks are so obvious. Krugman (1989) develops a "sunk cost model" in which a firm that is going to export its products to a foreign markets should take into account aspects like adapting its product to the foreign market, developing marketing and distribution network which are considered as the sunk costs. As a result, the firm is willing to increase activity in foreign market. In another work (jointly with Baldwin, 1989) he builds a theoretical model to study the exchange rate shock influence on trade. The model implies that the volume response to exchange rate depreciation is smooth and not simply a lag.

As some of the theoretical models predicts, increasing risk mainly is associated with exchange rate volatility. Risk-averse agents tend to direct resources to less risky economic activities. As a result, increasing exchange rate volatility leads to decreasing volumes of trade. In other words, according to risk-aversion hypothesis developed by Krugman (1989), export volume is negatively correlated with exchange rate volatility.

Following previous author, Franke (1991) uses a model with an assumption that firms are maximizing their profit from export activity, which is an increasing function of the real exchange rate. In addition, he states that export is associated with additional cost for entering (exiting) foreign market. But the profit from export grows faster than the associated additional transaction costs, hence firms benefit from increasing exchange rate.

A number of theoretical frameworks studying the effect of exchange rate changes on export flows control for additional parameters like export markups or import activity at firm level. In one of them, Halpern, Koren, and Szeidl (2011) study the behavior of importers and derive a framework in which they proved that import intensity of the firm is equal to the partial elasticity of this marginal cost with respect to the exchange rate. In other words, they proved that exchange rate changes influence import decisions, which also affect export volumes and prices. In the same time large exporters could simply change their markup and neglect the effect of exchange rate fluctuations. In order to control for this effect Atkeson and Burstein (2008) developed a model in which they prove that the market share of the company is a sufficient statistic for its markup.

From other hand, controlling for additional macro factors could lead to opposite result. Bacchetta and Van Wincoop (2000) build a simple general equilibrium model with two countries, in which they control for technological, monetary and fiscal shocks parameters. They compare the volume of trade under fixed and

floating exchange rate regimes. They find that there is no direct relation between the trade volumes and exchange rate regime. Under both systems, the volume of the trade can increase or decrease depending on consumer preferences and decisions on monetary policy in each country.

Based on developed theoretical models, empirical papers study the exchange rate effects on trade flows using firm-level trade data in different countries. In one of them Beggs, Beaulieu, and Fung (2009) show that the impact of changes in real exchange rate (both upward and downward) on firm survival is larger than the effect of tariff reduction and could seriously affect the volume of international trade. Gopinath and Neiman (2010) show that the entry-exit margin is not important in explaining import changes in Argentine during the 2001 currency crisis, while the exchange rate changes are significantly important.

In other recent papers authors include firm specific variables but reach the result, which is generally the same but is slightly different depending on firms parameters. Berman, Martin, and Mayer (2012) studies firms' adjustments in export volume and prices resulting from exchange rate fluctuations. In their model they prove that high-productivity firms usually increase margin instead of quantities when the producers' currency depreciates; while low-productivity firms use the opposite strategy. This model is supported by empirical evidence from micro-level export data of French firms. Thus firms' heterogeneity in their pricing-to-market decisions could be used for explanation of the impact of exchange rate changes on aggregate exports volumes. In other work using a large sample of Belgian firms Amiti, Itskhoki, and Konings (2012) find that the heterogeneous responses to the changes in exchange rate could be related to market share of every particular firm in foreign market and import intensity of materials and components. Li, Ma, Xu and Xiong (2012) use a detailed Chinese micro-level data for 2000–2007 and reach the same conclusion. They find that

changes in exchange rate have significant effect on export prices denominated in foreign currency and export volumes. Also they find that appreciation of national currency reduces the firms` willingness to export and amount of products for export in firms' product scope. They show that firms respond in different ways to exchange rate changes: highly productive change their markup instead of price, while firms with low productivity change their export volume and price. Using import intensity information and import-weighted changes in exchange rate, they fix the influence of marginal cost fluctuations on export prices and volume. In addition, firms with larger share in foreign market are less sensitive to exchange rate changes in their price decisions.

