EXCHANGE RATES, GLOBAL VALUE CHAINS, MARKET STRUCTURE AND TRADE RESTRICTIONS AS DETERMINANTS OF INTERNATIONAL PRICES

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Declaration

I declare that this thesis has not been submitted as an exercise for a degree at this or any other university and it is entirely my own work.

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Note: Alexander is the preferred spelling of the first name

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Summary

This dissertation addresses questions in the areas of exchange rate pass-through into international prices. It examines the effect of strategic competition in a destination market and the use of imported intermediate goods in production on the degree of export price adjustment following exchange rate shocks. It also discusses how to separate two factors affecting import prices: a non-tariff trade restriction (a partial import ban) and an importer currency depreciation. The introduction briefly reviews the topic of exchange rate pass-through and provides a link between three chapters of the dissertation. Chapter 1 analyses how imported inputs embodied in gross exports and an exporting country size affect the degree of exchange rate pass-through. A theoretical model allows firms to set variable markups under oligopolistic competition and use foreign inputs in production that affect the effective currency composition of marginal costs. The model makes two predictions: (i) the imported input share reduces export price reaction to exchange rate movements and (ii) the exporting country share in a destination market increases it. I test the hypotheses for 57 economies over the period 2000-15. For trade between advanced economies, imported inputs reduce pass-through, but only in the case of producer currency movements; for trade with emerging markets, the evidence is weaker. Chapter 2 considers the determinants of the exchange rate pass-through into export prices for the EU members with floating national currencies. These are clear-cut examples of small open economies for which the euro – neither a producer nor an importer currency – plays a dominant role. Considering their exports to 25 non-EU destination markets over the period 2001-18, I find that the degree of price adjustment following exchange rate fluctuations is asymmetric. Prices expressed in an importer currency react more to bilateral exchange rate changes caused by importer currency movements (against the euro) than to ones caused by producer currency movements. For determining the sources of this asymmetry, I apply a more developed version of the oligopolistic competition model where a bilateral exchange rate is explicitly decomposed into a producer currency component and a local currency one. The model predicts that imported inputs and firms' strategic competition are sources of the asymmetry. I empirically investigate both channels and quantify their contribution to the asymmetry of the exchange rate pass-through. Chapter 3 considers Russia's import ban of certain foodstuffs and agricultural products from the EU, US and some other states imposed in August 2014. The ban implementation coincided with the period of a substantial depreciation of the Russian ruble (by almost 40%). Before the ban, the target countries' share in Russia's import and total consumption varied across product groups in a wide range. Exploiting that heterogeneity, I disentangle the ban's influence on prices from the depreciation's one. The results show that the ban effect on import prices increased in the second half of 2014, then gradually declined, disappearing by the end of 2015. Moreover, the ban had a similar short-run effect on consumer prices for the affected product groups. The conclusion provides final remarks.

JEL codes: F12, F13, F14, F31, F41, F51, F62

Keywords: international trade, exchange rate pass-through, global value chains, market structure, export prices, import prices, consumer prices, the European Union, Russia, trade sanctions

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Introduction

One of the core questions of international macroeconomics is the relationship between exchange rates and international prices. The topic has a very long story and discussion began even before the Bretton Woods system collapsed[1].

The incompleteness[2] of the degree of price adjustment following exchange rate movements was a puzzle at the beginning. Now there are a lot of theoretical models and empirical evidence in the literature that describe and evaluate different determinants of the degree of exchange rate pass-through[3]. Here I restrict the overview of determinants only to the ones analysed in the dissertation. Pricing-to-market plays a key role in many studies, and it cannot be omitted when we consider pass-through[4]. It assumes that a firm's optimal price depends on competitors' prices in a destination market. Thus, trying to preserve its market share, a firm partially absorbs an exchange rate shock by adjusting markups[5].

One of the common ways to theoretically analyze pricing-to-market is through the lens of oligopolistic competition models with variable markups based on the nested CES demand function[6]. In such models, demand for a product negatively depends on (i) a firm's relative price because of the competition within the industry; and (ii) an industry price level due to the competition between industries. The optimal price is determined by the optimal markup over the marginal cost expressed in a local (importer) currency. The optimal markup is a function of the relative price, i.e. own price and competitors' ones. Thus, the exchange rate pass-through or the optimal response to an exchange rate shock is the composition of: (i) the elasticity of a firm's marginal cost to an exchange rate; (ii) the elasticity of the markup to own marginal cost; and (iii) the elasticity of the markup to competitors' prices (or competitors' marginal

[1]Friedman (1953) mentioned that "it is far simpler to allow one price to change, namely, the price of foreign exchange, than to rely upon changes in the multitude of prices that together constitute the internal price structure."

[2]Having a single world price, commodities traded on exchanges do not depend on exchange rates. Moreover, in some cases, like Russia, commodity prices may determine exchange rates.

[3]See a literature review by Burstein and Gopinath (2014).

[4]There are several classic studies devoted to pricing-to-market: Krugman (1986), Feenstra, Gagnon and Knetter (1996), Betts and Devereux (2000), Goldberg and Verboven (2001), Berman, Martin and Mayer (2012).

[5]It is important that it works both ways – exporters increase murkups following depreciation (Martin and Rodriguez, 2004). However, the degree of pass-through is different in periods of appreciation and depreciation for emerging markets (Caselli and Roitman, 2019).

[6]Atkeson and Burstein (2008) developed the nested CES demand model, following the pioneering work by Dornbusch (1987).

costs). It is possible to incorporate a number of mechanisms within this framework.

For instance, the elasticity of a firm's marginal cost (expressed in a local currency) and, in turn, pass-through could be below 100% due to foreign inputs used in production[7]or local distribution costs[8]. The role of the former factor as a determinant of pass-through is quite intuitive. Intensifying the use of foreign inputs in production, a firm reduces the dependence of the total costs on a producer currency exchange rate because some part of expenditure is effectively set in other currencies. It is notable that this mechanism has no (little) effect on the degree of export price adjustment after a local currency shock relative to a world benchmark currency, like the US dollar or the euro. In such case, there is no change in relative prices of domestic and foreign inputs[9]. I analyse the foreign inputs channel in Chapters 1 and 2. The applied theoretical models differ in the way I incorporate the strategic competition channel.

In Chapter 1, I consider homogeneous firms exporting to a destination market whose number is determined by an exporting country share on the market. As a result, there is no variation in the elasticity of the markup to own marginal cost. Nevertheless, the strategic competition channel (pricing-to-market) exists and acts through the competitor's prices. In this specification of the model, a higher share of an exporting country on the market implies a bigger number of firms are directly affected by an exporter (producer) exchange rate shock. This, in turn, is associated with a larger adjustment of the industry price level on the destination market after such shock. An increase in the industry price level leads to the growth of the optimal markups and prices. This (second) round of price adjustment links the degree of pass-through and an exporting country share on the market. Exporters from a country that occupies a substantial part of the market have a higher pass-through. Similar to the foreign inputs channel, an exporting country share affects the degree of pass-through only when a producer (exporter) currency moves against the world benchmark currency, but has no effect when a local (importer) currency does. The latter is quite intuitive as an importer currency shock directly affects all firms in the same degree regardless of exporting countries' shares on this market. Moreover, the size of an economy negatively correlates with the foreign input share and positively correlates with the exporting country share on destination markets. Thus, it is necessary to control both channels – omitting one induces a substantial bias in the other's estimation. The model's predictions are testable at the country-industry level, and this allows me to consider a broad sample of economies. I find robust evidence in favour of theoretical predictions for advanced economies and some weak support in case of emerging markets.

In Chapter 2, I separately model heterogeneous firms' reactions to a producer and local currency

[7]Several articles incorporate this channel into nested CES models: Amiti, Itskhoki and Konings (2014), Auer and Schoenle (2016) and Devereux, Dong and Tomlin (2017).

[8]I neglect the latter mechanism as it is more applicable to consumer prices; for more detail see Corsetti and Dedola (2005).

[9]except materials originating from a destination country. On average, their share is negligible.

exchange rate shocks. As before, firms may use foreign inputs, but this time they are heterogeneous in market shares. This property changes the functional form of the strategic competition channel. In contrast to the linear increase of the channel's effect with an exporting country share as in Chapter 1, here the effect depends on a firm's market share non-linearly. In such types of models, both the markup and the markup elasticity with respect to marginal costs depend on a firm's market share. In particular, having market power small firms set the same markup. A monopolist has no competitors within an industry, so it keeps markup unchanged; i.e. it faces complete pass-through of the marginal cost into prices. On the contrary, in an attempt to preserve market share, a mid-size firm will partially absorb exchange rate shocks in markup. My main innovation is an explicit decomposition of a bilateral exchange rate changes into producer currency movements against a dominant currency and local currency ones against it[10]. The model shows foreign inputs and strategic competition reduce the degree of price adjustment when a producer currency moves[11] and have no effect when a local currency does.

I test the theoretical predictions for a set of small open economies – the EU members with floating national currencies – that experience the influence of a dominant currency – the euro. These countries intensively use inputs originating from the Euro Area and compete with other exporters from the EU in destination markets. Using detailed trade data over the period 2001-18, I find that the degree of export price adjustment depends on the origin of bilateral (producer-importer) exchange rate movements. When an importer currency moves against the euro, pass-through is almost complete with no difference between the EU members with floating national currencies and the Euro Area countries. By contrast, when a producer currency moves, the degree of export price adjustment is far from complete. On the next step, I determine the sources of this asymmetry in the degree of pass-through and quantify the contribution made by each of them. More precisely, using the decomposition of a bilateral exchange rate, I isolate the role of foreign inputs and strategic competition, and show that both channels are equally important sources of the asymmetry. That is, they lead to a greater reduction of the degree of producer currency pass-through than on local (importer) currency pass-through. These results are in line with theoretical predictions.

Chapter 3 empirically analyses the effect of two simultaneous trade distortions on prices: a partial import ban of certain products and the substantial depreciation of an importer currency. Political relations between Russia and a number of Western countries deteriorated sharply in the middle of 2014. In response to an extension of sanctions, Russia imposed bans on the import of certain foodstuffs and

[10]The dominant currency paradigm was introduced by Gopinath, Boz, Casas, Díez, Gourinchas and Plagborg-Møller (2020).

[11]In other words, they reduce the price dependence (expressed in a local or dominant currenciy) on a producer currency exchange rate.

agricultural (listed) goods from the EU, US, Australia, Canada and Norway (the target states) on August 7th, 2014. At the same time, the Russian ruble exchange rate fell markedly against most currencies, declining in value by almost 40%. Both the import ban and the depreciation affected the consumer prices and the border prices of the listed products imported from other (third) countries to Russia. Assuming that the ban effect on the border and consumer prices depends on the initial target countries' share in Russia's import and consumption of the product, I disentangle the ban's influence on prices from the ruble depreciation's one. The results show that the ban effect on import prices increased in the second half of 2014, then gradually declined, disappearing by the end of 2015. The ban had a similar short-run effect on consumer prices for the affected product groups with the maximum at the beginning of 2015. The comparison of Russian and EU trade data shows that the violation of the import ban regime is mainly related to trade through Belarus and Serbia. This circumvention of the ban covered up to 7% of Russian imports from third parties and had a limited effect on import and consumer prices.

CHAPTER 1

Imported Intermediate Goods and Incomplete Exchange Rate Pass-Through into Export Prices

This chapter analyses the effect of imported inputs and the exporting country share on the degree of export price adjustment following exchange rate movements – pass-through. I present a model where firms set variable markups under oligopoly competition and use imported inputs affecting currency composition of marginal costs. The model predicts: (i) the imported input share reduces the degree of pass-through; and (ii) the exporting country share in a destination market increases it. Using industry-level data, I test the hypotheses for 57 countries over the period 2000-2015. For trade between advanced economies, imported inputs substantially reduce the degree of export price adjustment, but only in the case of producer currency movements. Controlling for exporting country share, the average pass-through is 39% when imported inputs are not used, but drops to 11% when imported inputs account for half of gross exports.

1.1 Introduction

How does firms' participation in global value chains affect their exports? There are several dimensions to study this influence. One of the possible ways is to focus on specific characteristics of exporters' behaviour such as the optimal price response to external shocks. Obviously, a price of an exported good is a key determinant of the demand for this product in destination markets. If a producer and an importer have different currencies, export prices suffer exchange rate fluctuations that force firms to adjust prices (in any currency they are expressed in). The degree of export price adjustment following exchange rate movements – exchange rate pass-through – shows which portion of changes in a bilateral exchange rate is absorbed by a producer and which one is transferred to change in price for an importer.

There are several different methods to formalize participation in the global value chains. The natural one is to consider import intensity of the production process which could be represented by the imported inputs share in gross exports of a firm or an industry. Intensifying the use of imported inputs, a firm affects currency composition of marginal costs decreasing the producer currency's share because a bigger part of expenditure is effectively set in foreign currencies. In practice, the imported input share and the exporting country size exhibit a strong negative correlation. Larger economies: (i) can purchase many intermediate inputs domestically, reducing import-intensity of production; and (ii) have higher shares in total exports in destination markets, increasing their influence on the overall price level in external markets. Thus creates an important econometric issue for empirical testing of pass-through based on a large sample of countries— omitting to control for import-intensity or an exporting country size may induce a substantial bias in the other's estimation.

The goal of this chapter is to analyse how imported inputs and the exporting country share on a destination market affect the degree of exchange rate pass-through (ERPT) into export prices. This chapter considers both channels simultaneously while previous studies have examined them in isolation and only for a particular country[12]. The effect of imported inputs on ERPT into export prices was earlier shown on French firm-level data by Berman, Martin and Mayer (2012) and more recently on Belgian firm-level data by Amiti, Itskhoki and Konings (2014). Their results provide evidence imported inputs have a substantial impact on ERPT into firms' export prices. Using US import data, Auer and Schoenle (2016) show that the exporting country share increases ERPT into import prices. Detailed industry-level data allows me to analyse the imported inputs effect on exchange rate pass-through for a broad set of exporting countries. As it is mentioned above, such generalization requires to control for the exporting country share on a destination market both theoretically and empirically.

The theoretical framework is that of firms setting variable markups under oligopolistic competition developed by Atkeson and Burstein (2008). I extend the model to incorporate the effect of imported inputs on ERPT by Amiti, Itskhoki and Konings (2014), (2017) with the effect of exporting country share in the destination market on ERPT by Auer and Schoenle (2016). There are three regions: the exporting country that uses producer currency, a destination market which currency is called a local one and the (rest of) world which currency is used as a benchmark level. The model considers the optimal

[12]A rare exception is the cross-country analysis provided by Ahmed, Appendino and Ruta (2015) where authors consider countries' total manufacturing export volumes. Using trade data for aggregated industries, they find the use of foreign components limits the sensitivity of export volumes to currency fluctuation.

price response to exogenous exchange rate shocks for producers from the exporting country that sell products on the destination market. It predicts: (i) the use of imported inputs reduces ERPT, (ii) the exporting country share in a destination market increases it, and (iii) both effects appear only after producer currency movements.

The intuition behind the model's predictions is the following. First, imported inputs are (partially) priced in the foreign (world) currency that weakening the dependence of the marginal production cost on producer currency movements. Thus reduces the size of an optimal reaction of export prices (in the destination currency). Second, producer currency exchange rate movements are not firm-specific shocks but exporting country specific ones. All companies directly affected by the shock adjust their prices; as a result, the industry price level in a destination market changes. The larger the cumulative share of the exporting country's firms in the destination market, the larger the effect of the producer currency shock on the industry price level in the destination market. Third, the use of imported inputs cannot hedge against the destination currency movements, as such movements do not provide any changes in relative costs between domestic and imported inputs[13]. Moreover, the destination currency changes create the same demand shock for all firms which export to the destination market, so exporting countries shares on the destination market also does not matter in this case.

The empirical estimations are based on annual industry-level data for 35 advanced economies and 22 developing countries over 2000-2015. There are four sources of data: the TiVA (join OECD and WTO database), COMTRADE (UN), IMF and the WB. Compared with firm level data, industry-level data has a number of advantages for quantifying the degree of pass-through. First, industry-level data are available for a large sample of countries. By contrast, the lack of detailed firm-level data limits the possibility to extend the empirical results to other countries. In addition, while mentioned studies use inputs imported by a given firm, the measure here also captures inputs which could be purchased domestically, but imported by another firm. This channel may be important for energy-intensive goods, as fuel is normally purchased on domestic market and would be construed as domestic inputs in firm-level data.

Depending on the sample of the exporting countries, the destination markets, and the measure of exchange rates, my estimation yields coefficients of the imported inputs effect in the range from -0.26 to - 0.66[14]. The main results support the prediction that imported inputs reduce ERPT into export prices through the cost channel: they lessen the ERPT only in case of producer's currency exchange rate

[13]This may happen only if the price of imported inputs correlates with the destination currency exchange rate.

[14]These findings are in line with the conclusion which was made by Amiti, Itskhoki and Konings (2014) based on their analysis of Belgian exporters (using firm-level data) Amiti, Itskhoki and Konings (2014) estimate the effect in the range from -0.29 to -0.40 depending on controls. However, instead of controlling for the aggregate share of firms which export from Belgium (Eurozone) they use dummy controls for destination markets.

movements, but not a destination one. The regressions provide evidence that omitting the exporting country share biases the estimation of imported inputs effect in favour of the hypothesis. On average, in the case of trade between advanced economies and controlling for exporting country size, the elasticity of export price index (in the destination currency) to a producer currency REER is 0.333 when the share of imported inputs is 12.57% (the 10th percentile of the distribution) and it is 0.118 when the share is 42.95% (the 90th percentile). Additional robustness checks are based on examining the imported inputs effect separately for each industry and each year. This shows the results are durable and present each year.

This chapter contributes to the literature in the following ways. First, I evaluate the imported inputs effect on ERPT based on industry-level data for the large country sample. This allows me to show imported inputs play a role in real hedging only against producer currency movement. Second, I evaluate the effects of imported inputs and the exporting country share in the destination markets on ERPT together. Without controlling for the exporting country share, the estimation of the imported inputs effect is biased.

The next section provides a theoretical explanation of an empirical specification. Section 3 describes the data, Section 4 presents the empirical results and Section 5 concludes.

1.2 Theoretical Framework

Using the setup of variable markups under oligopolistic competition the theoretical model combines two effects on ERPT. Imported inputs change the currency composition of the marginal costs, so influence the optimal price adjustment following exchange rate shock. The exporting country share in the destination market represents the cumulative market power of its exporter on a destination market, so it also determine the degree of price adjustment.

Firstly, I describe the theoretical framework of the oligopolistic competition using a classical nested CES demand model. Later, I develop the imported inputs channel and combine it with the exporting country size effect using the three-country setup. At the end of the section I provide a link to the empirical equation.

1.2.1 Pricing-to-Market

Price setting in a destination market follows the models developed by Dornbusch (1987) and Atkeson and Burstein (2008). Consumers exhibit a love of variety and have CES aggregate demand over industries s with the elasticity of substitution across industries $\eta > 1$. Within each sector s there are a finite number

N_s of (monopolists) firms which produce unique goods i. Consumers have CES demand over different products i within each industry. The elasticity of substitution within an industry is $\rho_s > \eta$. The last inequality represents the fact that it is easier to substitute a product by another one within the industry than by some products from other industries. The quantity consumed of industry s is:

$$Q_{is} = Y_s \left(\frac{P_{is}}{P_s}\right)^{-\rho_s} = P_{is}^{-\rho_s} P_s^{\rho_s-\eta} P^{\eta} C \tag{1.1}$$

that is determined by P_{is} - the price of a particular good i, P_s - the industry price level and $P^{\eta}C$ - demand factor which is common for all goods on a destination market.