On distinct from previous empirical papers, following studies control for export markups changes. Chatterjee and Dix-Carneiro (2011) study the effect of exchange rate shocks on export behavior of multi-product firms using the sample of Brazilian firms for 1997 – 2006. They find that in response to real exchange rate increasing, firms enlarge markups for all products, but markup increases decline with firms' marginal cost of production. In other work Tang and Zhang (2011) study the effect of real exchange rate movements on firm export behavior, using monthly data that cover the Chinese export transactions over the period of 2000-2006. They study exchange rate influence on an exporter's extensive (entry, exit, and product churning) and intensive exports margins. The estimated exchange-rate elasticity of exports is close to 0.4 in the year following the shock occurrence, with major adjustment in the following six months.

Based on the risk-aversion hypothesis different Rose (2000) using a panel dataset on more than 100 countries has estimated significant negative dependence between export volume and exchange rate volatility. Clark (2004) using fixed effect regression reaches the same conclusion. While Tenreyro (2007) also finds negative but small effect of volatility on export flows.

To sum up, there is a huge amount of literature on studying the effect of exchange rate fluctuations on export flows at firm level, but it focuses mostly on developed countries. All findings in literature are briefly summarized in table 1. This research will add to the scarce literature empirical findings for Ukrainian companies.

Chapter 3

METHODOLOGY

Theoretical framework

In the theoretical framework the determinants of export flows are estimated. A model developed by Goldstein and Kahn (1985) and Rose and Yellen (1989) would be used in the first part of the theoretical framework. In fact, original model takes into account both import and export flows, while we would focus only on export activity.

The model assumes that exported goods have limited price elasticity. In other words, goods exported by Ukrainian companies are not perfect substitutes for the same products produced domestically.

Let`s assume that foreign demand for domestic export Ex^D is given by equation (1):

$$Ex^D = f_2(Y^*e, P^{Ex}, P^*) \quad (1)$$

Where Y* is foreign income, P^{Ex} is export deflator, P* is foreign price level, and e is nominal exchange rate. In the first equation export deflator P^{Ex} denominate the price that foreign customers will pay for goods exported by Ukrainian companies. In other words, the model assumes that demand for exported goods on foreign market depends on level of income and price of domestic goods in destination country. The third variable represents the price for the substitute product in the export destination country. Moreover, exchange rate is included in the export demand equation because the model assumes that all variables are calculated in domestic currency.

Additional assumption for the model is that there are no inferior goods. Thus the conclusion that domestic income elasticity is positive could be made. Cross-price demand elasticity is also assumed to be positive, while elasticity of price assumed to be negative.

$$\frac{\partial Ex^D}{\partial Y^*} > 0, \frac{\partial Ex^D}{\partial P^{Ex}} < 0, \frac{\partial Ex^D}{\partial P^*} > 0$$

The demand function Y is assumed to be homogeneous of degree zero. It means that if all independent variables would be increased by the same fixed factor, the value of the function would not change. Using this property both equations could be devised by respective price level. In tesulting equation all variables are represented in the real terms. So, equation (1) could be rewritten as:

$$Ex_r^D = f_1'(Y_r, P_r^{Ex}), \tag{2}$$

where $Y_r = \frac{Y}{P}$ and $P_r^{Ex} = \frac{P^{Ex}}{P^*}$.

Note: $\frac{\partial Ex^D}{\partial Y^*} > 0, \frac{\partial Ex^D}{\partial P^{Ex}} < 0$.

The real price of exported products is equal to relative price of foreign import adjusted to exchange rate:

$$P_r^{Ex} = \frac{P^{Ex}}{P} = \frac{e P^*}{P} \frac{P}{P_{Im}^*} = RER \frac{P}{P_{Im}^*} = \frac{RER}{p_{Im}^*} \tag{3}$$

where RER is real exchange rate calculated based on purchasing power parity. In Chapter 4 the construction of real exchange rate would be discussed in more details.

$$RER = e \frac{P^*}{P} \tag{4}$$

In equations (3) and (4) exchange rate variable follows standard American notation It is measured as a number of foreign currency units per a unit of domestic currency. In fact, in empirical part of the work standard European notation would be used, where the exchange rate is a number of domestic currency units per a unit of foreign currency. Change of notion will not affect the model results, except the signs in the quantity and price equations, which are presented further in the chapter. This fact will be taken into account during the results interpretation.

The second part of the theoretical framework connects companies' exchange rate pass-through with their import intensity. The framework developed by Amiti, Itskhoki and Konings (2012) is partly used. It is based on import inputs choice model (Halpern, Koren, and Szeidl, 2011).

A number of assumptions should be made. First, the model do not catch entry/exit or export decisions (Melitz, 2003). Also decisions on destinations are taken as exogenous. Furthermore, firms are assumed to be single-product, however, it could be implied to multi-product firms do not without additional assumptions. In addition, model does not take into account switching of import source countries in order hedge exchange rate risk.

Suppose a firm i, which produce output Y_i using labor L_i and inputs In_i with the production function:

$$Y_i = \Omega_i X_i^{\varphi} L_i^{1-\varphi} \tag{5}$$

, where Ω_i – firm productivity, $\varphi \in [0,1]$ – sector specific share of imports.

Intermediate goods bundle forms the input vector, which is indexed by $j \in [0;1]$ and aggregates to the Cobb-Douglas function:

$$X_i = \exp\{\int_0^1 \gamma_j log X_{i,j} dj\} \quad (6)$$

, where γ_j – input importance in the production process ($\int_0^1 \gamma_j dj$=1).

Each type of input come as imperfect substitutes: domestic or foreign:

$$X_{i,j} = \left[Z_{i,j}^{\frac{\zeta}{1+\zeta}} + a_j^{\frac{1}{1+\zeta}} M_{i,j}^{\frac{\zeta}{1+\zeta}} \right]^{\frac{1+\zeta}{\zeta}} \quad (7)$$

, where $Z_{i,j}$ and $M_{i,j}$ - the quantities of used in production domestic and imported inputs j; $(1+\zeta) > 1$ - elasticity of substitution between the foreign and the domestic inputs. Production is possible without imported inputs, since they could be substituted by domestic.

In order to import each type of foreign inputs any particular firm should incur sunk cost f_i, which are additional labor cost. The wage rate W* (cost of labor) and prices of domestic inputs V_i^* are denominated in currency of producing country. The cost of foreign inputs in domestic currency is $\varepsilon_m U_j$, where ε_m is exchange rate and U_j is the cost denominated in foreign currency. The total cost are therefore:

$$W^* L_i + \int_0^1 V_j^* Z_{i,j} dj + \int_{J_{o,i}} (\varepsilon_m U_j M_{i,j} + W^* f_i) dj \quad (8)$$

, where J_0 - the set of imported inputs.

Given the production structure derived above, cost function could be determined. Taking the output Y_i and imported inputs $J_{o,i}$ every firm chooses the set of input in order to minimize total cost subject to the production in equations (5) and (6). Total variable cost function without fixed costs of import could be written as:

$$TVC_i^*(Y_i|J_{o,i})\frac{C^*}{B_i^{\varphi}\Omega_i}Y_i \quad (9)$$

, where C^* - cost index for firms without imported inputs.($C^* = \left(\frac{V^*}{\varphi}\right)^{\varphi}(\frac{W^*}{1-\varphi})^{1-\varphi}$ with $V^* = exp\left\{\int_0^1 \gamma_j \log(V_j^*/\gamma_j)dj\right\}$) For input importers cost-reduction factor is $B_i \equiv B(J_{o,i}) = exp\left\{\int_{J_{o,i}} \gamma_j log b_j dj\right\}$, where $b_j \equiv \left[1 + a_j(\varepsilon_m U_j/U_j^*)^{-\zeta}\right]^{1/\zeta}$ – effect of increasing productivity from importing input j, adjusted for the import variety relative cost.

In view of cost structure derived above, the share of total variable costs of imported inputs equals:

$$\omega_i = \varphi \int_0^{J_{o,i}} \gamma_j(1 - b_j^{-\zeta})dj \quad (10)$$

, where φ - share of material costs in total variable costs; $\gamma_j(1 - b_j^{-\zeta})$ – share of material costs spent on imported input j, for $j \in J_{o,i}$. In this case ω_i is the import intensity of the company and could be measured from available data.

Derived cost structure results in the following structure of marginal cost:

$$MC_i^* = C^*/\left[B_i^{\varphi}\Omega_i\right] \quad (11)$$

The share of imported inputs in firm's structure is equal to the partial elasticity of derived marginal cost structure with respect to exchange rate ε_m: $\omega_i = \frac{\partial log MC_i^*}{\partial log \varepsilon_m}$, which justify the importance of firm`s import intensity factor in the empirical model specification following below.