Under the assumption of oligopolistic competition, similar to Atkeson and Burstein (2008), the optimal price level depends on marginal cost MC and (minus) own price elasticity $\sigma_{is} \equiv -\frac{d\ln Q_{is}}{d\ln P_{is}}$. The markup $\mathcal{M}_{is}$ under Cournot and Bertrand competition is the same function of σ_{is} (but σ_{is} is different) [15]:

$$P_{is}^{*} = \frac{\sigma_{is}}{\sigma_{is}-1} MC_{is}; \qquad \mathcal{M}_{is} \equiv \frac{P_{is}}{MC_{is}} = \frac{\sigma_{is}}{\sigma_{is}-1} \tag{1.2}$$

where S_{is} is a firm's share on the destination market:

$$S_{is} = \frac{Q_{is}P_{is}}{\sum_{j\in s} Q_{js}P_{js}} = \left(\frac{P_{is}}{P_s}\right)^{1-\rho_s} \tag{1.3}$$

Following Auer and Schoenle (2016), I define the elasticity of markup with respect to firm's share on the market $\Gamma(S_{is})$ under Cournot competition[16]:

$$\Gamma(S_{is}) \equiv \frac{dln\mathcal{M}_{is}}{dlnS_{is}} = \frac{(\rho_s-\eta)S_{is}}{\eta(\rho_s-1)-(\rho_s-\eta)S_{is}} \tag{1.4}$$

Assuming σ_{is} is positive (own price elasticity of demand is negative), both expressions of the markup elasticity are positive and increasing functions of a firm's market share[17]. The equilibrium response of a firm's price could be obtained by considering the log-linearized form of the recursive relationship between a firm's price, market share, marginal cost and an industry price level. The lower case letters are used

[15] The (absolute value of) own price elasticity depends on the type of competition:

$$\begin{aligned} &Cournot: && \sigma_{is} = \left[\frac{1}{\rho_s}(1-S_{is}) + \frac{1}{\eta}S_{is}\right]^{-1} \\ &Bertrand: && \sigma_{is} = \rho_s(1-S_{is}) + \eta S_{is} \end{aligned}$$

By assumption a price of any good has infinity small effect on the overall price level $dP/dP_{is} = 0$

[16] Under Bertrand competition: $\Gamma(S_{is}) = \frac{(\rho_s-\eta)S_{is}}{[(\rho_s-1)-(\rho_s-\eta)S_{is}][\rho_s-(\rho_s-\eta)S_{is}]}$

[17] The monotonically decreasing markup elasticity does not provide monotonic ERPT as a function of a market share because the firm has its effect on overall industry price index, Auer and Schoenle (2016), also Devereux, Dong and Tomlin (2017).

for notation of log functions.

$$\Delta p_{is} = \Gamma(S_{is})\Delta s_{is} + \Delta mc_{is} \tag{1.5}$$

$$\Delta s_{is} = (\rho_s - 1)(\Delta p_s - \Delta p_{is}) \tag{1.6}$$

$$\frac{\partial p_s}{\partial p_{is}} = S_{is}; \qquad \Delta p_s = \sum_{i \in s} S_{is}\Delta p_{is} \tag{1.7}$$

The system solution gives the following equation for equilibrium price changes[18]

Proposition 1.1. *The equilibrium change of the firm's price is* [19]*:*

$$\Delta p_{is} = \underbrace{\gamma_{is}}_{response\ to\ \Delta p_s} \times \underbrace{\frac{\sum_{j\in s} S_{js}\alpha_{js}\Delta mc_{js}}{1 - \sum_{j\in s} S_{js}\gamma_{js}}}_{total\ effect\ on\ p_s} + \underbrace{\alpha_{is}\Delta mc_{is}}_{direct\ response\ to\ \Delta mc} \tag{1.8}$$

where:

$$\gamma_{is}(S_{is}) = \frac{\Gamma(S_{is})(\rho_s - 1)}{1 + \Gamma(S_{is})(\rho_s - 1)} \tag{1.9}$$

$$\alpha_{is}(S_{is}) = \frac{1}{1 + \Gamma(S_{is})(\rho_s - 1)} \tag{1.10}$$

There are two different situations when exchange rate movements affect marginal cost: the destination currency moves against the benchmark (world) currency or the producer currency does against it. In the first case, all exporters are affected, so the equilibrium effect on industry price level in a destination currency will be bigger than in the second case where only exporters from one country are affected.

1.2.2 Imported Inputs

The three-country model contains: a destination country - d, an exporting country - c and the rest of the world - w (the same notations are used for the corresponding currencies). The first two are small open economies, so the world benchmark does not react to the movements of their currencies. By assumption, foreign inputs which an exporting country uses in production are imported only from the rest of the world.

A firm that exports from country c to a destination market d has a production cost function which contains two parts: a domestic part (wages and domestic inputs) - H and an imported part (imported

[18] Proposition 2 in Auer and Schoenle (2016)

[19] Prices and marginal costs could be denominated in any currency with no difference. The log changes in price and marginal cost could be rewritten in any currency ^{w} in the following way: $\Delta p_{is} = \Delta p^w_{is} - \Delta e^w$ and $\Delta mc_{is} = \Delta mc^w_{is} - \Delta e^w$. It is easy to show, that $\gamma_{is} \times \frac{\sum_{j\in s} S_{js}\alpha_{js}}{1-\sum_{j\in s} S_{js}\gamma_{js}} + \alpha_{is} = 1$, as $\gamma_{js} + \alpha_{is} = 1$. Thus, the log changes in nominal exchange rates Δe^w could be cancelled.

intermediate goods and services) F. Goods and services are considered as imported inputs if they: are imported directly by the firm, are bought on the domestic market (imported by another firm), or they are embodied in domestic goods. In all these three cases are backward participation into Global value chains (GVCs). Prices of imported inputs response to changes in exchange rate of an exporter currency c against the world benchmark currency w. A firm's total variable cost function[20] denominated in the world currency:

$$TVC^{w}_{ict} = (H^{1-\phi_{ict}}_{ict} F^{\phi_{ict}}_{ict} Y^{a_{ic}}_{ict}) E^{w}_{ct} \tag{1.11}$$

where E^{w}_{ct} - a country c exchange rate against world benchmark w[21]. Considering changes in average variable cost as a proxy for changes in marginal cost:

$$\Delta mc^{w}_{ict} = (1-\phi_{ict})\Delta h_{ict} + \phi_{ict}\Delta f_{ict} + \Delta\phi_{ict}(f_{ict} - h_{ict}) + \Delta e^{w}_{ct} + a_{ic}\Delta y_{ict} \tag{1.12}$$

ϕ_{ict} - a share of imported inputs in total(marginal) cost of production; Δh_{ict} - log changes in average expenditure on domestic value added (denominated in producer currency) required for producing one unit of output (export); Δf_{ict} - log changes in expenditure on imported inputs (denominated in producer currency); $\Delta\phi_{ict}$ - changes of the structure of a production function[22]; $a_{ic} \geq 0$ - parameter of return-to-scale; y_{ict} - level of output. One of applied measures of producer currency exchange rate movement is a log change of firm's (exporter's) country exchange rate to the weighted basket of currencies of origin (k):

$$\Delta e^{\bar{k}}_{ict} = \frac{\sum\limits_{k \neq c} \Delta e^{k}_{ct} * \varphi_{kict}}{\sum\limits_{k \neq c} \varphi_{kict}} \tag{1.13}$$

φ_{kict} is a share of expenditure on intermediate inputs which is imported from a source country k in total cost of production($\sum\limits_{k \neq c} \varphi_{kict} = \phi_{ict}$) . Under the assumption that all foreign inputs are imported from the rest of the world: $\Delta e^{\bar{k}}_{ict} = \Delta e^{w}_{ct}$. The changes of expenditure on imported inputs (denominated in producer currency) could be expressed using ξ_{ic} - the producer currency exchange rate pass-through into imported inputs prices on the exporting country market. More generally, this coefficient could be

[20] Amiti, Itskhoki and Konings (2019) use a more general form of marginal cost which includes firm-specific idiosyncratic productivity.

[21] $\Delta e^{w}_{ct} > 0$ means appreciation of producer's currency against world benchmark.

[22] Under assumption that the production function is a Cobb-Douglas, this is equal to 0.

firm-specific, but for simplicity, it is set the same for all firms i (and exporting countries c):

$$\frac{\partial f_{ic}}{\partial e_c^w} = -\xi_{ic} = -\xi; \qquad 0 < \xi \leq 1 \tag{1.14}$$

The alternative assumption is just to fix imported inputs costs in world currency ($\xi = 1$); it is a reasonable approximation for small open economies, Fauceglia et al. (2014).

Under these assumptions, the changes of marginal cost could be divided into a part which is related to nominal exchange rate and another part Δr_{ict} which is not:

$$\Delta mc_{ict}^w \quad = \quad \Delta e_{ct}^w (1 - \xi \phi_{ict}) + \Delta r_{ict}, \qquad \Delta r_{ict} \perp \Delta e_{ct}^w \tag{1.15}$$

The same expression could be easily obtained based on the simplifying assumption that a firm cannot change production function or switch from domestic inputs to imported ones ($\Delta \phi_{ict} = 0$) and a production function has a constant return to scale ($a_{ic} = 0$).

1.2.3 Homogeneous and Equal-Sized Firms

In the simplest case, all exporting firms in a country c and an industry s are homogeneous in terms of the imported inputs share (ϕ_{cs}) and ERPT into costs of imported inputs (ξ_{cs}). Moreover, I assume that all firms on a destination market have the same size. This simplification allows me to analytically solve the equilibrium response of different exchange rate movements holding the effect of pricing-to-market (in case the share of domestic firms on destination market is bigger than 0). Following Auer and Schoenle (2016) I consider N_{ds} equal-sized firms on a destination market d in industry s[23], the number of firms is a constant and reflects an exporting country share on a destination market. There are three types of firms (with corresponding fractions): domestic firms (n_d), firms which export goods from exporting country c on this destination market (n_c), and other foreign firms (which export from the rest of world) - (n_w).

Under the assumption of the equal-sized firms on the market, the elasticity of markup with respect to price is the same for any firm $\bar{\Gamma} \equiv \Gamma(\frac{1}{N})(\rho - 1)$; moreover, the price changes will be the same for all firms which are exporting from the country c on destination market d in industry s. Thus, the equation in Proposition 1.1 for the firm i from the exporting country c could be rewritten in the following form:

$$\begin{aligned} \Delta p_i \quad &= \quad \frac{\bar{\Gamma}}{1+\bar{\Gamma}} \times \frac{\sum_{j \in sd} S_j \frac{1}{1+\bar{\Gamma}} \Delta mc_j}{1 - \frac{\bar{\Gamma}}{1+\bar{\Gamma}}} + \frac{1}{1+\bar{\Gamma}} \Delta mc_i \\ \Delta p_c \quad &= \quad \bar{\gamma} \sum_x n_x \Delta mc_x + \bar{\alpha} \Delta mc_c, \quad where \ \ x \in \{D, C, W\} \end{aligned} \tag{1.16}$$

[23]Later I drop the indexes ds which identify that the industry s on the market d is considered

The equation (1.16) has the same form for any currency.

Proposition 1.2. *Under the assumption of homogeneous equal-sized firms, the equilibrium response of price index of goods exported from country c to destination market d* (Δp^w_{cd}) *(denominated in world currency) is:*

- *in case of the destination currency exchange rate movements* e^w_d *against the world benchmark:*

$$\Delta p^w_{cd} \quad = \quad \bar{\gamma} n_d \Delta e^w_d (1 - \xi \phi_d) = \beta_d \Delta e^w_d \tag{1.17}$$

- *in case of exporting country's currency exchange rate movements* e^w_c *against the world benchmark:*

$$\Delta p^w_{cd} \quad = \quad \bar{\gamma} n_c \Delta e^w_c (1 - \xi \phi_c) + \bar{\alpha} \Delta e^w_c (1 - \xi \phi_c) = \bar{\alpha} \Delta e^w_c + \bar{\gamma} n_c \Delta e^w_c + \theta_c \phi_c \Delta e^w_c \tag{1.18}$$

where $\beta_d = \bar{\gamma} n_d (1 - \xi \phi_d) > 0$ *and* $\theta_c = -\xi(\bar{\alpha} + \bar{\gamma} n_c) < 0$

The appreciation (depreciation) of the destination currency would have only indirect positive (negative) effect on prices (denominated in a world benchmark currency) Δp^w_{cd}. The effect is determined by the destination market characteristics (share of domestic firms on the destination market n_d and their import intensity ϕ_d) and the parameters $\bar{\gamma}$ and ξ. The appreciation of an exporting country's currency would have the following effects: a positive "basic direct" one ($\bar{\alpha}$), a positive size effect ($\bar{\gamma} n_c$) and a negative imported inputs effect ($\theta_c \phi_c$). Actually, $\bar{\alpha}$ (the basic direct effect) is equal to the overall direct effect only if imported inputs are not used in production of goods. A size effect catches the influence of cumulative share of all firms from exporting country c. It is important to emphasize that a firm's share in a destination market and an exporting country's share act on ERPT in opposite directions. On the one hand, under the assumption of strategic competition, the optimal response to an exchange rate movement depends negatively on a firm's share in the market. Larger and more productive exporters significantly adjust their markups to preserve market share, Atkeson and Burstein (2008). On the other hand, for equal-sized firms, their optimal response is positively related to the total share (number) of firms which are directly affected by the exchange rate shock. As a result, the bigger n_c, the higher total influence of exporting country's exchange rate e^w_c on industry price level on destination market d.

The imported inputs effect emphasizes the fact, that usage of imported inputs reduces the influence of producer's currency exchange rate movements (against some world benchmark or against a weighted basket of origin countries' currencies) on marginal cost function[24].

[24] The coefficient θ_c contains the measure of cumulative share n_{cd}. However, as far as $\bar{\alpha} > \bar{\gamma}$ this part gives the second order effect. I will neglect the fact that θ_c is a function of n_{cd}.

Combining both cases from the preposition 1.2 the following estimating equation is obtained:

$$\Delta p^{w}_{scdt} \quad = \quad \alpha_{sd}\Delta e^{w}_{ct} + \beta_{sd}\Delta e^{w}_{dt} + \gamma_{sd} n_{scd}\Delta e^{w}_{ct} + \theta_{sc}\phi_{sc}\Delta e^{w}_{ct} + r_{scdt} \tag{1.19}$$

where r_{scdt} is the error term. In the model, the coefficients $\alpha_{sd},\ \beta_{sd},\ \gamma_{sd}$ are destination-specific, but in the empirical part,they are assumed the same across industries and countries or only industry-specific.

To see the intuition behind the imported inputs effect (θ), imagine a simple situation where one-third of a company's total cost is imported intermediate materials priced in the foreign currency (world benchmark), and the remaining two-thirds is wages priced in the producer currency. In this case, 10% appreciation of the producer currency (against the world benchmark) will raise the total cost of production (denominated in the destination currency) by 6.7%. As a result, one may observe incomplete ERPT into export prices since the total cost is partially denominated in foreign currency[25]. The use of imported inputs reduces ERPT only in the case of a producer currency movements (against some world benchmark). Otherwise, in the case of the destination currency movements, there is no change in an exporting firm's expenditure on domestic inputs relative to imported ones.

To see the main idea of the exporting country share effect, consider UK as an exporting country and two destination markets: Norway and Australia. The exchange rate movements of the sterling relative to the Norwegian krone and the Australian dollar will have the same direct effect on the exporting firm's marginal cost (in destination currencies). However, the indirect effect would be higher in the Norwegian market: a larger share of importers are exposed directly to the sterling movement and will change their prices. For this reason, the effect of the sterling exchange rate movement on industry price level will be higher in the Norwegian market. Moreover, there is an asymmetry in the effect of exchange rate movements. The destination currency movements equally affect firms exporting from any country, so the share of any particular exporting country is irrelevant in that case.

1.3 Data Description

Empirical estimation uses four primary sources of international data. TiVA (join WTO and OECD) database is used for calculation of the imported value added share in gross export for each exporter-industry pair. The IMF database of yearly average exchange rates is used for calculating changes of bilateral nominal exchange rates, exporting country's and destination currencies exchange rates against US dollar (USD) and Special Drawing Rights(XDR). The WB database provides information about

[25]This effect increases incompleteness of ERPT which is provided by oligopolistic competition under variable markups

changes in real effective exchange rate indexes for most of countries in my sample. The COMTRADE database contains information about values and volumes of trade flows between countries for each 6-digit HS commodity group which is used for calculation of exporter-industry-destination price indexes. A sample is divided into two groups of countries: advanced economies and other countries. The classification (according to IMF) is presented in Table A.1.

1.3.1 Trade in Value-Added Database

The indicator "Origin of Value Added in Gross Exports" from TiVA database is used[26]. It is available for 1995-2011 years. The structure of original data is presented in Table A.2. Value added (TiVA) data and trade (COMTRADE) data are expressed in current US dollars.

The indicator "Origin of Value-Added in Gross Exports" provides information about value added which was produced by source industry l[27] in source country k and was embodied in gross exports of country c in industry s in year t. Firstly, I expressed the value-added share of each source country k as a percentage of gross exports of country c in industry s in year t - φ_{ksct}. Obviously, $\sum\limits_{k\neq c} \varphi_{ksct} = \phi_{sct}$ is a share of imported value added in gross export from country c in industry s in year t. In the case where a source country is an exporting one ($k = c$), this variable measures a share of domestic value-added. The significant restriction is that the same share ϕ_{sct} for all destinations d is used due to the lack of information about value added composition on an exporter-industry-destination level.

However, for Eurozone countries, I consider imported inputs from other Eurozone countries as domestic ones. There are no bilateral exchange rate movements between exporting and source countries when both countries are Eurozone members. Value added originating from other Eurozone countries behaves as domestic one in case of Euro appreciation (depreciation); thus, (1.13) could be rewritten:

$$\Delta e_{sct}^{\bar{k}} = \frac{\sum\limits_{curr\ k \neq curr\ c} \Delta e_{ct}^{k} * \varphi_{ksct}}{\sum\limits_{curr\ k \neq curr\ c} \varphi_{ksct}} \tag{1.20}$$

there $curr\ k \neq curr\ c$ means that only imported inputs from source countries k (which have currencies different from country c) are taken into consideration. A share of imported value added, which is produced in countries that use other currencies, in gross export from country c in industry s in year t is $\widetilde{\phi}_{sct}$ [28].

[26] There are four more public datasets of Value-Added Exports which cover different samples of countries or regions during different periods of time, see. Table 1 on p.123 in Johnson (2014)

[27] In most of the regressions the information about a source industry is not used, instead of that sum of all sources industries (*ctotal*) is applied.

[28] It is also possible to broaden this idea and consider as a domestic value added not only other Eurozone members but also countries that use ERM regimes. Instead of that, I deleted countries which use ERM to Euro out of sample. The results are very similar to the reported ones.

Moreover, instead of using the imported inputs share in the current year t, I use the second lag of it (or the last available year for 2014 and 2015), so $\tau \leq t-2$. It is necessary because the value of imported inputs itself depends on current exchange rate. The usage of data for previous years avoids this causality problem[29]. Justification of such replacement is based on the fact that total import value-added share in gross export is quite stable for a lot of countries, so previous values are the valid instrument for current ones.