Empirical framework

Empirical framework consists from two models. In the first model specification in order to connect export volume and price to exchange rate movement benchmark regression is used (Li, Ma, Xu and Xiong, 2012):

$$\ln(Q_{fpct}) = \beta_0 + \beta_1 RER_{c,t} + \beta_2 Z_{ct} + \beta_3 \mu_{fpc} + \beta_4 \lambda_t + \varepsilon_{fpct} \quad (12.1)$$

$$\ln(P_{fpct}) = \alpha_0 + \alpha_1 RER_{c,t} + \alpha_2 Z_{ct} + \alpha_3 \mu_{fpc} + \alpha_4 \lambda_t + \varepsilon_{fpct} \quad (12.2)$$

where firms are indexed by f, export destination country by c, and time by t; RER – the real exchange rate of Ukrainian hryvnia relative to the export destination country currency. Coefficient β_1 is expected to have positive sign, since currency appreciation leads to decrease in export volumes. Coefficient α_1 is expected to have negative sign, since currency appreciation lead to increase in the price of exported goods denominated in foreign currency units.

Using the traditional in international trade gravity approach market-specific macro factor Z_{ct} is included into model specification. Specifically, in order to control for the income effect GDP per capita of export destination country is included into dataset and aggregate GDP to control for the size effect.

Year dummy variables are included in order to control for year fixed effects such as new technology introduction or business cycle. To control for various shocks like implementation of tariffs on particular product by particular country firm-product-country fixed effect is controlled with μ_{fpc} variable.

Most of papers on pricing-to-market study companies' behavior using the demand factors to explain export pricing decisions. However, exchange rate shocks have ambiguous impact on exporting companies involved in international supply chains. Amiti, Itskhoki and Konings (2012) based on their

empirical findings show that most of exporting companies are also large importers. Moreover, they show strong dependence between company's import intensity and company size as well as other company characteristics. Based on this fact import intensity of particular company could be used as a proxy variable for marginal cost sensitivity to the exchange rate changes.

The advantage of the first model specification is that it includes large variety of exporting companies from different sectors. However, the disadvantage is that by including all companies the important difference across companies' import performance is missed.

The second model specification follows Berman, Martin, and Mayer (2012) studies. The only difference is that import performance instead of firm productivity factor is used. The empirical specification of the second model is:

$$\ln(Q_{fpct}) = \beta_0 + \beta_1 RER_{c,t} + \beta_2 RER_{c,t} \times \ln(\omega_{f,t}) + \beta_3 \ln(\omega_{f,t}) + \beta_4 Z_{ct} + \mu_{fpc} + \beta_6 \lambda_t + \varepsilon_{fpct} \quad (13.1)$$

$$\ln(P_{fpct}) = \alpha_0 + \alpha_1 RER_{c,t} + \alpha_2 RER_{c,t} \times \ln(\omega_{f,t}) + \alpha_3 \ln(\omega_{f,t}) + \alpha_4 Z_{ct} + \mu_{fpc} + \alpha_6 \lambda_t + \varepsilon_{fpct} \quad (13.2)$$

where firms are indexed by f, export destination country by c, and time by t. Coefficient β_3 is expected to have negative sign, since companies with a large share of imported inputs are less sensitive in their export to exchange rate movements. Coefficient α_3 is expected to have positive sign, since companies with a large share of imported inputs are more sensitive in price of their export to exchange rate movements.

As a measure of firm import intensity it is proposed to use a share of imported inputs in total firm`s cost structure for a particular time period:

$$\omega_{f,t} = \frac{Import_{f,t}}{Cost_{f,t}} \quad (14)$$

Some of the companies import their inputs from countries which are different from that to which they export their products. As a result, companies faces different degree of real exchange rate changes for their import and export transactions. In order to control for this issue import-weighted real exchange rate changes are constructed (Li, Ma, Xu and Xiong, 2012):

$$\theta_{f,t} = \sum_c MS_{f,c,t} \times \ln(RER_{c,t}) \quad (15)$$

Replacing real exchange rate by import-weighted exchange rate in equation (6) additional model specification could be obtained.

As a measurement of companies' risk-aversion the annual standard deviation of real exchange rate could be included in the model:

$$\sigma^2 = \frac{\sum_{t=1}^{n}(RER_{c,t} - \overline{RER_{c,t}})}{n} \quad (16)$$

where n – number of months in the year, $\overline{RER_{c,t}}$ – average annual real exchange rate for particular export-destination country`s currency in particular year.

The sign of the coefficient on the standard deviation is predicted to be negative for volume regression, since according to risk-aversion hypothesis firms should move their activities from foreign markets to the less risky home market, decreasing amount of export. For price regression the sign of the coefficient on the standard deviation is predicted to be positive, since the firms would require risk premium for uncertainty.

Using generated import intensity variable the equations (13.1) and (13.2) can be estimated using pooled OLS, fixed or random effect regressions. Particular

estimation method would be chosen based on specification tests results in chapter 5. Coefficients estimated in equations (13.1) and (13.2) are consistent, while the standard errors and consequently test statistics may not be valid, since the regressor was generated following equation (14). (Wooldridge, 2002). Such Generated Regressor problem could be solved using the instrumentation of the regressor. In our particular case, such method can not be used since equation (14) is not a linear function. To the best of our knowledge there are no methods to solve this possible estimation issue for non-linear models.

Chapter 4

DATA AND DESCRIPTIVE ANALYSIS

A large sample from database on Ukrainian export and import firms is used in empirical tests. The dataset is constructed as combination of firms` export and import transactions information and macroeconomics factors for Ukraine and export-destination countries.

The sample on export and import transactions of Ukrainian firms is obtained from the customs database of the National Bank of Ukraine. The dataset is provided by one of the largest corporate bank in Ukraine. The base include information for 2008-2011 on transactions basis and is aggregated to monthly and quarterly basis. The data on import-export transactions volumes, volumes denominated in hryvnia, destination country of export is included into dataset. Since particular company faces different exchange rates on its export and import operations, monthly exchange rates is calculated as weighted average.

The data on company trade activity was merged using 8-digit company code with a data on companies cost, provided by SMIDA on their official web-site (http://www.smida.gov.ua/db), in order to calculate firm specific import activity factor.

The information on average annual exchange rate come from databank of World Bank. The information on monthly exchange rate for volatility calculation comes from the statistical reports of the National Bank of Ukraine. Data on CPI, GDP and GDP per capita for export-destination countries come from the International Financial Statistics (IFS) of the International Monetary Fund (IMF).

Following the used methodology, real exchange rate (RER_{it}) is denominated in the Ukrainian Hryvna per unit of foreign currency, and is calculated as adjusted by the CPI index multiplied by net exchange rate and divided by the Ukrainian CPI:

$$RER_{it} = \frac{NER_{it} * CPI_{it}}{CPI_{Ukraine,t}} \quad (17)$$

The initial dataset contains information on 615834 export records, which was aggregated by firm-export destination – product bases. After adding a data on companies` import volumes and costs resulting dataset contains 18639 records. The amount of companies in the dataset is 204, which exported their products to 38 countries. On average one company every year export 5 products to 6 countries. The descriptive statistics is provided in Table 2.

Chapter 5

EMPIRICAL RESULTS

In this section the empirical results of the exchange rate influence on export flows are presented.

Based on test results presented in Table 2 fixed effect regression, rather than random or pooled OLS was chosen for results estimation.

Estimated results for the initial benchmark models 12.1 and 12.2 are reported in first column of Table 4 for the volume regression and in second column of Table 4 for the price regression. In the case of price regression there is a negative dependence between real exchange rate changes and export prices. The regression predicts that, on average, increasing in real effective exchange rate by 1 unit lead to decreasing of export price by 8,1 percent. For volume regression the model estimates that on average increasing in real effective exchange rate by 1 unit lead to increasing in export volume by 8,2 percent.

Estimations from benchmark regression partly contradict to results of other authors in their studies for different countries. For example, Gopinath and Rigobon (2008) in their work find negative exchange rate path-through of 22% into the US export prices. Li, Ma, Xu and Xiong (2012) in their recent work using similar benchmark model for Chinese firms find high pass-through of exchange rate on export price and volume, which is also consistent with the estimations of Berman, Martin, and Mayer (2012) for French export firms. Possible explanation for this fact is that Ukrainian companies use higher portion of imported materials in production process. As a result, the effect of exchange rate changes on export prices and volume is completely absorbed by increased companies' costs.

Despite the fact that benchmark model for price and volume regressions works well, there are suspicious that results for RER coefficient on prices and volumes are biased, since we do not control for any type of firms heterogeneity. Fortunately, the situation changes once it is taken into account.

In the third column of Table 4 the estimated results for the second empirical specification (equations 13.1) of export volume regression are reported and in the fourth column of Table 4 the results for price regression (equation 13.2) are reported. The second model specification takes into account heterogeneity in companies` import activity and cost structure. Estimated results are consistent with theoretical predictions of the coefficients signs. On average, the currency depreciation by one unit leads to decrease in export prices by 9,7% and increase in export volumes by 11,9%.