1.3.2 Exchange Rates

The IMF database contains information about almost all national currencies of countries that are presented in TiVA database for all necessary years (since 1999). $\Delta e_{ct}^{\$}$ — log changes of annual average nominal exchange rates of exporting country c against USD. Meanwhile, annual average exchange rates of USD to the special drawing rights (XDR) are used for constructing exporting country exchange rates against XDR – Δe_{ct}^{X} ($e_{ct} > 0$ means appreciation of producer currency). The log changes of bilateral nominal exchange rates of producer currency c to destination currency d in year t to previous year is: $\Delta e_{cdt}^{B} = \Delta e_{ct}^{\$} - \Delta e_{dt}^{\$}$.

According to the model, an exporting country exchange rate movement against the weighted basket of origin currencies is a direct measure of the effect of imported inputs on the marginal cost of production. TiVA database allows me to calculate the producer currency exchange rate against the weighted (by shares in imported inputs in gross export) basket of origin currencies, defined in (1.20)[30].

The second possible measure of the marginal cost channel is the changes of the real effective exchange rate (REER) of an exporting country Δe_{ct}^{R}. REER indexes for 1999-2015 years (2010 is a base year) are taken from the World Bank database[31].

The correlation table for all five used exchange rates and data sources is presented in Table A.4.

1.3.3 Export Price Index

COMTRADE[32] annual trade data contains the following information about trade flows: reporter (exporter), partner (destination), product code (HS 6-digit), year, trade value in USD (in current prices)[33], net weight (kg), quantity units[34] (units, m^3, kg, others), quantity (in quantity units). It is well-known that export data quite often are different from import data for the same trade flows, so only export data

[29] Two-year lag is necessary as exchange rate in a previous year is used as a base for calculating changes in exchange rates.
[30] This exchange rate is defined for an industry s of exporting country c in year t, so it is an industry-specific ER.
[31] The use of prices in nominal term (current USD) is correct as the industry-year dummies are applied.
[32] Harmonized Commodity Description and Coding Systems, rev. 1996
[33] All observations less than \$ 10 thousand are deleted. They account for no more than 1% of total trade.
[34] In most cases quantity units is equal to kg

is used. There is no issue because of possible differences in evaluations of gross exports between TiVA and COMTRADE databases: the first one is used for expressing imported inputs shares and the second one – for export prices.

I calculate unit weight prices in USD for each commodity i that was exported from reporter c to a partner d in year t. There are around 5,000 different 6-digit HS groups of commodities and 16 manufacture industries in the TiVA database. TiVA industries are matched to ISIC (rev. 3)[35] and HS(96) 6 digit codes – to ISIC (rev. 3)[36]. Using those matching keys 6-digit HS groups are linked to TiVA (manufacture and raw material) industries, each industry s contains from 55 to 884 different HS 6-digit groups i_s (see Table A.3).

In the empirical specification, the log changes of Paasche price index are used as a proxy for changes of exporting country firms' prices on destination market Δp_{scdt}. There are several reasons for it. First, Paasche index weights product values within industry s trade flow from c to d. The alternative possible measure is unweighted average or separate consideration of all prices for different commodities (HS 6-digit groups) within each industry. Such a measure would overestimate the influence of small and volatile commodities on overall prices on destination market. A significant difference between unweighted and weighted (by trade) ERPT was observed by Amiti, Itskhoki and Konings (2014). Second, imported inputs shares in gross export are available only on industry level. In such situation, it is possible that distribution of φ_{iscd} could be in a wide range. As a result, unweighted average of φ_{iscd} among the commodities i within industry s could be quite far from the available value of imported inputs share ϕ_{scd}.

For each industry s and exporter-destination pair log changes of Paasche index (ΔXPI_{scdt}) are calculated using core trade groups J_{icpt}. A commodity group i_{scdt} is included in a core if it satisfies the following conditions: (i) its exports from ad to c were positive in current and previous years; (ii) the log of annual change in unit price is below 50% in absolute value.[37] The bigger difference in price probably reflects changes of commodity composition within HS 6-digit group rather than such significant changes in prices of the same product. It is difficult to imagine the manufacturing (or agricultural) goods which prices suffer 65% growth or 40% drop. Such magnitude of price changes is more often for raw materials. However, they are traded mostly on a stock exchange and have universal world prices (adjusting for transportation costs) and exchange rate has (almost) zero effect for their prices. Industry-year dummies control price levels of stock commodities.

It is worth mentioning that core groups are not the same for different years. Moreover, a core group

[35] `http://www.oecd.org/sti/ind/TiVA_2015_Industry_List.pdf`

[36] `http://wits.worldbank.org/product_concordance.html`

[37] The unit value price satisfies: $-0.5 < ln\left(\dfrac{UWP_{icd,t}}{UWP_{icd,t-1}}\right) < 0.5$

weight CGW_{scdt} is calculated as a ratio of core groups value to the trade flow of industry s from c to d in year t. The bigger part of core group indicates more stable trade flows in terms of trade composition. I use CGW_{scdpt} as a weight for corresponding trade flows in some regressions.

1.3.4 Exporting Country Share in a Destination Market

Also using COMTRADE data, I construct a proxy for a share of firms exporting from country c on market d in industry s. Precisely, Z_{scdt-1} is the share of country c in world exports to destination market d in previous year $t-1$. The main limitation is that Z_{scdt-1} does not consider the total sales of domestic firms on the destination market d. However, it is quite common in empirical studies and usually justified by the Armington assumption. Similar to imported inputs share, $\tilde{Z}_{scd}$ is the total share of firms exporting from countries that share the same currency.

1.4 Empirical Results

This section is organized in the following way. The first subsection discusses the asymmetry of the influence of producer and destination currency movements on an export price index. The second one outlines the effect of imported inputs on bilateral (producer–destination) exchange rate pass-through. The third subsection tests the main predictions using: exporter and destination exchange rates against different world benchmarks (USD and XDR), the weighted exchange rate and the real effective one. The fourth subsection considers the heterogeneity of pass-through among industries. The last one discusses the time stability of ERPT.

1.4.1 Asymmetry between Producer and Destination Currency ERPT

A broad literature is devoted to estimation of ERPT[38]. Bussière and Peltonen (2014) estimate one-quarter ERPT into export prices to be around 33% for the sample of 41 countries (advanced economies and emerging markets). Thus, after 10% appreciation of a producer currency against a destination one, the export price index (denominated in producer currency) does down by 3.3%. However, authors do not distinguish between appreciation of the producer currency (against a world benchmark) and depreciation of the destination currency (against it). As it was shown in the model, these movements differently affect the export price index. The effect of producer currency movements are limited due to the use of imported inputs. Moreover, in the case of destination currency depreciation, all exporters on that

[38] See the literature review by Burstein and Gopinath (2014), or the estimation of ERPT for big sample of developing countries and emerging markets by Bussière and Peltonen (2014)

market are in the same situation. Adjusting prices, they will create bigger changes in industry price level on the market (in destination currency). In contrast, when a producer currency appreciates, exporters (from that country) face almost unchanged industry price level, as competitors (exporters from other countries and domestic firms) will keep their prices quite stable. Annual data allows me to estimate only the long-run (or medium-run) ERPT, as the long-run ERPT typically is up to 2 years, Burstein and Gopinath (2014).

The following regressions detect the described asymmetry. The first one estimates the classical ERPT: it regresses an export price indexes (Paasche indexes denominated in producer currency) - Δp^c_{scdt} on changes in a bilateral (exporter – destination) exchange rate Δe^B_{cdt}. Two other regressions emphasize the fact that the degree of export price adjustment depends on which (producer or destination) currency moves. The producer currency ERPT is estimated by the second regression. For controlling changes in a destination currency exchange rate, I include the destination-year dummy D_{dt}. Those dummies catch nominal exchange rate movements of a destination currency along with inflation rate on this market. In later subsections, I isolate producer and destination currencies' influence on export prices applying the direct decomposition of a bilateral exchange rate. Precisely, I include two exchange rates: producer currency exchange rate against a world benchmark currency and destination one against it. The main conclusion will be the same. Similarly, the third regression evaluates the destination currency ERPT using the exporting-country-year dummy C_{ct} that catches producer currency movements along with other producer-specific shocks. All regressions include controls for the world price level (the industry-year dummy S_{st}).

$$\Delta p^c_{scdt} = \alpha \Delta e^B_{cdt} + S_{st} + \{D_{dt}\} + \{C_{ct}\} + r_{scdt} \tag{1.21}$$

The results are presented in Table A.5 for the whole sample - all countries (ALL) and two separate groups: advanced economies (ADV) and developing ones (DEV). Regressions based on trade between all countries in the sample (ALL-ALL) find that bilateral ERPT into export prices is -43.3%, column (1.1). Thus, a 10% appreciation of a producer currency against a destination one provides, on average, 4.3% decrease in export prices. That is quite similar to the findings by Bussière and Peltonen (2014). Column (1.2) controls for destination-specific shocks (D_{dt}) including exchange rate movements. It shows the effect of producer currency movements on export prices is significantly larger in absolute value: -80.9%. In the case of a producer currency appreciation (against some world benchmark) by 10%, export prices (denominated in producer currency) go down by 8.1%. The very different result is observed when the regression contains controls for producer-specific shocks (C_{ct}). Column (1.3) shows the degree of export price adjustment following destination currency movements is only -6.2%. In other words, in case of the destination currency depreciation by 10% the export prices (denominated in producer currency) go down only by 0.6%.

These results are in line with the prediction that *the degree of export price adjustment depends on which currency has moved* (against others). The results for exports from advanced economies (to all countries) predictably shows lower ERPT or more stable export prices. Moreover, when only trade between advance economies are considered, the main conclusion remains the same: the export price elasticity to exporting country exchange rate is bigger than its elasticity to destination currency exchange rate (68.5% and 13.1%, correspondingly).

1.4.2 Bilateral ERPT

To my knowledge there are a limited number of articles which consider the effect of imported inputs on the ERPT into export prices based on the data about only one exporting country[39]. The estimated coefficients of ERPT are quite different from each other. One of the possible explanation for that could be invoicing currency[40]. In current work I consider 57 countries that allows me to evaluate unweighted average (among countries) value of the effect. According to the model, both the marginal cost channel (the effect of imported inputs) and the size channel (the effect of exporting country share on a destination market) should affect the degree of export price adjustment following only producer currency exchange rate movements (the producer currency ERPT). As a result, the export price elasticity to producer currency exchange rate is the main interest. The second part of bilateral exchange rate movements - the destination currency movements (against some benchmark) - will be controlled by D_{dt}. The world average export price elasticity to producer currency exchange rate is α and the average effect of imported inputs on it is θ, so both coefficients are neither country nor industry specific:

$$\Delta p^c_{scdt} \quad = \quad \alpha \Delta e^B_{cdt} + \theta \tilde{\phi}_{sc\tau} \Delta e^B_{cdt} + \gamma \tilde{Z}_{scdt-1} \Delta e^B_{cdt} + D_{dt} + S_{st} + r_{scdt} \tag{1.22}$$

All regressions contain variables $\tilde{\phi}_{sc\tau}$ and $\tilde{Z}_{scdt-1}$ when the multiplicative variables with them are used. The results are presented in Table $A.6$[41].

The results for the whole sample of the countries are driven by the developing countries (including

[39]See, for example, Fauceglia, Shingal and Wermelinger (2014) for Swiss export prices (2004-2011); Amiti, Itskhoki and Konings (2014) for Belgian(2000-2008); or Berman, Martin and Mayer (2012) for French ones (1995-2005).

[40]France and Belgium more likely set export prices in their own currency than Switzerland which trades mostly with Eurozone countries. However, Gopinath, Itskhoki and Rigobon (2010) argue that currency choice is endogenous.

[41]The results for α are not presented as it mixes two different values. In some regressions (without destination-year dummies) it represents bilateral ERPT. In others (with destination-year dummy) it represents the reaction of export price index on the movement of exporting country exchange rate (against some benchmark) only. The difference between these two situations is discussed in previous subsection and Table A.5.

emerging markets). Excluding these economies from the set of exporting countries changes the sign of coefficient θ. The expected results are observed for trade between advanced economies. Without controlling for the destination currency movements the estimation of the imported inputs channel (θ) is very sensitive to presence of $\tilde{Z}_{scdt-1}$ – a share of exporting country on a destination market. This is related to the fact that $\tilde{\phi}_{sc\tau}$ and $\tilde{Z}_{scdt-1}$ have a strong negative correlation. On the one hand, the bigger economies, ceteris paribus, use less imported inputs as their firms have better opportunity to cover their need in intermediate inputs by domestic ones. On the other hand, the bigger economies normally have a more significant average share on destination markets. More precisely, the additional control for a size channel $\tilde{Z}_{scdt-1}\Delta e^{B}_{cdt}$ drops the coefficient θ roughly twice (from -0.486 to -0.294, columns (2.1) and (2.2) in Table A.6). However, in case of controlling for the destination currency exchange rate movements (by destination-year dummies) the coefficient θ particularly does not react on excluding or including the control for a size channel (-0.335 and -0.347, correspondingly). Moreover, controlling for the destination currency movements, the coefficient of imported inputs channel is significant even after excluding US and Eurozone members from the sample (-0.26)[42].

The main conclusion based on these results is that *imported inputs play a role of real hedging against producer currency exchange rate movements.* Usage of foreign intermediate goods makes export prices (denominated in some world benchmark) more stable in case of producer currency exchange rate movements. Numerically, in case of trade between advanced economies and controlling for the destination currency exchange rate, the elasticity of export price index (in destination currency) to a producer currency exchange rate is 0.379 when the share of imported inputs is 12.57% (the 10th percentile of the distribution) and it is 0.274 when $\tilde{\phi}_{sc\tau}$ is 42.95% (the 90th percentile).

D_{dt} captures not only the movements of the destination currency exchange rates but also another destination specific changes, such as: period of business cycle in a destination market, inflation rate and others. Later I present evaluations of the effect of exchange rate movements of producer currency and destination one separately. Such consideration excludes possibility for using destination-time specific dummy D_{dt}.

1.4.3 Two-component ERPT

Bilateral exchange rate movement contains two components: a movement of the producer currency against some international benchmark (USD or XDR) and a movement of the destination currency against it.

[42]It is well known that the US as the biggest economies is a some kind of specific case from the point of its reaction on exchange rate movements. The Eurozone members may provide the bias as they all use the same currency and have an extremely high market share in a lot of destination markets. Excluding from the sample does not mean recalculating the imported inputs shares or market shares.

As it was shown it the model, the effect of this two movements could be different due to the asymmetry in pricing-to-market.

The consideration of two-components exchange rate is necessary because the marginal cost channel could work only against movements of a producer currency. Fauceglia, Shingal and Wermelinger (2014) find that ERTP into imported intermediate goods prices is almost complete[43]. Thus, the imported inputs prices are quite stable (denominated in the basket of foreign currencies, USD or XDR). The possible explanation is that the distribution cost share for intermediate goods is lower than for consumer goods, Goldberg and Campa (2010). It is important because used database considers as imported inputs: all foreign goods and services which were bought on domestic market and imported value added embodied in domestic products along with goods which were imported directly by a firm. The coefficient for imported inputs channel (θ) should be close (in absolute value) to the coefficient for simple direct effect (α) as the cost of imported inputs are not affected by the changes of exporting country's currency exchange rate movement.

The key simplification which is used here: $\Delta e^{\bar{k}}_{sct} \approx \Delta e^{\$}_{ct} (\approx \Delta e^{X}_{ct})$. It assumes that weighted by trade (shares of imported inputs) producer currency exchange rate movement is close to one against a world benchmark currency (USD or XDR). There are several reasons that justify this assumption: a lot of inputs (especially raw materials) are pricing in USD; ERPT into imported inputs price index depends on invoicing currency, type of the goods or commodities, so equation (1.20) is also an approximation of measure of ERPT into imported inputs price index. Under this assumption, the effect of imported inputs on ERPT should be caught by the coefficient for an imported value added share multiplied by exporting country's exchange rate against USD or XDR:

$$\Delta p_{scdt} = \alpha \Delta e_{ct} + \beta \Delta e_{dt} + \theta \tilde{\phi}_{sc\tau} \Delta e_{ct} + \gamma \tilde{Z}_{scdt-1} \Delta e_{ct} + S_{st} + r_{scdt} \quad (1.23)$$

The regression results are presented in Table $A.7$. The coefficients for the destination currency part of ERPT (β) are quite similar in all columns. The coefficients for exporting country (producer currency) exchange rates (α) are higher when XDR is used as the benchmark. The bias in the estimations of the imported inputs effect is observed. Without control for an exporting country's share on the destination market (columns 1.1 and 2.1), there is significant coefficient for the imported inputs effect θ: -0.255 when USD is used as the benchmark currency and -0.479 when XDR. However, the including the control for the market share (columns 1.2 and 2.2) drops the coefficient θ substantially. Precisely, there is no significant effect of imported inputs when USD is used as a benchmark; the effect is still significant, but lower in

[43]"Our import side results... suggest that prices of imported inputs faced by Swiss output/export industries are mainly invoced in currencies of the foreign supplier."

absolute value (-0.282) when XDR is applied.

The next step considers the possibility that an imported inputs share just catches the difference between industries rather than marginal cost changes. The idea is that the group of industries like machineries, computers or transport is different from the other one like mining or basic metal. These industries have different average imported inputs shares in gross exports and may have different levels of ERPT. For checking this I run the regression (1.23) with the industry-specific price elasticities to producer and destination currency exchange rates (α_s and β_s), see columns 1.3 and 2.3. The imported inputs effect is less in absolute value (-0.156) but still significant when XDR is used as a benchmark.

The evaluations of the size effect (γ) - the importance of an exporting country share on destination market - are similar in value and significance whether USD or XDR is used as a benchmark. The US and Eurozone countries are some kind of outliers in the sense on their share on destination markets. Excluding them from the sample reduces the absolute value and significance of the estimated effect of imported inputs, see columns 1.4-1.6 and 2.4-2.6.

The decreasing in marginal cost of production (denominated in producer currency) after appreciation of producer currency is proportional to exchange rate of producer currency against the weighted basket of origin currencies (1.20). This may explain the difference in estimation of the cost channel effect based on USD and XDR, if the movement relative to XDR is a better approximation of such weighted producer currency exchange rate movement.

For testing this explanation I applied two measures of changing in marginal cost of production: weighted exchange rate e^W and real effective exchange rate e^R. The first one is an exporting country exchange rate movement against weighted basket of origin currencies, see the equation (1.20). The regression results for (1.23) using e^W_{sct} – a exporter country weighted exchange rate[44] – are presented in Table $A.8$. Comparison of the results for trade between advanced economies with previous ones (see Table $A.7$) supports the suggested explanation. First, the estimated coefficient for imported inputs effect on ERPT is bigger (in absolute value) and more significant in all regressions, see columns 2.1-2.4[45]. Precisely, the estimations of $\hat{\theta}$ are quite similar in all regressions(from -0.531 to -0.633) and omitting control for exporting country's share in a destination market creates lower bias (compare columns (2.1) and (2.2)). Other coefficients mostly are in line with the previous estimations. Regressions without the US and Eurozone members provide similar result.

However, all four used nominal exchange rates fail to find any evidence in favour of imported inputs

[44] Destination weighted exchange rate is defined through the exporter-destination bilateral ER: $\Delta e^W_{sdt} \equiv \Delta e^W_{sct} - \Delta e^B_{cdt}$.

[45] The regression (2.4) checks that the results are not driven by the used definition of the destination weighted exchange rate.

effect in case of trade between all countries (including emerging markets and developing economies).[46] It may reflect the fact that inflation is higher in such countries than in advanced ones. For this reason, I run regression (1.23) using the annual changes of real effective exchange rate (REER) – Δe^R. The results are presented in Table A.9. In case of trade between advanced economies, the estimations of the imported inputs effect are slightly bigger than the ones based on weighted exchange rate. However, the estimations of the exporting country share effect are substantially bigger. The important difference is that the regressions based on REER reveal the negative imported inputs effect on ERPT for exports from developing countries.[47] Thus, *omitting inflation rate significantly changes the estimation of the imported inputs effect for developing countries.* The relatively lower difference of the results based on REER and weighted ER for the set of advanced economies may reflect lower and more stable inflation rates in these countries.

Additional robustness check includes two multiplicative variables (columns (1.4, 2.4, 3.4)in Table A.9). The first one is the intersection of a destination currency exchange rate with an imported inputs share ($\Delta e^R_{dt}\tilde{\phi}_{sc\tau}$); and the second one - with an exporting country share in a destination market ($\Delta e^R_{dt}\tilde{Z}_{scdt-1}$). These variables substantially reduce the estimated coefficient of export price elasticity to the destination currency exchange rate (β). Moreover, the intersection of an imported inputs share with a destination exchange rate is significant only at 10% level in case of trade between advanced economies[48]. Thou, *imported inputs play a role in real hedging only in case of producer currency movements.* Such results are in line with the assumption that imported inputs act through cost channel.

1.4.4 Industry Specific ERPT

The ERPT has a significant amount of variation across industries. Industries are vary in: the average share of imported inputs, intensity of processing trade and share of final goods in gross export - all that define the common place in the global value-added production chains. They also have different transportation cost, heterogeneity of goods within a single 6-digit HS position, and other characteristics that may affect the value of the effect of import intensity on ERPT. There are trade data for 17 industries represented in TiVA database, see Table A.3. For considering industry-specific ERPT in case of trade between advanced economies (excluding the US), I run regression (1.23) for each industry separately.

$$\Delta p_{scdt} = \alpha_s \Delta e_{ct} + \theta_s \tilde{\phi}_{sc\tau} \Delta e_{ct} + \gamma_s \tilde{Z}_{scdt-1} \Delta e_{ct} + D_{sdt} + r_{scdt} \tag{1.24}$$

[46] See columns (1.1)-(1.4) and (4.1)-(4.4) in Tables A.6 and A.8.

[47] Compare columns (4.1)-(4.4) in Table A.9 and Tables A.6, A.8.

[48] It is insignificant in case of trade between advanced economies without the US and Eurozone member.

The results based on weighted exchange rates[49] are presented in Figure $A.1$, export price indexes are in US dollar. All industries (except wood) have positive and statistically significant coefficients of exporting country's currency ERPT into destination market prices (α_s). The range of its absolute values is wide: from 0.19 to 0.72, Figure A.1, the left side. Wood industry is the only one for which the regression does not find any relationship between producer currency exchange rate and export prices. It is also the smallest industry, its share in total trade between advanced economies (without USA) is only 0.9%.

All industries (except wood industry, again) have negative estimated values of the imported inputs effect on ERPT (θ_s). The coefficients are negative and statistically significant for 9 out of 17 industries[50], Figure A.1, the right side. The estimated effect of imported inputs is positive for wood industry. However, this coefficient becomes insignificant without Canada – one of the biggest exporters of wood.

The positive effect of exporting country share in destination market on ERPT is detected for 6 out of 17 industries[51]. The regressions results (1.24) without direct controlling of the exporting country share in destination market are quite similar to the presented ones.

1.4.5 Time Variety of ERPT

The one more robustness check considers time dynamic of the imported inputs effect on ERPT. I run the following regression for trade between advanced economies (without the US) using weighted by imported inputs shares exchange rates (Δe^W_{sct}):

$$\Delta p_{scdt} \quad = \quad \alpha_t \Delta e^W_{ct} + \theta_t \tilde{\phi}_{sc\tau} \Delta e_{ct} + \gamma_t \tilde{Z}_{scdt-1} \Delta e_{ct} + D_{sdt} + r_{scdt} \tag{1.25}$$

Producer currency ERPT into export prices α_t is positive and statistically significant for 2001-2015 years, except 2004 and 2006, see the upper part of Figure $A.2$. The imported inputs effect on ERPT θ_t is negative for 13 out of 15 years, see the lower part. However, it is statistically significant only for 10 periods. The same regression based on real effective exchange rate gives very similar results.

1.5 Conclusion

This chapter theoretically and empirically analyses the effects of imported inputs and the exporting country share in a destination market on the degree of ERPT into export prices. Using industry-level data for 35 advanced economies and 22 developing countries over 2000-2015, I test both effects applying

[49]The results based on real affective exchange rate are very similar.
[50]for 11 when the real effective exchange rate is used
[51]for 10 when the real effective exchange rate is used

clustered errors. The results show imported inputs reduce ERPT into export prices through the cost channel: they lessen the ERPT only in case of producer's currency exchange rate movements, but not a destination one. Moreover, there is evidence in favour of the positive effect of an exporting country's share on the producer's currency ERPT - the degree of export price adjustment followint producer currency movements.

The empirical estimations use five different measures of exchange rates. The first one is the bilateral producer-destination exchange rate which measures the classical ERPT. The preliminary estimation gives average bilateral ERPT from 57% to 76% depending on the country sample. It is similar to the results by Bussière and Peltonen (2014) for the big sample of advanced economies and emerging markets.

The other four measure distinguish two components: a producer currency movement against some benchmark and a destination one against it. Two simple world benchmarks are used: the US dollar and the Special Drawing Rights. In addition, I apply the weighted exchange rate — the producer currency exchange rate against the basket of currencies of origin, weighted by imported inputs shares. It directly catches the changes in imported inputs costs. All these measures of exchange rates support the theoretical predictions for advanced economies. However, only the estimations based on real effective exchange rates (REER) provides evidence in favour of the imported inputs effect for developing countries. It may reflect the fact that inflation is higher and has a more significant impact on nominal export prices in developing economies than in advanced ones. The weighted exchange rate and REER have highest predictive powers.

For trade between advanced economies, controlling for an exporting country share, after a 10% appreciation of the producer currency, the export price index goes up: it rises by 3.3% when the share of imported inputs is 12.57% (the 10th percentile of the distribution), and by 1.2% when the share is 42.95% (the 90th percentile). The results also show the 10 ppt higher exporting country share in the destination market, ceteris paribus, is associated with roughly 5 ppt higher ERPT.

The bigger economies, ceteris paribus, have both: bigger shares in a destination market and a smaller imported inputs share in gross export. As a result, the imported inputs share in gross export and the share of an exporting economy on a destination market have negative correlation (-0.37). The presented results clearly show that omitting control for the exporting country share create a bias in the estimation of the imported inputs effect.

1.A Data Appendix

Table A.1: The list of countries and currencies

Country	Currency	Advanced	Country	Currency	Advanced
Argentina	ARG	0	Israel	ISR	1
Australia	AUS	1	Italy	EURO	1
Austria	EURO	1	Japan	JPN	1
Belgium	EURO	1	Cambodia	KHM	0
Bulgaria	BGR	0	Korea, Rep.	KOR	1
Brazil	BRA	0	Lithuania	LTU	1
Canada	CAN	1	Luxembourg	EURO	1
Switzerland	CHE	1	Latvia	LVA	1
Chile	CHL	0	Mexico	MEX	0
China	CHN	0	Malta	MLT/EURO since 2008	1
Colombia	COL	0	Malaysia	MYS	0
Costa Rica	CRI	0	Netherlands	EURO	1
Cyprus	CYP/EURO since 2008	1	Norway	NOR	1
Czech Republic	CZE	1	New Zealand	NZL	1
Germany	EURO	1	Philippines	PHL	0
Denmark	DNK	1	Poland	POL	0
Spain	EURO	1	Portugal	EURO	1
Estonia	EST/EURO since 2011	1	Russia	RUS	0
Finland	EURO	1	Saudi Arabia	SAU	0
France	EURO	1	Singapore	SGP	1
United Kingdom	GBR	1	Slovak Republic	SVK/EURO since 2009	1
Greece	EURO	1	Slovenia	MLT/EURO since 2007	1
Hong Kong, China	HKG	1	Sweden	SWE	1
Croatia	HRV	0	Thailand	THA	0
Hungary	HUN	0	Turkey	TUR	0
Indonesia	IDN	0	United States	USA	1
India	IND	0	Vietnam	VNM	0
Ireland	EURO	1	South Africa	ZAF	0
Iceland	ISL	1	Rest of the World		0

Source: IMF, World Economic Outlook, April 2016

Table A.2: Description of the original data from TiVA database

Description	Original name	Used name	Unique values
Year	v_1	year	**17: 1995-2011**
Source country – country where this part of VA was produced	v_2	VA_ORGN	81: 63 countries and rest of the world, 15 groups of countries, **DXD (domestic) and WOR (total)**[a]
Source industry – industry that was used in the production of that part of VA	v_3	VA_IND	51: 34 industries and 17 groups of (the same) industries[b], including CTOTAL – the sum of all source industries
Exporter – country which gross export is analysed	v_4	EXPORTER	79: **63 countries**, 15 groups of countries and rest of the world
Export industry – industry which gross export is analysed	v_5	EXPORT_IND	51: **34 industries** and 17 groups of (the same) industries
Value added	v_6	VA	$17 * 81 * 51 * 79 * 51 = 2.8 * 10^8$

[a] http://www.oecd.org/sti/ind/tiva/TiVA_2016_CountriesRegions.pdf

[b] http://www.oecd.org/sti/ind/tiva/TiVA_2016_ISIC3_Industries.pdf

Source: TiVA

Table A.3: The result of matching TiVA industries and HS commodity groups

Industry description (TiVA, 2015)	Exporting industry (ISIC, rev.3)	Number of HS 6-digit commodity groups
Agriculture, hunting, forestry and fishing	C01T05	307
Mining and quarrying	C10T14	106
Food products, beverages and tobacco	C15T16	423
Textiles, textile products, leather and footwear	C17T19	853
Wood and products of wood and cork	C20	69
Pulp, paper, paper products, printing and publishing	C21T22	156
Coke, refined petroleum products and nuclear fuel[a]	C23	20
Chemicals and chemical products	C24	884
Rubber and plastics products	C25	122
Other non-metallic mineral products	C26	164
Basic metals	C27	359
Fabricated metal products except machinery and equipment	C28	219
Machinery and equipment n.e.c	C29	528
Computer, electronic and optical products	C30T33X	350
Electrical machinery and apparatus n.e.c	C31	136
Motor vehicles, trailers and semi-trailers	C34	55
Other transport equipment	C35	81
Manufacturing n.e.c; recycling	C36T37	188
Electricity, gas and water supply[a]	C40T41	3
Research and development and Other Business Activities[a]	C73T74	5
Other community, social and personal services[a]	C90T93	10

[a] these industries are not include in the analysis because of the lack of trade data

Source: author's calculation

Table A.4: The correlation table for used exporting country exchange rates

The measure of annual changes in exchange rate	(1) bilateral (against the destination currency)	(2) against USD	(3) against XDR	(4) against weighted basket origin currencies	(5) real effective exchange rate
Δe_{ct}	Δe^{B}_{cdt}	$\Delta e^{\$}_{ct}$	Δe^{X}_{ct}	Δe^{W}_{cst}	Δe^{R}_{ct}
Data source:	IMF	IMF	IMF	IMF & TiVA	World Bank
bilateral	1				
against USD	0.3990	1			
against XDR	0.3313	0.9818	1		
weighted ER	0.5261	0.8255	0.7350	1	
REER	0.4776	0.7237	0.6147	0.8788	1

1.B Additional Tables and Figures

Table A.5: The regression results of (1.21), XPI in exporter currency, bilateral exchange rate

Dep. var.: Δp^c_{scdt}	$(1.1)^d$	$(1.2)^c$	$(1.3)^d$	$(2.1)^d$	$(2.2)^c$	$(2.3)^d$	$(3.1)^d$	$(3.2)^c$	$(3.3)^d$	$(4.1)^d$	$(4.2)^c$	$(4.3)^d$
Exporting countries:		ALL			ADV			ADV without US			DEV	
Destination markets:		ALL			ALL			ADV without US			ALL	
Δ Bilateral ER: Δe^B_{cdt}	-0.433*** (-9.24)	-0.809*** (-25.32)	-0.0620*** (-4.93)	-0.242*** (-6.78)	-0.664*** (-22.18)	-0.0698*** (-5.03)	-0.393*** (-16.91)	-0.685*** (-21.50)	-0.131*** (-9.47)	-0.560*** (-9.91)	-0.861*** (-16.28)	-0.0485*** (-6.47)
Industry-year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Destination-year dummy		Yes			Yes			Yes			Yes	
Exporter-year dummy			Yes			Yes			Yes			Yes
N	547875	547875	547875	340113	340113	340113	183339	183339	183339	207762	207762	207762
adj. R^2	0.169	0.257	0.289	0.096	0.140	0.167	0.114	0.142	0.176	0.267	0.365	0.393

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: CGW_{scdt} is used as a weight for each observation. ^{d} - standard errors are clustered at the destination-year level; ^{c} - standard errors are clustered at the exporter-year level. Alternative clustering at the destination level and at the exporter level provides the same conclusion.

Table A.6: The regression results based on bilateral exchange rate (1.22)

Dep. var.: Δp^{c}_{scdt}	$(1.1)^{d}$	$(1.2)^{d}$	$(1.3)^{c}$	$(1.4)^{c}$	$(2.1)^{d}$	$(2.2)^{d}$	$(2.3)^{c}$	$(2.4)^{c}$	$(3.1)^{d}$	$(3.2)^{d}$	$(3.3)^{c}$	$(3.4)^{c}$	$(4.1)^{d}$	$(4.2)^{d}$	$(4.3)^{c}$	$(4.4)^{c}$
Exporting countries:	ALL				ADV				ADV without US and EZ				DEV			
Destination markets:	ALL				ADV				ADV without US and EZ				ALL			
Δ Bilateral ER $\times$ Imported inputs share: $\tilde{\phi}_{sc\tau}\Delta e^{B}_{cdt}$	0.631***	0.762***	0.167	0.189*	-0.486***	-0.294***	-0.335***	-0.347***	-0.108	-0.0737	-0.262**	-0.260**	0.997***	1.007***	0.239**	0.236**
	(8.43)	(12.67)	(1.94)	(2.12)	(-9.09)	(-4.59)	(-3.64)	(-3.59)	(-1.37)	(-0.91)	(-2.79)	(-2.70)	(17.76)	(19.99)	(2.84)	(2.84)
Δ Bilateral ER $\times$ Share in dest-n market: $\tilde{Z}_{scdt-1}\Delta e^{B}_{cdt}$		0.841***		0.115***		0.490***		-0.0267		0.499**		0.0325		0.535*		0.0663
		(14.51)		(3.83)		(8.57)		(-0.57)		(2.89)		(0.20)		(2.10)		(1.05)
Destination-year dummy			Yes	Yes			Yes	Yes			Yes	Yes			Yes	Yes
Industry-year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	547873	547873	547873	547873	199819	199819	199819	199819	69551	69551	69551	69551	207762	207762	207762	207762
adj. R^2	0.174	0.183	0.257	0.257	0.118	0.121	0.145	0.145	0.127	0.127	0.162	0.162	0.284	0.285	0.366	0.367

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: CGW_{scdt} is used as a weight for each observation. ^{d} - standard errors are clustered at the destination-year level; ^{c} - standard errors are clustered at the exporter-year level. Alternative clustering at the destination level and at the exporter level provides the same conclusion.

Table A.7: The regression results of (1.23),exchange rates and XPI in USD or XDR

	(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)
Benchmark:	USD: $\Delta p^{\$}_{scdt}$, $\Delta e^{\$}_{ct}$, $\Delta e^{\$}_{dt}$						XDR: Δp^{X}_{scdt}, Δe^{X}_{ct}, Δe^{X}_{dt}					
Exporting countries:	ADV			ADV without US and EZ			ADV			ADV without US and EZ		
Destination markets:	ADV			ADV without US and EZ			ADV			ADV without US and EZ		
Δ Exporter ER : Δe_{ct}	0.400*** (28.57)	0.326*** (20.68)		0.319*** (13.01)	0.270*** (10.76)		0.461*** (29.63)	0.380*** (21.91)		0.386*** (14.40)	0.333*** (12.01)	
Δ Destination ER : Δe_{dt}	0.137*** (17.73)	0.132*** (17.41)		0.127*** (10.57)	0.121*** (10.18)		0.137*** (17.75)	0.133*** (17.43)		0.127*** (10.60)	0.122*** (10.20)	
Δ Exporter ER $\times$ Imported inputs share: $\tilde{\phi}_{sc\tau}\Delta e_{ct}$	-0.255*** (-6.16)	-0.0683 (-1.56)	0.0193 (0.41)	-0.0991 (-1.54)	-0.0161 (-0.25)	0.133 (1.89)	-0.479*** (-8.88)	-0.282*** (-5.08)	-0.156* (-2.51)	-0.326*** (-4.01)	-0.244** (-3.01)	-0.0262 (-0.28)
Δ Exporter ER $\times$ Share in dest-n market: $\tilde{Z}_{scdt-1}\Delta e_{ct}$		0.276*** (10.98)	0.300*** (11.59)		1.085*** (6.27)	1.147*** (6.55)		0.457*** (10.98)	0.495*** (11.65)		1.268*** (5.71)	1.372*** (6.24)
Industry-specific alpha			Yes			Yes			Yes			Yes
Industry-specific beta			Yes			Yes			Yes			Yes
Industry-year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	199819	199819	199819	69551	69551	69551	199819	199819	199819	69551	69551	69551
adj. R^2	0.210	0.211	0.212	0.168	0.170	0.171	0.078	0.080	0.080	0.071	0.072	0.073

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: CGW_{scdt} is used as a weight for each observation. Standard errors are clustered at exporter-destination level. Alternative clustering at the destination-year or exporter-year level provides the same conclusion; except that the clustering at exporter-year level finds the coefficient θ are significant only in regressions (1.1) and (1.2).