Recognizing the difference in firms` cost structure, coefficients on corresponding factor were estimated. On average, increasing the portion of imported inputs in the cost structure by 1% leads to increasing of export price by 1,1% and decreasing of export volume by 4,2%.

Estimated high sensitivity of export prices and volumes to exchange rate changes after controlling for firms` import heterogeneity is surprising at first glance and is not consistent with results on aggregated macro data. However it is consistent with another firm level studies on different countries such as already mentioned Berman, Martin, and Mayer (2012) and Amiti, Itskhoki, and Konings (2012). In the study of French firms, Berman, Martin, and Mayer estimated that in response to a 10 percent euro appreciation, on average, the exporter increase its price by amount between 0,6 and 1,4 percent depending on the used sample. Li, Ma, Xu and Xiong (2012) using the similar model for China exporters and controlling for heterogeneity in firms` productivity estimated that currency appreciation by 1% lead to increasing export prices by 10% and decreasing export volume by 24,5%.

According to risk-aversion hypothesis the exchange rate volatility was additionally included into regression. The estimations results for extended model specification are presented in columns 5 and 6 in table 4. The model predicts that, on average, the currency depreciation by one unit leads to decrease in export prices by 8,7% and increase in export volumes by 8,9%. In addition, prediction of risk-averse behavior of Ukrainian exporters holds. On average increase in volatility by 1% lead to increasing of price by 0,7% and decreasing of volume by 2,2 %.

Results of robust corrected estimations for model specifications 13.1 and 13.2 are provided in Table 5. The coefficients of main interest on real effective exchange rate remain significant for both volume and price regression. It could be concluded that problem of heteroscedasticity does not arise.

Results obtained for Ukrainian firms completely coincide with results on other countries in terms of signs predicted. However, Ukrainian firms have higher elasticity of price and volume to changes in real effective exchange rate than French companies and are similar to results for Chinese companies. The possible explanation is that, on average, companies from emerging countries use higher portion of imported inputs in their cost structure than companies in developed countries.

Chapter 6

CONCLUSIONS

The hypothesis tested in this Master thesis is whether export volume and price of Ukrainian firms are affected by significant changes of exchange rate.

After the careful study of the theoretical and empirical literature it was concluded that in order to estimate studied effect correctly firms heterogeneity in import activity and cost structure should be taken into account. Using a dataset containing an information on Ukrainian companies` export and import activities for 2008-2011 and combining it with the information on companies` costs the resulting model specification was estimated. Taking into account firm risk-averse behavior the resulting regression was estimated. On average, the currency depreciation by one unit leads to decrease in export prices by 8,7% and increase in export volumes by 8,9%.

Estimated results coincide with results of other authors on different countries. However, Ukrainian firms have higher elasticity of export price and volume to changes in real effective exchange rate than companies from developed countries and are similar to elasticity for companies from developing countries. As it was predicted, the risk-averse hypothesis for Ukrainian exporting companies holds. On average increase in volatility by 1% lead to increasing of price by 0,7% and decreasing of volume by 2,2 %.

For further studies the researches could estimate the same effect using full population of Ukrainian exporters additionally controlling for price mark-ups.

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TABLES

Table 1. Literature review

Model	Author	Findings
Derive basic theoretical model	Clark (1973)	Predict negative correlation
Derive export supply and input demand equilibrium	Kohlhagen (1978)	Predict negative correlation
Derive sunk cost model	Krugman (1989)	Companies have low incentive to revert export
Control for export-import margin as proxy for sunk cost	Neiman (2010)	Entry-exit margin is not significant
Risk-aversion hypothesis	Krugman (1989)	Predict negative correlation
Risk-aversion hypothesis	Rose (2000) Clark (2004) Tenreyro (2007)	Empirical evidence of negative dependence between exchange rate volatility and export
Proves that market share is a proxy for exporters markups	Atkeson and Burstein (2008)	Company adjust markups instead of prices
Control for markups in empirical study	Berman, Martin, and Mayer (2012) Chatterjee and Dix-Carneiro (2011)	Empirical evidence that company adjust markups instead of prices
Proves that exchange rate movements changes import decision, which affect export	Halpern, Koren, and Szeidl (2011)	Increased cost of inputs lowers export price elasticity
Control for firms import heterogeneity	Amiti, Itskhoki, and Konings (2012) Li, Ma, Xu and Xiong (2012)	Empirical evidence that companies with high import share in costs structure have low elasticity of export prices