Table A.8: The regression results of (1.23),weighted exchange rates, XPI in USD

	$(1.1)^d$	$(1.2)^d$	$(1.3)^d$	$(1.4)^y$	$(2.1)^d$	$(2.2)^d$	$(2.3)^d$	$(2.4)^y$	$(3.1)^d$	$(3.2)^d$	$(3.3)^d$	$(3.4)^y$	$(4.1)^d$	$(4.2)^d$	$(4.3)^d$	$(4.4)^y$
Exporting countries:	ALL				ADV				ADV without US and EZ				DEV			
Destination markets:	ALL				ADV				ADV without US and EZ				ALL			
Δ Exporter ER : Δe^W_{sct}	0.136^{***}	0.108^{***}		0.116^{**}	0.427^{***}	0.394^{***}		0.422^{***}	0.394^{***}	0.352^{***}		0.356^{***}	0.0835^{***}	0.0768^{***}		0.0772^{*}
	(13.24)	(11.29)		(2.64)	(26.40)	(20.96)		(8.51)	(13.39)	(11.35)		(5.68)	(9.61)	(8.94)		(2.53)
Δ Destination ER : Δe^W_{sdt}	0.0669^{***}	0.0640^{***}			0.138^{***}	0.137^{***}			0.128^{***}	0.125^{***}			0.0593^{***}	0.0598^{***}		
	(16.77)	(16.24)			(16.88)	(16.78)			(10.10)	(9.95)			(9.24)	(9.35)		
Δ Exporter ER $\times$ Imported inputs share: $\tilde{\phi}_{sc\tau}\Delta e^W_{sct}$	0.141^{***}	0.172^{***}	0.350^{***}	0.152	-0.633^{***}	-0.559^{***}	-0.531^{***}	-0.631^{***}	-0.540^{***}	-0.472^{***}	-0.339^{***}	-0.487^{**}	0.229^{***}	0.220^{***}	0.470^{***}	0.207
	(4.42)	(5.48)	(10.65)	(1.07)	(-11.15)	(-9.39)	(-7.91)	(-4.06)	(-6.17)	(-5.38)	(-3.36)	(-2.65)	(6.85)	(6.57)	(12.44)	(1.49)
Δ Exporter ER $\times$ Share in dest-n market: $\tilde{Z}_{scdt-1}\Delta e^W_{sct}$		0.516^{***}	0.523^{***}	0.434^{***}		0.186^{***}	0.198^{***}	0.114		1.005^{***}	1.107^{***}	0.962^{***}		0.317^{*}	0.246^{*}	0.294
		(11.99)	(11.83)	(6.92)		(5.16)	(5.39)	(1.26)		(4.45)	(4.95)	(3.51)		(2.52)	(2.21)	(1.76)
Destination-year dummy				Yes				Yes				Yes				Yes
Industry-specific alpha			Yes				Yes				Yes				Yes	
Industry-specific beta			Yes				Yes				Yes				Yes	
Industry-year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	547863	547863	547863	547863	199812	199812	199812	199812	69549	69549	69549	69549	207759	207759	207759	207759
adj. R^2	0.177	0.179	0.180	0.183	0.205	0.205	0.206	0.208	0.163	0.164	0.164	0.167	0.184	0.185	0.186	0.190

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: CGW_{scdt} is used as a weight for each observation. ^{d} - standard errors are clustered at the exporter-destination level; ^{y} - standard errors are clustered at the exporter-year level.

Table A.9: The regression results of (1.23),real effective exchange rates, XPI in USD

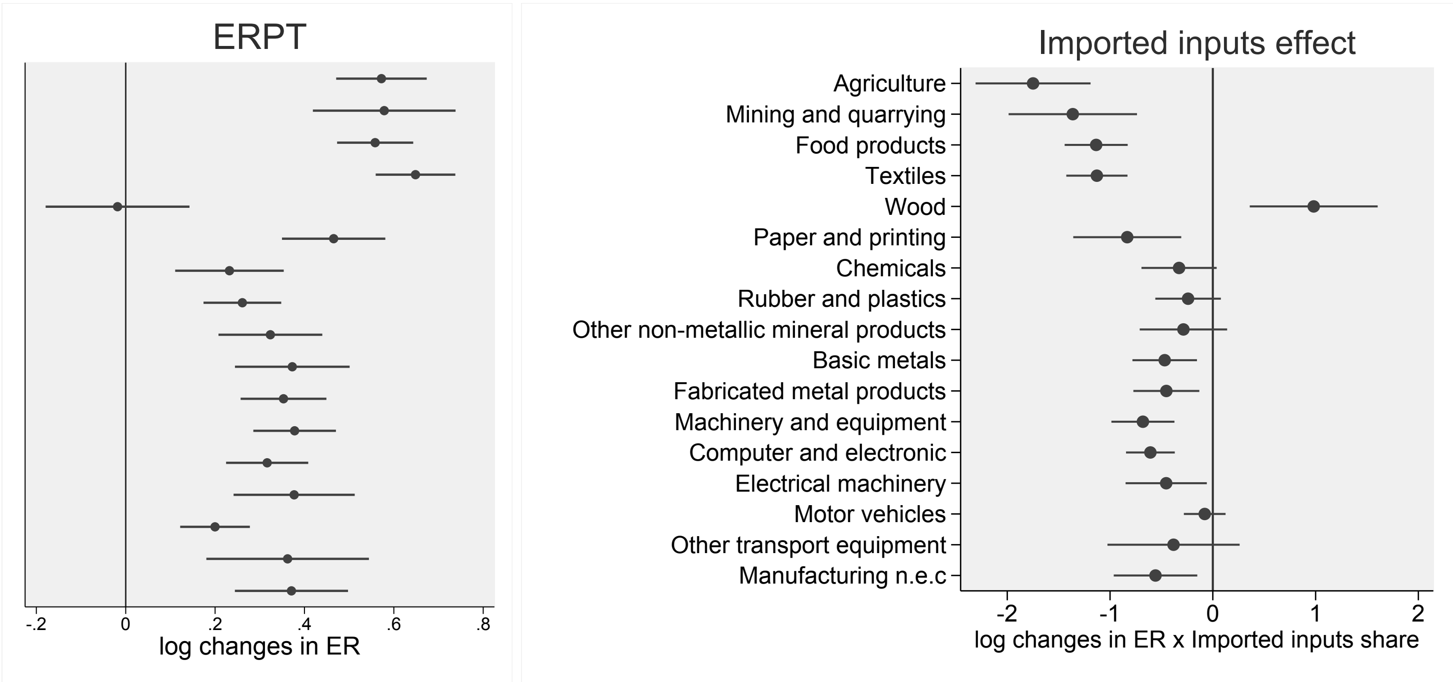
	(1.1)	(1.2)	(1.3)	(1.4)	(2.1)	(2.2)	(2.3)	(2.4)	(3.1)	(3.2)	(3.3)	(3.4)	(4.1)	(4.2)	(4.3)	(4.4)
Exporting countries:	ALL				ADV				ADV without US and EZ				DEV			
Destination markets:	ALL				ADV				ADV without US and EZ				ALL			
Δ Exporter ER : Δe^R_{ct}	0.412***	0.361***		0.362***	0.475***	0.422***		0.421***	0.396***	0.353***		0.357***	0.298***	0.281***		0.281***
	(35.80)	(31.07)		(31.29)	(24.72)	(20.29)		(20.36)	(13.59)	(11.78)		(12.09)	(18.89)	(17.89)		(17.94)
Δ Destination ER : Δe^R_{dt}	0.0774***	0.0782***		0.0419**	0.106***	0.109***		0.0405	0.0951***	0.0949***		0.0309	0.0661***	0.0653***		0.0585**
	(14.55)	(14.73)		(3.26)	(12.32)	(12.76)		(1.80)	(6.62)	(6.60)		(0.85)	(6.64)	(6.56)		(2.72)
Δ Exporter ER $\times$ Imported inputs share: $\tilde{\phi}_{sc\tau}\Delta e^R_{ct}$	-0.571***	-0.500***	-0.349***	-0.501***	-0.804***	-0.707***	-0.686***	-0.704***	-0.576***	-0.511***	-0.383***	-0.518***	-0.250***	-0.256***	0.0401	-0.254***
	(-15.01)	(-13.14)	(-7.95)	(-13.24)	(-12.95)	(-11.01)	(-9.29)	(-11.04)	(-6.38)	(-5.65)	(-3.73)	(-5.79)	(-4.61)	(-4.73)	(0.60)	(-4.71)
Δ Exporter ER $\times$ Share in dest-n market: $\tilde{Z}_{scdt-1}\Delta e^R_{ct}$		0.831***	0.857***	0.822***		0.568***	0.590***	0.568***		0.989***	1.124***	0.935***		0.741***	0.670***	0.733***
		(12.74)	(12.89)	(12.74)		(5.94)	(6.03)	(5.97)		(4.20)	(4.91)	(3.57)		(5.02)	(4.58)	(4.94)
Δ Destination ER $\times$ Imported inputs share: $\tilde{\phi}_{sc\tau}\Delta e^R_{dt}$				0.0896*				0.195*				0.156				0.00610
				(2.22)				(2.52)				(1.45)				(0.10)
Δ Destination ER $\times$ Share in dest-n market: $\tilde{Z}_{scdt-1}\Delta e^R_{dt}$				0.111***				0.139***				0.637**				0.190
				(4.28)				(3.58)				(2.75)				(1.59)
Industry-specific alpha			Yes				Yes				Yes				Yes	
Industry-specific beta			Yes				Yes				Yes				Yes	
Industry-year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	361608	361608	361608	361608	157416	157416	157416	157416	50335	50335	50335	50335	114544	114544	114544	114544
adj. R^2	0.192	0.194	0.194	0.194	0.212	0.213	0.213	0.213	0.172	0.173	0.173	0.173	0.199	0.200	0.201	0.200

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

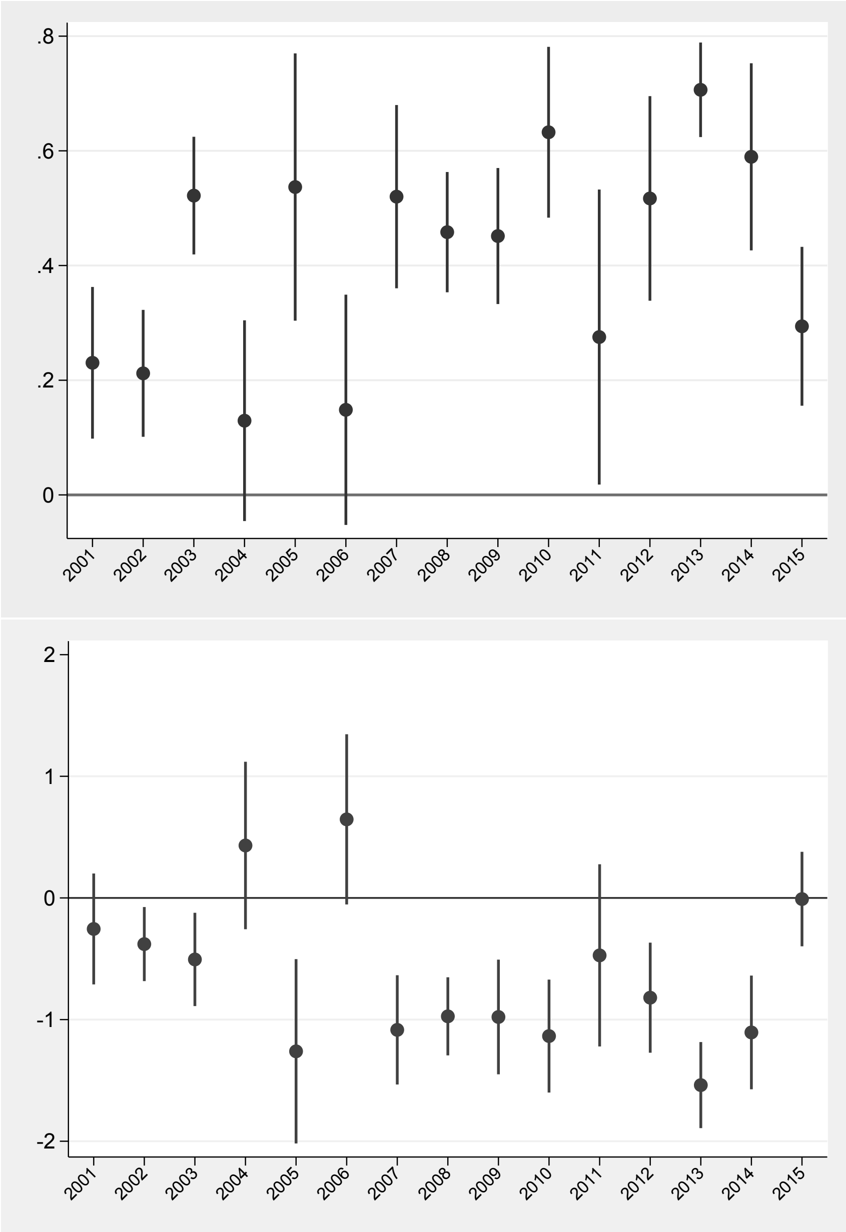
Note: CGW_{scdt} is used as a weight for each observation. Standard errors are clustered at the exporter-destination level.

Figure A.1: The variance of ERPT and the imported inputs effect across industries.



Note: Figure presents the results of (1.24) based on trade between advanced economies (without USA). The weighted exchange rate is used, the export price index is denominated in US dollar. 90% confident intervals are shown.

Figure A.2: Time variance of ERPT and the imported inputs effect.



Note: Figure presents the results of (1.25) based on trade between advanced economies (without USA). The weighted exchange rate is used, the export price index is denominated in US dollar. 90% confident intervals are shown.

CHAPTER 2

The EU National Currencies and the Asymmetry in Exchange Rate Pass-Through

This chapter examines the degree of export price sensitivity to exchange rate movements for a set of small open economies where a dominant currency – the euro – plays a significant role in international trade. Using detailed trade data over the period 2001-18, I find that pass-through into export prices expressed in an importer currency depends on the origin of exchange rate movements. When an importer currency moves against the euro, the degree of pass-through is almost complete (87%). For a producer currency movement, however, the degree of pass-through is markedly lower (39%). These results are in line with the dominant currency paradigm developed by Gopinath et al. (2020). To explain these findings, I present a model of oligopolistic competition predicting two sources of this asymmetry: (i) the use of foreign inputs in production and (ii) exporters' strategic competition in the destination market. By lowering the degree of producer currency pass-through, these channels account for roughly half of the observed asymmetry.

2.1 Introduction

Exchange rate adjustment is the core mechanism of an open economy's response to external and internal shocks. The classical view assumes depreciation of a national currency, under Marshall-Lerner condition,[52] improves balance of trade and export competitiveness. However, for some countries, the role of a

[52]Bussière et al. (2020) show the Marshall–Lerner condition is widely satisfied, including all (16 considered) EU-members.

national currency could be limited in international and even domestic transactions as foreign currencies are intensively used.[53] In such circumstances, the exchange rate has a much smaller effect on trade than usually assumed. I examine this issue considering one of the perennial questions of international trade: *how export prices respond to exchange rate movements.* From a policy perspective, the concern is the export response to a producer (national) currency shock. The limitation of using the conventional bilateral exchange rate in estimation is that it implicitly assumes the same degree of export price adjustment after a producer currency depreciation and an importer currency appreciation.[54] The problem arises as the bilateral (producer-importer) exchange rate does not distinguish which currency – producer or importer – actually moves against world benchmark currencies. I show that the bilateral exchange rate overestimates the degree of export price adjustment.

The empirical part focuses on the EU members who have not adopted the euro and therefore have floating national currencies. These are clear examples of small open economies where the euro, which is neither a producer nor an importer currency, plays a dominant role. These countries intensively use inputs originating from the Euro Area and compete with other exporters from the EU in destination markets. For them, the degree of export price adjustment crucially depends on the origin of bilateral exchange rate movements. For instance, the Polish zloty appreciation against the Russian ruble could be driven by (i) strengthening of the zloty against the euro (a dominant currency) or (ii) by the weakening of the ruble against the euro. In these cases, prices of Polish products exported to Russia (denominated in the Russian ruble) react differently. According to my estimates, if the Polish zloty appreciates by 10% against the euro (and the ruble), price adjustment is moderate (+ 4.1% only). By contrast, if the ruble depreciates by the same 10% against the euro (and the zloty), price reaction is almost complete (+ 9.4%). For this reason, the estimation of export price adjustment should distinguish between two components of bilateral exchange rate movements: (i) producer and (ii) local (importer) currency movements against the dominant currency. I analyze EU members' export prices to 25 non-EU destination markets over the period 2001-18, excluding the Great Recession.[55] There were eight EU members with floating national currencies: Croatia (*de jure*), Czechia, Hungary, Poland, Romania, Slovakia (until 2008),[56] Sweden and the UK. Having documented the similar asymmetry for each of mentioned countries, I answer the question: *what are the determinants of the observed asymmetry in exchange rate pass-through?*

[53]In Hungary, Poland and Romania substantial proportions of mortgage loans are denominated in euro, Brzoza-Brzezina et al. (2017). In Croatia, Bulgaria, Romania, more than a third of deposits were in foreign currencies, Brown and Stix (2015).

[54]The issue was discussed in Gopinath et al. (2020)

[55]The whole period is considered in the robustness check.

[56]Slovakia *de facto* had a floating exchange rate until 2008: floating and later fixed with several substantial adjustments. An eight-years period is enough for sufficient empirical estimations. Since 2001 some other EU-members had floating exchange rate for shorter periods: Slovenia had it until June 2004, Cyprus and Malta - until May 2005. These periods do not cover a sufficient number of quarters (observations) to construct meaningful estimates.

The recent dominant currency paradigm emphasizes that the degree of pass-through depends on which currency, producer or local, actually moves against the dominant currency, Gopinath et al. (2020). To theoretically examine these issues, I adapt the classical model of oligopolistic competition by Atkeson and Burstein (2008). Within this framework, Amiti et al. (2014) show that imported inputs embodied in exports reduce the marginal cost response to (bilateral) exchange rate movements and, in turn, the degree of pass-through. Using a similar setup, Devereux et al. (2017) and Auer and Schoenle (2016) focus on the role of market structure in explaining pass-through. In my framework, to analyse the contribution of each channel to the asymmetry, I explicitly decompose a bilateral exchange rate into producer and local currency parts. The model predicts that imported inputs and strategic competition affect the producer currency pass-through more than the local currency one. Therefore, both channels underlie the asymmetry in exchange rate pass-through into export prices.

Following the paradigm and considering the euro as a dominant currency for eight EU members, I decompose a bilateral exchange rate, e^b_{pl}, into the (i) producer currency exchange rate, e_p and (ii) local currency one, e_l: $e^b_{pl} = e_p - e_l$. Thus, there are two components of pass-through: the producer and the local currency pass-through. *For all EU members with floating national currencies, the producer currency pass-through is far from complete* (with an average value of 39%). However, the degree of local currency pass-through for them is nearly complete (90%) and is similar in magnitude to that of the Euro Area members (92%). Thus, the average difference between the local currency and the producer currency pass-through—the asymmetry—is 0.50. Estimations show that two equally important determinants, imported inputs and strategic competition, account for nearly half of it. That is consistent with the theoretical predictions.

The intuition behind the foreign inputs effect is quite straightforward as they affect producers' marginal cost of production. If the Polish zloty appreciates, Polish firms which import inputs from abroad now face a fall in their marginal costs. As a result, they will set lower prices, and the price Russian importers pay will not rise one-for-one with the zloty appreciation. Ruble-denominated prices will rise by less, thereby resulting in less pass-through. However, this dynamic will not occur if the Russian ruble depreciates uniformly against all currencies. Another source of asymmetry is the competitors' price effect, a channel arising from strategic competition. In case of zloty appreciation, it directly affects only Polish exporters, but not other EU exporters. By contrast, when the local currency moves against the euro, all EU exporters are directly affected and have to adjust their export prices in this destination market. In this case, the overall price level in the market changes, and the degree of a Polish exporter's price adjustment rises. Overall, the presence of other EU exporters in a local market makes a firm's export price (expressed in euro) more stable.

This research can be distinguished from existing studies in a number of ways. Firstly, I find a substantial difference between the local and the producer currency pass-through into export prices for each EU member with a floating national currency. By examining a number of countries, I broaden the results observed for Colombia by Gopinath et al. (2020). Using firm level data, they find that local currency pass-through into international prices is nearly four times higher than the degree of producer currency (peso) pass-through.[57] Interestingly, I find a similar difference in export price reactions following importer and producer currency movements for six Eastern European countries – all emerging markets – with floating national currencies. The similarity of the results across various economies suggests that the forces underlying them are robust. Most significantly, I quantify two sources of the observed asymmetry: imported inputs and strategic competition. Both mechanisms are especially relevant for the EU members outside the Euro Area, as they intensively use intermediate inputs originating from the Euro Area and strategically compete in many destination markets with exporters from the Euro Area countries. As a result, these economies provide a useful setting to examine the role of a dominant currency in exchange rate pass-through. The individual roles of imported inputs and strategic competition in (bilateral) exchange rate pass-through has been explored before (see e.g., Amiti et al. (2014), Auer and Schoenle (2016) and Devereux et al. (2017)). In my analysis, I integrate both channels into my empirical work, and disaggregate exchange rate movements into two components: producer and local (or importer) currency movements against the euro. Analysing two components of pass-through separately, I quantify the contribution each mechanism plays in explaining asymmetry. Throughout, I use disaggregated 8-digit HS (harmonised system) country-level data on market shares to proxy for an exporting firm's share in a market.[58] The empirical estimates show that imported inputs and competitors' price effects are equally important sources of the asymmetry in pass-through. These channels can explain all of the asymmetry for advanced economies (the UK and Sweden) and roughly half of it for six Eastern European countries.

The chapter proceeds as follows. The next section discusses the theoretical framework of oligopolistic competition where exporters use foreign inputs in production. Section 3 describes the data and provides summary statistics. Section 4 presents empirical results and robustness checks. The last section concludes.

[57]Considering the US dollar as the dominant currency, Gopinath, Boz, Casas, Díez, Gourinchas and Plagborg-Møller (2020) estimate a local currency pass-through between 86% - 92%, and producer currency pass-through in the range of 18%-27%. I estimate the long-run local and producer pass-through into export prices for six Eastern European countries in the ranges of 88% - 92% and 15% - 38%, respectively. Note: Gopinath et al. (2020) define pass-through as 1 minus the estimated coefficients.

[58]Auer and Schoenle (2016) (in the working paper version) use similar country-level data as a proxy for a firm's share in the US market. They find "for 61.2% of the observations ..., there is only one active firm per trade partner-HS10-year-month combination..."

2.2 Theoretical Discussion

This section provides a theoretical framework for strategic competition with the use of imported inputs in production. Strategic (or oligopolistic) competition is a common setup for understanding incompleteness of the exchange rate pass-through.[59] It is based on the model of (nested) CES demand provided by Atkeson and Burstein (2008), following the pioneering work by Dornbusch (1987). The presented model considers two determinants of pass-through: (i) the usage of foreign inputs in production and (ii) exporters' strategic competition in a destination market. These were earlier discussed in a number of works using the same framework. Amiti et al. (2014) show imported inputs reduce the degree of (bilateral) pass-through. Moreover, Auer and Schoenle (2016) and Devereux et al. (2017) analyse two components of strategic competition: the own price effect and the competitors' price effect. The first one is the firm's optimal response to its own marginal cost shock. The second one is the reaction to changes in competitors' prices.

The presented model follows the aforementioned articles, mainly Amiti et al. (2014) and Devereux et al. (2017). The main difference is that the bilateral exchange rate is decomposed into two parts: (i) producer currency movements against the dominant currency and (ii) the local currency movements against it. This allows me to consider the effects of these channels on producer currency pass-through and the local currency one separately and, in turn, to evaluate the contribution made by each channel to the asymmetry.

The next part of the section gives an overview of the model's assumptions, intuition and the main predictions. Section 2.2.2 provides formal expressions of the model. Section 2.2.3 formalises the predictions of each channels' contribution into the asymmetry in pass-through. Section 2.2.4 discusses the applied issue of the (aggregated) pass-through characteristics in the case where there is more than one firm involved in a trade flow.

2.2.1 The Overview of the Model

In the nested CES models, demand for a product negatively depends on both: (i) a relative price (a ratio of own price to an industry price level) because of the competition within the industry and (ii) the industry price level itself due to the competition between industries. The optimal price is determined by the optimal markup over the marginal cost expressed in a local currency. The optimal markup is a function of the relative price, i.e. own price and competitors' ones. Thus, the exchange rate pass-through

[59] Burstein and Gopinath (2014) provide an extensive review of the articles which use this setup along with works which apply alternative models of the incomplete exchange rate pass-through.

is the composition of: (i) the elasticity of a firm's marginal cost to an exchange rate, (ii) the elasticity of the markup to own marginal cost and (iii) the elasticity of the markup to the competitors' prices (or competitors' marginal costs).

The marginal cost channel is the most obvious source of the asymmetry. The cost function reacts differently to producer currency and local (importer) currency movements against the dominant currency because of foreign inputs embodied in exports. An exporting firm can use in production: (i) domestic labour and materials, (ii) imported inputs originating from the rest of world and (iii) imported inputs coming from a destination market. On average, the domestic part is around two-thirds, the second part is nearly one third and the last one is negligible.[60] When a local currency moves against other currencies including the producer currency, the costs of all inputs face the same percentage changes. Therefore, there marginal cost of production converted into local (importer) currency exhibits complete pass-through. On the contrary, when the producer currency moves against other currencies including a local one, only the cost of domestic inputs (the producer's value added) are directly affected. Ignoring incompleteness of pass-through into foreign input costs,[61] one may conclude that the elasticity of marginal cost to a producer currency exchange rate is equal to the domestic input share in the total expenditure. As this share is much lower than 100%, the predicted producer currency pass-through into marginal cost and, as a result, into export prices is far from complete.

Strategic competition has two components: the own price effect and the competitors' price effect. However, only the latter one is a source of the asymmetry.

I define own price effect as the export price elasticity to own marginal cost (both expressed in local currency)[62] that is 1 plus the elasticity of the markup to own marginal cost. The key feature of the model is monopolistic power: by adjusting price, a firm changes an industry price level and takes this into consideration. A firm's influence on an industry price level is proportional to its share which, in turn, is fully determined by the relative price and monotonically decreasing with it. Very small firms with negligible shares cannot affect an industry price level. There is no way for them to strategically compete. In another extreme case, when a firm's share is close to one, an industry price level is affected by a firm's price. So there is no room for strategic competition again, as a firm's competitors are too small to take a substantial part of the market. Thus, very small firms and monopolists are not as concerned about competitors, so the optimal markup is the same as it was. Consequently, they have zero elasticity of the markup to the marginal cost or, equivalently, complete marginal cost pass-through into export prices.

[60] The share of inputs originating from a destination market could be substantial in two cases: when a destination market is the main trade partner or when a firm participates in processing trade. Both cases are more common for trade within the EU, which I exclude from consideration.

[61] Later I show that non-zero pass-through into foreign input costs is a sufficient condition for the presence of the effect.

[62] One may consider the imported inputs effect as part of the own price effect. However, I separate them throughout.

However, firms with mid-size market shares prefer to absorb some part of exchange rate movements adjusting their markup. As a result, they have incomplete marginal cost pass-through. The last case is classical pricing-to-market behaviour. Thus, the own price effect is a non-monotonic (U-shaped) function of a firm's market share.

The competitors' price effect acts through the changes in an industry price level. When a competitor's currency moves against a local one, a (directly affected) competitor adjusting its price affects the local market conditions. Facing a new industry price level, a (not directly affected) firm adjusts its price as the profit maximizing price depends on the optimal relative price. The asymmetry of this effect is quite straightforward. When a local currency moves (against other currencies including the producer one), all exporters are directly affected. Taken together, they provide a substantial competitors' price effect, shifting an industry price level by a measurable value. In the other case, when a producer currency moves against other currencies, only firms exporting from the same country are directly affected. Their cumulative share in a local market, on average, is relatively small, so their influence on an industry price level is quite limited.

2.2.2 Model Setup

Consumers have a love of variety and have CES demand for individual good i (within industry s). Moreover, as usual, the elasticity of demand for individual goods is higher than for an industry's composite good ($\rho > \eta > 1$). The demand for good i (Q_{is}) is determined by the relative price level of the good within the industry, the industry price level P_s and the common scale factor for all goods within the industry (Q_s).

$$Q_{is} = \left(\frac{P_{is}}{P_s}\right)^{-\rho} P_s^{-\eta} Q_s \tag{2.1}$$

where P_{is} is a price of good i. All prices are expressed in a local currency, unless otherwise stated. Each firm exports a unique good i. It is assumed that the number of firms within an industry in a destination market is relatively small. Thus, they compete strategically in the local market l. Adjusting market prices, any firm affects industry price level P_s and takes this into account:

$$P_s = \left[\sum_i P_{is}^{1-\rho}\right]^{\frac{1}{1-\rho}} \tag{2.2}$$

The next common assumption is that the production function has constant returns to scale. A firm that exports to several destination markets is considered as a number of independent firms, each of which exports to only one destination market. Otherwise, we have to distinguish the increase in production and the redistribution of exports among destination markets. The marginal cost of production $\psi(W_i^P)$ is a function of a vector of input prices W^P (denominated in producer currency ^{P}). A firm's maximization problem could be separated into destination-specific ones:

$$\max: \quad Q_{is}P_{is} - Y_{is}E_{pl}\psi(W_i^P), \tag{2.3}$$

where E_{pl} is a local currency price of one unit of the producer currency and Y_{is} is a quantity of product i exported to the local market l. The equilibrium condition is just $Y_{is} = Q_{is}$. The optimal price is the markup over the marginal cost (converted to the local currency):

$$P_{is} = \underbrace{\frac{\epsilon_{is}}{1-\epsilon_{is}}}_{markup} \times \underbrace{E_{pl}\psi(W^P)}_{MC}, \tag{2.4}$$

where ϵ_{is} is the demand elasticity. Under Bertrand competition[63] it is a function of a market share θ_{is}:

$$\epsilon_{is} \equiv -\frac{d\ q_{is}}{d\ p_{is}} = \rho + (\eta - \rho)\left[\frac{P_{is}}{P_s}\right]^{(1-\rho)} = \rho + (\eta - \rho)\theta_{is}, \tag{2.5}$$

where q_{is} and p_{is} represent log quantity and log price, respectively.

Holding other prices constant, the elasticity of markup to a firm's price is:

$$\Gamma_{is} \equiv -\frac{\partial\ log\ \dfrac{\epsilon_{is}}{1-\epsilon_{is}}}{\partial\ p_{is}} = \frac{(\rho-\eta)(\rho-1)\theta_{is}}{\epsilon_{is}(\epsilon_{is}-1)} > 0, \quad \forall\theta > 0 \tag{2.6}$$

Imported inputs

The exchange rate elasticity of marginal cost depends on the foreign inputs share in gross exports (ν) which contains intermediate goods originating from a destination market (ν^L) and the rest of the world (ν^R):

$$\frac{d\ mc_{is}}{d\ e_{pl}^b} = 1 + \underbrace{\frac{\partial\psi}{\partial W^P}\frac{W_i^P}{\psi}}_{\hat{\psi}>0}\frac{d\ w_i^P}{d\ e_{pl}^b} = 1 - \hat{\psi}_{is}\zeta_{is}(\nu_{is}^L + \varphi_{pl}\nu_{is}^R), \tag{2.7}$$

where e_{pl}^b is a log-exchange rate; $\hat{\psi}$ is the reaction of marginal cost to changes in prices of intermediate goods (both expressed in a producer currency); ζ is the degree of the exchange rate pass-through into imported inputs prices; $\varphi = corr(\bar{\varepsilon}_p, e_{pl})$, where $\bar{\varepsilon}_p$ - nominal effective exchange rate of the producer currency against the rest of the world. In the simplest case, there is no substitution between domestic

[63] The alternative Cournot competition has a similar implication, see Chapter 1. Amiti et al. (2019) argue both price and quantity competition provide the same qualitative implications. I restrict the analysis considering only Bertrand competition.

and foreign inputs, so $\hat{\psi} = 1$, and it is > 1 if a producer can adjust inputs composition after changes in relative cost.

It is implicitly assumed that prices of domestic[64] inputs and wages do not react to exchange rate movements of the producer currency when they are expressed in it. Moreover, the pass-through into imported inputs prices is high and close to complete,[65] so $\zeta \approx 1$. Relaxing both assumptions has no effect on qualitative conclusions. The only necessary condition for imported inputs channel is this: a producer currency exchange rate should have lower influence on prices of domestic inputs and wages than on prices of imported inputs (all expressed in producer currency).

The asymmetry of marginal cost reaction (2.7) is related to φ. When a local currency moves against the dominant currency (the rest of the world), $\varphi = 0$. In the opposite case, when a bilateral exchange rate shock arises from a producer currency movement against the dominant currency (ROW), $\varphi = 1$.

Strategic competition

The derivative of a log price (2.4) with respect to log of a (bilateral) exchange rate is:

$$\frac{d\ p_{is}}{d\ e^b_{pl}} = -\Gamma_{is}\frac{d\ p_{is}}{d\ e^b_{pl}} + \Gamma_{is}\sum_j \theta_{js}\frac{d\ p_{js}}{d\ e^b_{pl}} + \frac{d\ mc_{is}}{d\ e^b_{pl}} \tag{2.8}$$

Thus, the expression of the optimal price reaction to an exchange rate contains three components:

$$\frac{d\ p_{is}}{d\ e^b_{pl}} = \underbrace{\frac{1}{1+\Gamma_{is}(1-\theta_{is})}}_{own\ price\ eff.} \times [1 \underbrace{-\hat{\psi}_{is}\zeta_{is}(\nu^L_{is} + \varphi_{pl}\nu^R_{is})}_{imp.\ inputs\ eff.}] + \underbrace{\frac{\Gamma_{is}}{1+\Gamma_{is}(1-\theta_{is})}\sum_{j\neq i}\theta_{js}\frac{d\ p_{js}}{d\ e^b_{pl}}}_{competetors'\ price\ eff.} \tag{2.9}$$

The own price effect represents the optimal response of a firm's price to a bilateral exchange rate movement, holding all other firms' prices constant. Figure 2.1 represents this effect as a function of a producer's market share. The own price effect is symmetric. The intuition of the U-shaped relationship is the following. Only a firm that occupies mid-share of the destination market has incentives to adjust its markups competing for market share. By contrast, a very small firm and a monopolist prefer high (full) pass-through. The former firm has no market share to lose and does not have any market power for strategic competition. The latter one does not care about competitors as they are too small to affect its sales.

The competitors' price effect depends on the degree of other firms' export price reaction. They substantially adjust export prices when their marginal costs of production are directly affected by exchange

[64]For Euro Area countries, inputs from other EA members are considered as domestic ones.
[65]Fauceglia et al. (2014) show the exchange rate pass-through into imported intermediate goods in Switzerland is statistically different from zero for almost all industries and it is not different from 100% for most industries. Switzerland is a relevant example for our sample, as it is also a small open economy which is deeply integrated with the Euro Area.

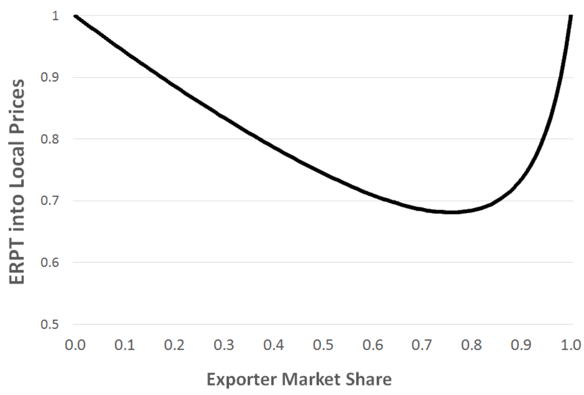


Figure 2.1: Own price effect: $\rho = 5,\ \eta = 2$

rate movements. Consequently, a local currency movement affecting all exporters provides a meaningful competitor price effect. For clarity, the optimal price reaction could be expressed from (2.8) as a function of marginal cost reactions of all firms:[66]

$$\begin{aligned} \frac{d\ p_{is}}{d\ e^b_{pl}} &= \frac{1}{1+\Gamma_{is}}\left(1+\frac{\Gamma_{is}\theta_{is}}{(1+\Gamma_{is})\omega_s}\right)\frac{d\ mc_{is}}{d\ e^b_{pl}} + \frac{\Gamma_{is}}{(1+\Gamma_{is})\omega_s}\sum_{j\neq i}\left[\frac{\theta_{js}}{1+\Gamma_{js}} \times \frac{d\ mc_{js}}{d\ e^b_{pl}}\right] \\ \omega_s &\equiv 1-\sum_k \frac{\Gamma_{ks}\theta_{ks}}{(1+\Gamma_{ks})} \quad > 0 \end{aligned} \tag{2.10}$$

Under the assumption that there is only one exporting firm from country p, the second term equals zero in the case where the producer currency moves. Moreover, the own marginal cost reaction is incomplete in that case. Later I relax the assumption and show that the qualitative results of the model are the same. In contrast, when a local currency moves against the dominant currency, the euro, a lot of (all) firms are directly affected. In this case, the second term becomes important.