Table 2 Summary statistics

Variable	Label	Obs.	Mean	Std. Dev.
Quantity	Q	18639	349323,5	1378645
Log of quantity	lnQ	18639	10,04197	2,810492
Price per unit in foreign currency of destination country	P	18639	21780,69	1193786
Log of price	lnP	18639	4,527775	3,032113
Rear effective exchange rate	RER	18639	1,472139	2,162771
Share of import in firm`s costs structure	w	18639	0,1977504	0,1907761
Log of share of import in firm`s costs structure	lnw	18639	-2,323242	1,575898
Real effective exchange rate weighted on the log of import share in costs structure	RERw	18639	-3,367636	6,346592
Gross domestic product, constant 2000 US$	GDP	18639	$4{,}76e^{+13}$	$1{,}56e^{+14}$
Standard deviation of real exchange rate	vol	18639	0,0403949	0,1667423
Log of standard deviation of real exchange rate	lnvol	18639	-8,796983	5,042647

Table 3 Estimation method tests

Model Comparison	Null hypothesis statements	Outcome
Fixed vs Random	Test H_0: difference in coefficients not systematic Ptob > chi2 = 0,0000	Use fixed effects regression since the difference in coefficients is systematic
Fixed vs Pooled	F test that all $\varepsilon_i = 0$: Prob > F = 0,0000	Use fixed effect regression instead of pooled effects regression since the null hypothesis about equality of all fixed effects to zero is rejected

Table 4 Regressions results

	Benchmark regression		Resulting regression			
	(1) Q	(2) P	(3) Q	(4) P	(5) Q	(6) P
RER	**0,082***	**-0,081*****	**0,119****	**-0,097*****	**0,089***	**-0,087*****
	(0,05)	(-0,02)	(0,05)	(0,02)	(0,052)	(0,022)
RER*ln(w)	**-**	**-**	**0,01****	**-0,004***	**0,009***	**-0,0035***
			(0,005)	(0,002)	(0,005)	(0,002)
ln(w)	**-**	**-**	**-0,042*****	**0,011****	**-0,039****	**0,01***
			(0,013)	(0,005)	(0,013)	(0,005)
GDP	**7,50e^{-15}****	**-6,12e^{-15} *****	**7,58e^{-15}****	**-6,12e^{-15}*****	**6,63e^{-15}****	**-5,81e^{-15}*****
	(3,33e^{-15})	(1,38e^{-15})	(3,33e^{-15})	(1,38e^{-15})	(3,34e^{-15})	(1,38e^{-15})
lnvol	**-**	**-**	**-**	**-**	**-0,022*****	**0,007*****
					(0,007)	(0,003)
2010	**0,13*****	**0,198*****	**0,12*****	**0,12*****	**0,05**	**0,22*****
	(0,022)	(0,009)	(0,022)	(0,01)	(0,031)	(0,012)
2011	**-0,13*****	**0,6*****	**-0,12*****	**0,59*****	**-0,16*****	**0,61*****
	(0,021)	(0,009)	(0,022)	(0,01)	(0,025)	(0,01)
Constant	**9,56*****	**4,68*****	**9,442*****	**4,71*****	**9,38*****	**4,73*****
	(0,174)	(0,072)	(0,178)	(0,07)	(0,179)	(0,073)
Observations	18639	18639	18639	18639	18639	18639

Note: Standard errors are reported in parentheses.

Table 5 Robust regression results

	Resulting regression	
	Q	P
RER	**0,119****	**-0,097*****
	(0,05)	(-0,01)
RER*ln(w)	**0,01***	**-0,004****
	(0,005)	(0,002)
ln(w)	**-0,04*****	**0,01**
	(0,014)	(0,009)
GDP	**$7{,}58e^{-15}$**	**$-6{,}12e^{-15}$ *****
	($4{,}69e^{-15}$)	($1{,}41e^{-15}$)
2010	**0,12*****	**0,2*****
	(0,02)	(0,006)
2011	**-0,12*****	**0,59*****
	(0,02)	(0,01)
Constant	**9,44*****	**4,71*****
	(0,024)	(0,065)
Observations	18639	18639

Note: Standard errors are reported in parentheses.