2.2.3 Predictions

The bilateral (producer-local) exchange rate could be disaggregated into producer currency exchange rate against the dominant currency and the local currency one against it: $e^b_{pl} = e_p - e_l$. For any firm j that exports from another country ($j \notin p$), marginal cost mc_{js} does not react to a competitor's currency movement:

$$\frac{d\ mc_{js}}{d\ e_p} = \hat{\psi}_{js}\zeta_{js}\nu^P_{js} \approx 0, \tag{2.11}$$

where ν^P_{js} is a share of inputs originating from country p in production costs of firm j that is negligible for most $j-p$ country pairs. On the other hand, the marginal cost reaction is almost complete when the

[66]The same equation, with another permutation of summands, could be found in Auer and Schoenle (2016).

local currency moves:

$$\frac{d\ mc_{js}}{d\ e_l} = 1 - \hat{\psi}_{js}\zeta_{js}(\nu^L_{js} + \varphi_{jl}\nu^R_{js}) \approx 1 - \hat{\psi}_{js}\zeta_{js}\nu^L_{js} \tag{2.12}$$

$\varphi = corr(\bar{\varepsilon}_j, e_l) \approx 0$, as the nominal effective exchange rate of currency j against the rest of world $\bar{\varepsilon}_j$ does not depend on the local currency exchange rate. Using equation (2.10) it is easy to conclude that, other things being equal:

$$\frac{d\ p_{js}}{d\ e_l} > \frac{d\ p_{js}}{d\ e_p} \tag{2.13}$$

Thus, the competitors' price effect is bigger when the local currency moves than when the producer currency does. The same is true for the response of own marginal cost (expressed in the local currency):

$$\frac{d\ mc_{is}}{d\ e_l} = 1 - \hat{\psi}_{is}\zeta_{is}\nu^L_{is} \quad > \quad 1 - \hat{\psi}_{is}\zeta_{is}(\nu^L_{is} + \nu^R_{is}) = \frac{d\ mc_{is}}{d\ e_p}. \tag{2.14}$$

Proposition 2.1. *The pass-through of a marginal cost shock into export prices (the own price effect) is a U-shaped function of an exporter's market share θ. Holding constant other firms' prices, this relationship is symmetric across sources of bilateral exchange rate movements, (2.9).*

$$f(\theta_{is}) \equiv \left.\frac{d\ p_{is}}{d\ mc_{is}}\right|_{dp_j=0,\ j\neq i} = \frac{1}{1+\Gamma_{is}(1-\theta_{is})}; \qquad \lambda_1 = \frac{\partial f(\theta_{is})}{\partial \theta_{is}} < 0, \qquad \lambda_2 = \frac{\partial^2 f(\theta_{is})}{\partial \theta^2_{is}} > 0 \tag{2.15}$$

Proposition 2.2. *Imported inputs ν limit the degree of producer currency pass-through into export prices as they reduce marginal cost reaction to Δe_p. Holding constant other firms' prices, this relationship is asymmetric $\kappa_p \neq \kappa_l$, (2.14).*

$$v^p_{is}(\nu) \equiv \left.\frac{d\ p_{is}}{d\ e_p}\right|_{dp_j=0,\ j\neq i} = f(\theta_{is})[1 - \hat{\psi}_{is}\zeta_{is}(\nu^L_{is} + \nu^R_{is})]; \qquad \kappa_p = \frac{\partial v^p_{is}}{\partial \nu_{is}} < 0 \tag{2.16}$$

$$v^l_{is}(\nu) \equiv \left.\frac{d\ p_{is}}{d\ e_l}\right|_{dp_j=0,\ j\neq i} = f(\theta_{is})[1 - \hat{\psi}_{is}\zeta_{is}\nu^L_{is}]; \qquad \kappa_l = \frac{\partial v^l_{is}}{\partial \nu_{is}} \approx 0, \quad as \quad \frac{\nu^L}{\nu^L + \nu^R} << 1 \tag{2.17}$$

Proposition 2.3. *The competitors' price effect increases pass-through into export prices. Holding constant a firm's marginal cost, the effect is asymmetric: its influence on the local currency pass-through is higher than on the producer currency one, (2.13).*

$$c^k(\theta_{is}, \theta_{js}) \equiv \left.\left|\frac{d\ p_{is}}{d\ e_k}\right|\right|_{dmc_{is}=0} = \frac{\Gamma_{is}}{1+\Gamma_{is}(1-\theta_{is})}\sum_{j\neq i}\theta_{js}\left|\frac{d\ p_{js}}{d\ e_k}\right|; \qquad k \in \{p, l\} \tag{2.18}$$

$$\mu_k = \frac{\partial c^k(\theta_{is}, \theta_{js})}{\partial(\sum_{j\neq i}\theta_{js})} > 0; \qquad \mu_l > \mu_p, \qquad as \qquad \left|\frac{d\ p_{js}}{d\ e_l}\right| > \left|\frac{d\ p_{js}}{d\ e_p}\right| \quad \forall j \notin p, \quad \forall s \in l$$

2.2.4 Aggregation within Trade Flow

This part discusses the more general situation when more than one firm exports goods from country p to market l within industry s. From the purely theoretical point of view, this case is the same as that discussed earlier. However, the country level data I use contains information about producer country-local market-product group ($p-l-s$) trade flows. It requires us to consider the aggregated pass-through for two (or more) firms within a trade flow as such pass-through is observed in the data. The consideration contains two main steps. First, I include the part of competitors' price effect, which is created by other firms acting within the same trade flow, into the own price effect. I refer the resulting sum as the cumulative own price effect. Second, I show how the use of a unit value price affects the observed pass-through. For example, if the smaller firm within a trade flow increases price and the bigger one has the same price, then the resulting changes in price should be positive according to Laspeyres, Paasche, Fisher or other price indexes. The limitation of a unit value price is that it captures the substitution effect. Under CES demand, the smaller firm has a higher price. An increase in its price may lead to decrease in the unit value price as a share of more expensive products in trade flow falls. However, this effect cannot change the U-shape of the relationship between (aggregated) pass-through and the cumulative market share. Without loss of generality, I illustrate it in the case where there are two acting firms within one trade flow; see Figure 2.2. The equations are provided in Appendix 2.A.

2.3 Data

2.3.1 Country Sample

The set of exporting countries includes all EU members, which can be divided into three groups: ones with floating national currencies, the Euro Area countries, and others. The main interest is the former group. There are seven EU member states that had floating exchange rates against the euro over the whole period 2001-2018: Czechia, Hungary, Poland, Romania, Sweden, the UK, and Croatia.[67] Several EU members switched from the floating to fixed/pegged regimes or joined the Euro Area within the period; see Figure B.2. Out of them, only Slovakia had a sufficient period under the floating exchange rate regime (until the end of 2008[68]) for the pass-through estimations.

The Visegrad countries, **Czechia, Hungary, Poland** and **Slovakia**, are similar in many aspects. They became EU members on May 1^{st} 2004. At the beginning of the period, none of them were considered

[67] Croatia *de jure* has a floating exchange rate.

[68] Slovakia has participated in the ERM since late 2005, but several times adjusted its exchange rate before it adopted the euro.

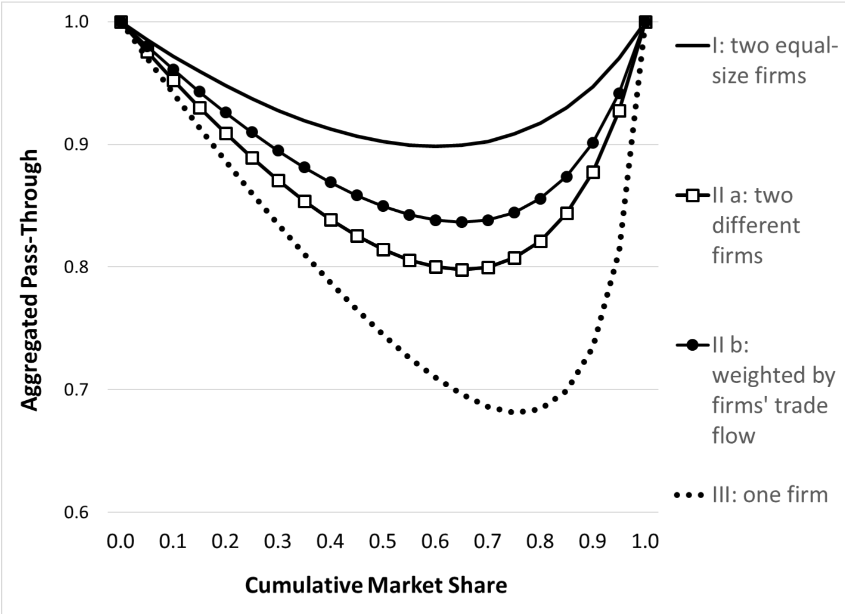


Figure 2.2: The cumulative own price effect for two acting firms

Note: I – two equal-size firms; II – two firms, one of which is four times bigger: IIa – changes in a unit value price & IIb – changes in prices, weighted by firms' contribution to trade flow (the measures are different only for not equal-size firms); III — one acting firm.
Lines represent the cumulative own price effect on pass-through. For each firm, it contains own price effect and the competitor's effect created by another exporter from the same country. Parameters: $\rho = 5,\ \eta = 2$

as developed economies.[69] Their national currencies varied in similar ranges (30% - 45%), see Table 2.1. For these countries, there was a (weak) positive correlation between changes in their exchange rate and inflation. This was driven by the first half of the considered period when they experienced a strengthening of national currencies and a high level of inflation rates.

Romania experienced the biggest variation of its exchange rate and had a strong negative correlation between the inflation rate and the exchange rate. On the contrary, **Croatia** had a very stable exchange rate against the euro with the range +/- 4% around the mean within the eighteen-year period. Later in the text, these six countries are considered as emerging markets.

There are two advanced economies in the sample: Sweden and the UK. **Sweden** is the wealthiest economy in the sample. However, the krona fluctuated within a wide range against the euro and its exchange rate had a weak (negative) correlation with the inflation rate. In that sense, Sweden is similar to Visegrad countries.

It is reasonable to consider **the UK** as a possible outlier. First, the UK is the biggest economy in the sample — its GDP exceeds the total one of the other seven countries. As a result, the average market share

[69]Now all of them are classified as developed economies by the World Bank. Czechia and Slovakia are also included in the advanced economies group by the IMF.

Table 2.1: Summary statistics for the EU national currencies exchange rates

ISO	Producer country	Exchange rate range^a	Mean annual appr. $4\overline{\Delta e_p}$, %	s.e.(Δe_p), %	corr $(\Delta e_p, \Delta e_l)$	Mean annual inflation $\overline{4\pi_p}$, %	corr $(\Delta e_p, \pi_p)$
CZ	Czechia	.44	1.50	2.27	-.006	2.00	.081
HU	Hungary	.31	-1.18	2.98	.045	4.30	.036
PL	Poland	.36	-0.25	3.98	.119	2.59	.065
RO	Romania	1.06	-6.92	4.15	.085	9.63	-.641
SE	Sweden	.28	-0.48	2.26	.134	1.54	-.044
HR	Croatia	.08	-0.06	1.05	.079	2.22	.199
GB	the UK	.41	-1.16	2.91	.244	2.03	-.066
SK	Slovakia^b	.40	3.36	2.13	.008	5.47	.084

Source: author's calculation based on Eurostat data: (i) Euro/ECU exchange rates - quarterly data (ert_bil_eur_q); (ii) Former euro area national currencies vs. euro/ECU - quarterly data (ert_h_eur_q) and (iii) Harmonised index of consumer prices (prc_hicp_mmor)
Note: e_p is the quarterly average exchange rate of a producer currency versus euro, i.e. the log of unit price of a national currency expressed in euro, e_l - is the one of local currency (25 countries); π_p is the quarterly inflation rate in a producer country.
Note: ^{a} – the range is $2(E_p^{max} - E_p^{min})/(E_p^{max} + E_p^{min})$; ^{b} for Slovakia the time period is till the end of 2008.

of British exporters and their market power is bigger than for firms exporting from other countries; see Table B.2. Moreover, the probability that there are more than one acting firm within a trade flow should be much higher than for other countries. Second, only the UK extensively uses the national currency in international trade. The share of exports to outside of the EU priced in non-euro EU currencies was 57% for the UK in 2016; this is much higher than for Sweden (22%) or the other six countries in the sample (2-10%).[70] In addition, the sterling exchange rate against the euro was substantially correlated with local currencies' exchange rates against it (.24). For these reasons in the robustness check I exclude the UK from the sample.

The sample of destination markets includes 25 countries: 13 advanced economies and 12 emerging markets; see Table B.1. They cover 66% of total EU exports to non-EU countries. None of the destination markets' currencies is fixed or pegged to the euro. Thus, local currencies are considered as floating ones.

2.3.2 Unit Value Price

Despite a number of limitations, unit value prices (UVPs) are still widely used in trade statistics including the construction of price indexes.[71] The Eurostat database contains information about monthly export values and volumes at a very disaggregated 8-digit HS level for each EU member and destination market. In addition to HS classification, the supplementary units are used for some products. I define a product

[70] Source: Eurostat, Extra-EU exports of goods by invoicing currency (ext_lt_invcur)
[71] For detailed discussion of the limitation, see Chapters 1 and 2 of the Import and Export Price index Manual, ILO, IMF, OECD, Eurostat, UN and WB (2009).

industry (s) as a unique combination of a 8-digit HS code and a supplementary unit – 15,155 product industries in total. Product i is a producer country - product industry pair (p, s). As a result, the unit value price is a ratio of the quarterly export value of product s from country p to destination market l to the corresponding volume. Changes in UVP exceeding twofold rise or fall are dropped from the consideration.[72] There is a trade-off between the frequency of observations and the continuity of the panel. On the one hand, aggregation from monthly to quarterly trade allows me to calculate changes in UVP for a bigger portion of trade flows. On the other hand, shipments are more frequent for trade flows with more than one acting firm. The very small trade flows (less than €2,000) and ones that are non-zero less than 50 percent of the time are excluded as they are extremely noisy.

The unit value price of a producer country's exports to a destination market expressed in local (destination) currency is a proxy for a firm's price P_i.

2.3.3 Market Share Proxies

Similarly, a producer country's share in a destination market proxies for θ_{isl}. Following the literature, I assume that the "macro" Armington elasticity is smaller than "micro" or that the competition between aggregate foreign goods and domestic ones is weaker than between different imported goods (Feenstra, Luck, Obstfeld and Russ, 2018).[73] Going further, one may consider domestic goods and similar foreign goods (from the same 8-digit HS product category) as two different sub-industries s_d and s_f. Thus, a producer's market share is its fraction in the world exports of these products to a destination market. However, for most considered markets the last one is available only for a higher level of aggregation and on annual basis. I introduce two proxies for an actual market share. The first one, $S_{ipl\tau}$, is a share of the producer country p in total EU exports of these products ($i \in s$) to destination (local) market l. It is calculated quarterly at an 8-digit HS level based on Eurostat trade data. Avoiding possible technical correlation between market shares and changes in exchange rates, I apply a one-year lag ($\tau = t - 4$). The second measure of market share, $S^{EU}_{\iota l\tau}$, is the EU share in a destination country's total imports of product sector ι. COMTRADE country-level import data is used as it is usually more accurate than the export one. $S^{EU}_{\iota l\tau}$ is computed at 6-digit HS level (5,222 sectors ι) and on an annual basis; here τ reflects the previous year. Table B.2 provides summary statistics.

There are two ways I incorporate these measures into the regression analysis. The first (main) option is to use $S_{ipl\tau}$ as a proxy of a firm's market share and $S^{EU}_{\iota l\tau}$ as a proxy of affected competitors' market

[72] This filter has been applied in a number of works, including Amiti et al. (2014) and Devereux et al. (2017). It is difficult to find a reasonable explanation for such big changes in unit value prices except mixing very different products within one trade flow.

[73] Authors find that the empirical evidence in favour of the hypothesis for nearly half the product groups using the US data.

share. In such case, a producer's market share may vary in the whole range from 0% to 100%, but non-EU exporters are in some way ignored. The second measure of a firm's market share is the interaction $S_{ipl\tau} * S_{\iota l\tau}^{EU}$ that uses in the robustness check.

Both measures S_{ipl} and $S_{ipl} * S_{\iota l}^{EU}$ should positively correlate with the actual share $\theta_{ipl} = S_{ipl} * \tilde{S}_{il}^{EU}$, where $\tilde{S}_{il}^{EU}$ is the *unobservable* EU share at the same level of aggregation (i). For the estimation of the linear term in the own price effect, the second measure does not systematically overestimate a market share. However, it affects the comparison between the theoretically predicted coefficients and the estimated ones.

For the quadratic term estimation, the main concern is the ability of a measure to accurately predict a monopolistic share ($\theta_{isl} \approx 1$). $S_{ipl} \approx 1$ implies a single EU member accounts for most EU exports of i to a destination market, it is reasonable to assume that, with high probability, its position in a market is a leading one. Thus, S_{ipl}^2 achieving 1 proxies θ_{ipl}^2. The other measure is limited, as $(S_{ipl} * S_{\iota l}^{EU})^2 \leq (S_{\iota l}^{EU})^2$. The problem is the (observable) EU share in destination market's imports of the same product i ($\tilde{S}_{il}^{EU}$) could be substantially different from its (observable) share in imports of the product sector ι ($S_{\iota l}^{EU}$), $i \in \iota$.

2.3.4 Imported Inputs

Having a lack of detailed information about import intensity, I applied country-industrial sector level data from the TiVA database.[74] Using country inputs-outputs tables, this provides an annual estimation of the foreign inputs share in a country's gross exports (to all destinations) at an industrial sector level. Such approach exists in the literature. For instance, the TiVA database was used for evaluating the effect of imported inputs on export volumes after producer currency depreciations by Ahmed, Appendino and Ruta (2015).

I include 15 tradable industrial sectors in the sample: all goods except mining, agricultural and foodstuff products. The CES demand model should be applied for heterogeneous products that are producer-specific. The excluded goods are mainly homogeneous commodities with the same universal prices regardless of exporting or importing countries. $V_{xp\tau}$ is the share of foreign inputs embodied in a country's p gross exports of industrial sector x. I use it as a proxy for ν_{ispt}, $\forall\ is :\ i \in s \in x$. Avoiding possible technical correlation between exchange rates and the imported inputs share, I use lags: τ reflects a two-year lag.[75] This does not affect results substantially, as the imported inputs shares are stable over time.[76] Moreover, for all years since 2013, I use 2011 values, which is the last available year in the TiVA database.

[74] Trade in Value-Added database is a joint OECD and WTO project.
[75] Lags are also used in Amiti et al. (2014).
[76] The correlation between $V_{xp,t}$ and $V_{xp,t-1}$ is 98,9%; $t \leq 2011$.

2.3.5 A Number of Exporting EU Members

The use of country-level data makes the results more relevant for policy implications. However, this raises the issue of the accuracy of the country-level data as a proxy for the firm-level data. The core assumption I made is that only one firm acts within the trade flow in most cases. In Section 2.2.4 I discuss how the violation of this assumption would affect the own price effect estimation and the accuracy of unit value index as a measure of price changes. The other possible way to look at it is to analyse the number of EU members exporting products in the same product industry $i_1, ..i_n \in s$. An exporting firm competes with exporters from 6 other EU members in the median trade flow and with 10 in the 75th percentile one; see Table B.2. The median number is from 9 to 11 for Visegrad countries, and it is lower for Sweden and the UK. Thus, for all countries in the sample, in most cases less than half of the EU members export the same product group s to the same local market. To a large extent, this supports the assumption that in many cases there is a single firm exporting per exporting country. This is especially correct for smaller economies.

2.4 Empirical Results

This section tests the theoretical predictions on trade data. First, following the newest Dominant Currency Paradigm (DCP) developed by Gopinath et al. (2020), I consider export price reaction to two sources of changes in bilateral exchange rate: (i) producer currency movements against the dominant currency (the euro) and (ii) local currency movements ones against it. The estimation finds export prices react more to local currency exchange rate movements against the euro than to producer currency ones. This difference in the degree of export price adjustment — the asymmetry in pass-through — is statistically significant for all eight EU members with floating national currencies. In Section 2.4.2, I show the presence of imported inputs and strategic competition channels using the conventional bilateral (producer-local) exchange rates. Strategic competition contains two channels: (the cumulative) own price effect and the competitors' one. I show that the former effect is a non-monotonic function of an exporter's share in a destination market. This is consistent with theoretical predictions. It also justifies the use of a country-level share at the very disaggregate level to approximate a firm's share in a destination market. In Section 2.4.3, I consider both channels' influence on the producer currency pass-through and on the local currency one separately. The use of imported inputs is a significant source of the asymmetry. It decreases producer currency pass-through, reducing the dependence of marginal cost on an exchange rate of a producer's national currency. The other source of the asymmetry is the competitors' price effect.

Estimations show the bigger cumulative share of EU exporters in a market, the more stable export prices are, when they are converted in euro. At the end of the section, I evaluate the contribution made by each channel to the observed asymmetry in pass-through. Section 2.4.4 contains various robustness checks.

2.4.1 The Asymmetry in Pass-Through

As the initial step of the empirical analysis, I estimate pass-through using the conventional bilateral (producer-local) exchange rate over a two-year time period:

$$\Delta p^l_{iplt} = \alpha_{it} + \sum_{k=0}^{7} \beta_{[p]k} \Delta e^b_{pl,t-k} + \gamma Z_{pt} + r_{iplt}, \tag{2.19}$$

where Δp^l denotes log-changes in a unit value price (expressed in local currency) of product s exporting from producer country p to destination (local) market l in quarter t. To clarify the link to the theoretical model, a firm-specific product is a unique combination of an 8-digit HS product (group) i, exporting country p, and destination market l: $\{i, p, l\}$. The equation contains α_{it}, which controls of the world price level of a product group. This also eliminates the concern that the US dollar is another possible dominant currency for the considered countries. Z_{pt} controls for a price level in a producer country (with lags) using an inflation rate, π_{pt}.[77] $\Delta e^b_{pl,t-k}$ denote log-changes in the bilateral exchange rate of a producer currency against a local one; positive values correspond to appreciation of a producer currency. Figure 2.3 represents one-quarter $\beta_{[p]0}$ and two-year $\sum_{k=0}^{7} \beta_{[p]k}$ bilateral exchange rate pass-through coefficients for all EU members; all pass-through coefficients are producer-country-specific $[p]$. Table B.3 provides the same coefficients.

For most of the EU members, the one-quarter bilateral pass-through is not statistically different from the two-year one, see Figure 2.3. Frequency of export prices adjustment is around a half-year to one year.[78] As a result, a substantial part of exporters would adjust their prices after exchange rate movements within one quarter. For most of the countries (23 out of 28), the first lagged coefficient $\beta_{[p]1}$ of the exchange rate is negative.[79] This could reflect the fact that just after exchange rate movements, export prices with higher probability will move in the same direction. Exporters who have adjusted their prices with lower probabilities will do it shortly after. This creates an imbalance between the number of

[77] The empirical works usually apply the following controls for a price level in a producer country: the inflation rate, changes in nominal wages or in PPI. Regressions with such controls (changes in PPI at industrial sector level and changes in nominal wages) provide the similar results, not reported.

[78] Gopinath and Rigobon (2008) find the average duration of price adjustment is 13 months for US exporters. Fitzgerald and Haller (2008) report that the weighted median time of Irish exporters' price adjustment is six months. Vermeulen et al. (2012) estimate the average monthly frequency of producer price adjustment for six EA countries is 21%.

[79] For 18 countries, it is significant at 10% level.

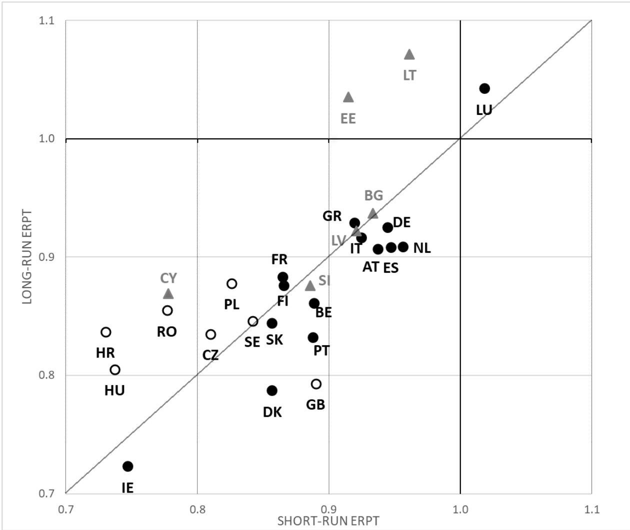


Figure 2.3: Short-run (1Q) and Long-run (2Y) bilateral exchange rate pass-through

Note: black circles – 12EA member and Denmark; empty circles – countries applied floating ER against the euro; grey triangles – other EU members.
For any country in the sample (except Lithuania), pass-through is not statistically bigger than 1, for Lithuania the long-run pass-through exceeds 1 at 10% significance level. Malta is skipped. Danish krone has a quite narrow fluctuation band of ±2.25% for the exchange rate against the euro since 1999.

firms increasing their prices and ones decreasing them.[80] The average value of the first lagged coefficient is only -.036. Its absolute value is markedly less than the degree of short-run pass-through for all countries in the sample.

In the short-run the degree of pass-through for all Euro Area countries (except Ireland) is higher than for any of the EU members with floating national currencies (except the UK). The difference in the degree of pass-through between these two groups of EU members remains in the long-run. The unique position of Sterling among other national currencies of the EU could explain the relatively high degree of pass-through for UK exports to non-EU destinations. In the very short-run, prices are rigid in the currency they are set in. The UK is the only country in the sample which extensively uses national currency in international trade. Moreover, the Republic of Ireland – the other exception – has deep economic relations with the UK.

One may suggest this inequality in the degree of export price adjustment after a bilateral (producer-local) exchange rate movement is related to the type of producer currency. The Euro Area countries use one of the dominant world currencies. The other EU members use national currencies whose roles in the global economy are less important. The economic intuition behind this is quite straightforward. Local

[80]Gopinath and Rigobon (2008) find the higher probability of observing price decreases one month after a large depreciation. However, the probabilities of observing increases and decreases of prices become equal two months following depreciation.

currency movements against a world dominant currency, like the euro, should have bigger effect on prices (expressed in local currency) than movements against a less important currency.

There are two main producer currencies within the EU: the world dominant currency, the euro, or a national currency with a floating exchange rate against the euro. Countries with the fixed or pegged exchange rates are closer to the first group, with some reservations. The hypothesis is that *the degree of pass-through depends on the type of producer currency.* For testing the hypothesis, I decompose (log changes in) a bilateral exchange rate (Δe^b_{pl}) into a local currency exchange rate against the euro (Δe_l) and a producer one against the euro (Δe_p): $\Delta e^b_{pl} = \Delta e_p - \Delta e_l$. As a result, the classical pass-through equation (2.19) transforms into the following equation with two groups of the corresponding pass-through coefficients:[81]

$$\Delta p^l_{iplt} = \alpha_{it} - \sum_{k=0}^{7} \beta^l_{[p]k} \Delta e_{l,t-k} + \sum_{k=0}^{7} \beta^p_{[p]k} \Delta e_{p,t-k} + \gamma Z_{pt} + r_{iplt}, \tag{2.20}$$

where $\beta^l_{[p]}$ represents the degree of the local currency pass-through, the elasticity of export prices to local currency exchange rate against the euro. Similarly, $\beta^p_{[p]}$ is the degree of the producer currency pass-through; they are distinguished with the upper index. The asymmetry in pass-through is the difference between them: $\chi \equiv \beta^l - \beta^p$. A (positive) asymmetry shows export prices (expressed in a local currency, p^l) react more to local currency movements (against the euro) than to similar shifts of a producer (national) currency. The Euro Area countries have no second component by definition ($\Delta e_p \equiv 0$). Figure 2.4 represents both components of pass-through for EU members with floating exchange rates against the euro (Germany is added as a benchmark level of local currency pass-through).

The asymmetry in pass-through is statistically significant for all eight EU members with floating exchange rates, see Table B.4. Figure 2.4 shows the degree of the local currency pass-through for the non-EA countries is in the same range as the twelve EA members. It is almost complete and relatively stable in time. The one-quarter local currency pass-through for the non-EA countries is from .77 (Croatia) to .95 (the UK); for the EA12 it is from .75 (Ireland) to 1.03 (Luxembourg). Thus, the difference in the (bilateral) pass-through between the two groups of countries comes from the fact that the producer currency pass-through is far from complete for the EU members with floating exchange rates. Moreover, it is declining over time for most of the countries in the group: as a result, the asymmetry is bigger in the long-run than in the short-run.

[81] Gopinath et al. (2020) apply another way to show the difference in the reaction. They add the exchange rate of the Colombian peso against the US dollar rather than through decomposing a bilateral (peso-importer) exchange rate. As expected, applying this method produces identical results, because the alternative specification uses the linear combination of the same exchange rates. However, I think the presented regression provides coefficients that could be interpreted more easily.

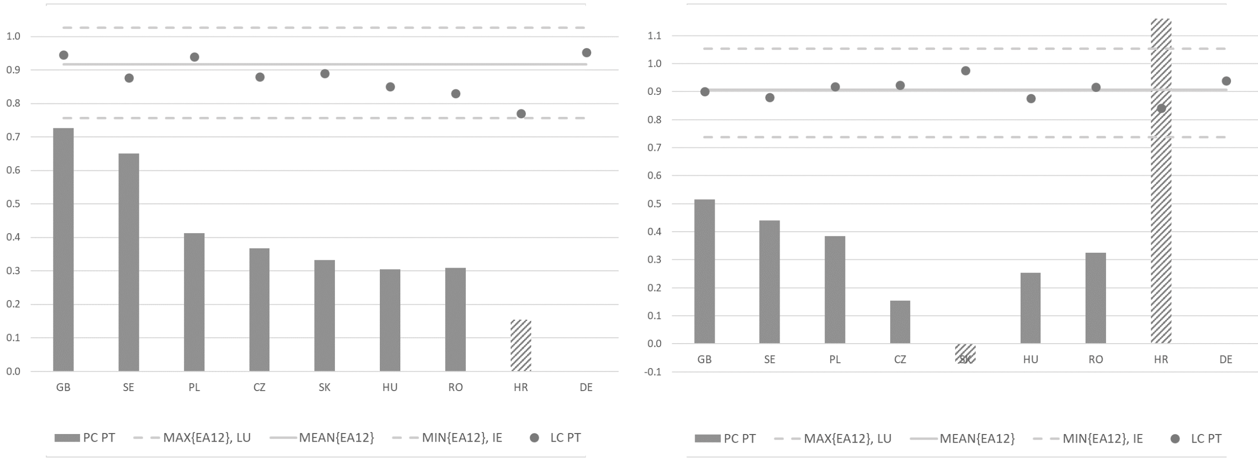


Figure 2.4: Producer currency (PC) and local currency (LC) pass-through: in the short-run (left) and the long-run (right)

Note: The asymmetry in pass-through is represented by the gap between local currency pass-through (dots) and the producer currency one (bars). Slovakia had a *de facto* floating exchange rate (floating and later fixed with several substantial adjustments) until the end of 2008. Croatia *de jure* has floating exchange rate. Striped bars represent statistically insignificant values. The coefficients with standard errors are also represented in Table B.4.

Decreasing reaction to producer currency movements could be also related to the invoicing currency that I discuss in the next part.

2.4.2 Strategic Competition and Imported Inputs

The contribution of strategic competition and imported inputs channels to the observed asymmetry in pass-through is estimated in Section 2.4.3. Before doing that, I show the presence of both channels based on the conventional bilateral exchange rate and also justify the used proxy for a producer market share.

The theory has a non-trivial implication: the own price effect is a U-shaped function of an exporter's share in a destination market. Because of data limitations, I use a producer country share as a proxy for a producing firm's share. The proxy is an actual share only when there is just one acting firm within (producing country-product group-destination) trade flow. If there are (for simplicity) two firms within trade flow, they suffer identical exchange rate shocks.[82] Thus, the own price effect cannot be distinguished from the competitor's price effect created by another firm (within the same trade flow). It is easy to show that the sum of these two effects on pass-through is also a U-shaped function of their cumulative market share. The intuition behind this is the following. If both firms (exporting product i from country p to market l) are small, they both have a high degree of pass-through (see Figure 2.1). However, because they supply a tiny part of the market, they do not provide any spillover effects on each other. If firms

[82] In that case, the Euro Area should be considered as one country.

cover the whole market, each firm knows that the other one, which is the only competitor, suffers the same exchange rate shock. As a result, they again have a high degree of pass-through. However, then their cumulative share is mid-size, both firms (at least the bigger one) prefer to absorb some part of an exchange rate movement into their markups to maintain market share. The numerical example is presented in Figure 2.2. In case there are more than one acting firm within a trade flow, I refer to the sum of these two effects as the own price effect; see Appendix 2.A for the proof and definitions.

The following regression tests the presence of the imported inputs channel and the strategic competition one, which includes own and competitors' price effects:

$$\Delta p^l_{iplt} = \alpha_{it} + \tilde{\beta}_{[\bullet,p,l]}\Delta e^b_{plt} \ + \left[\lambda_1 S_{ipl\tau} + \lambda_2 S^2_{ipl\tau}\right]\Delta e^b_{plt} + \left[\mu_1 S^{EU}_{\iota l\tau} + \mu_2 (S^{EU}_{\iota l\tau})^2\right]\Delta e^b_{plt} \\ + \kappa V_{xp\tau}\Delta e^b_{plt} + \gamma\pi_{pt} + r_{iplt} \tag{2.21}$$

where $S_{ipl\tau}$ is a share of exporting (producing) country p in total EU exports of product i to destination market l; $S^{EU}_{\iota l\tau}$ is the share of the EU in the world export of product ι to to market l,[83] $V_{xp\tau}$ is a share of imported inputs value added in gross exports of producer country p in industrial sector x (weighted average to all destinations), π_{pt} is an inflation rate in a producer country. One concern is that inflation captures some part of imported inputs effect, creating a downward bias in its estimation. However, regressions with changes in nominal wages instead of π_{pt} provide very similar results. Three types of pass-through measure are used: (i) nonspecific $\tilde{\beta}_{[\bullet]}$, (ii) producer-specific $\tilde{\beta}_{[p]}$, which is the baseline regression, and (iii) destination-specific $\tilde{\beta}_{[l]}$. The results are reported in Table 2.2.

The currency of invoicing is another important determinant of pass-through.[84] Before adjustment, prices are fixed in the currency they are set in. If it is a producer currency, we observe complete producer currency pass-through, and zero in the opposite case. Data limitation prohibit a direct measure for this channel. However, aggregate data shows that only British exporters extensively use a national currency in export pricing. The producer-country specific pass-through coefficients capture the cross-country variation of the invoiced currency shares. For this reason, I consider the regressions with $\tilde{\beta}_{[p]}$ as the baseline ones. According to the model by Devereux et al. (2017), the currency choice is related to the optimal (desired) pass-through and, as a result, depends on a firm's share in the market. Thus, the used proxy of a firm's share in a local market may partially capture within-country variation in the invoiced currency shares.

[83] EU trade data is available at 8-digit HS level i, the world export data is at 6-digit HS level ι; $i \in \iota$.

[84] Gopinath et al. (2010) show that the long-run pass-through for US imports priced in US dollar and in other currencies are very different from each other. However, the US is a special case. Devereux et al. (2017) observe that the substantial difference in pass-through into Canadian import prices among trade flows priced in Canadian dollar and in dominant currencies such as USD or euro.

Table 2.2: Pass-through, market share and imported inputs

	β - nonspecific		β_p - producer-specific		β_l - destination-specific	
	(1)	(2)	(3)	(4)	(5)	(6)
Producer market share $S_{ipl\tau}$:						
$S_{ipl\tau} \times \Delta e^b_{plt}$ - linear term (λ_1)	-.0394***	-.0861**	-.0606***	-.1436***	-.0469***	-.1202***
	(.0080)	(.0351)	(.0101)	(.0367)	(.0097)	(.0331)
$S^2_{ipl\tau} \times \Delta e^b_{plt}$ - quadratic term (λ_2)		.0560		.0966**		.0843**
		(.0367)		(.0383)		(.0350)
EU market share $S^{EU}_{\imath l\tau}$:						
$S^{EU}_{\imath l\tau} \times \Delta e^b_{plt}$ - linear term (μ_1)	.0475***	.1018**	.0494***	.0952**	-.0291**	-.0713*
	(.0082)	(.0505)	(.0094)	(.0483)	(.0118)	(.0370)
$(S^{EU}_{\imath l\tau})^2 \times \Delta e^b_{plt}$ - quadratic term (μ_2)		-.0575		-.0485		.0445
		(.0354)		(.0355)		(.0379)
Imported inputs: $V_{sp\tau}\Delta e^b_{plt}$ (κ)	-.2236***	-.2300***	-.0616	-.0640	-.2487***	-.2565***
	(.0244)	(.0246)	(.0500)	(.0501)	(.0247)	(.0250)
Inflation: π_{pt}	.1486***	.1492***	.1539***	.1543***	.1472***	.1480***
	(.0371)	(.0371)	(.0372)	(.0372)	(.0372)	(.0372)
N-obs. .	6,191,187	6,191,187	6,191,187	6,191,187	6,191,187	6,191,187
R^2-adj.	.0257	.0257	.0257	.0257	.0258	.0258
Inversion point S: $-\lambda_1/2\lambda_2$		*0.767*		*.743*		*.712*

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table represents the result of (2.21). All regressions include $S_{ipl\tau}, V_{ip\tau}, S^{EU}_{il\tau}$, specifications (2), (4) & (6) also include $S^2_{ipl\tau}, (S^{EU}_{il\tau})^2$. All corresponding coefficients are statistically insignificant. Clustered at destination-industry level standard errors are in parentheses.

First, own price effect reduces the bilateral pass-through. The linear term λ_1 is negative and statistically significant at 1% level in any specification. The quadratic term λ_2 is positive. Most importantly, it is significant at 1% level in the specification with producer-specific $\tilde{\beta}_{[p]}$ and at 5% level with destination market-specific $\tilde{\beta}_{[l]}$; see Table 2.2. Moreover, in all three specifications, the estimated inversion point $(-\lambda_1/2\lambda_2)$ is in the narrow range from 72% to 78% and close to the theoretically plausible values.[85] Thus, the evidence validates the prediction that *pass-through is a non-monotonic U-shaped function of a producer market share.*

Second, the competitors' price effect (the part of the effect created by exporters from other EU countries) is an increasing function of the EU market share; see columns (1)-(4) in Table 2.2. There is no evidence in favour of non-linearity of the competitors' price effect: quadratic terms (μ_2) are not significant. In the regression with destination-specific pass-through coefficients $\tilde{\beta}_{[l]}$ they capture most of the variation in the EU share among destination markets.

Third, the imported inputs effect is negative, a result consistent with theoretical predictions. There is no statistically significant effect in the main specification (see column (3) and (4), Table 2.2). Similar to the EU market share, the producer-specific pass-through coefficients capture the variation in import

[85] Under common elasticities values ($\rho = 5, \eta = 2$), the degree of pass-through (for a single acting firm within trade flow) achieves a minimum at market share $\theta = 0.76$, see equations (2.9), (2.6) and (2.9).

Table 2.3: Market share, imported inputs and the asymmetry in pass-through

Two components of ER:	Producer currency		Local currency		Symmetric
Producer Market Sh × ER	λ_1^p	-.182 (.163)	λ_1^l	-.165*** (.0366)	
Producer Market Sh^2 × ER	λ_2^p	.120 (.182)	λ_2^l	.111*** (.0388)	
EU Market Sh × ER	μ^p	-.161*** (.0432)	μ^l	.0535*** (.0108)	NO***
Imported Inputs Sh × ER	κ^p	-.420** (.176)	κ^l	-.0686 (.0572)	NO**

Number of observations:4,895,052; R^2-adj =.0263; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Regression (2.22) includes inflation in producing country ($\gamma = .107$***, s.e.(.0287)), coefficients for $S_{ipl\tau}, S^2_{ipl\tau}, V_{ip\tau}, S^{EU}_{il\tau}$ are not statistically significant. Clustered at destination-industry level standard errors are in parentheses.

intensity. According to the theory, the channel has asymmetric influence on pass-through. The presence of the imported inputs channel is examined below.

2.4.3 The Determinants of the Asymmetry

In this section I consider the sources of the asymmetry in pass-through. The theoretical consideration provides at least two mechanisms which have asymmetric effects on pass-through components: imported inputs and the competitors' price effect. The latter one is a part of strategic competition along with own price effect.

For countries with floating exchange rates, there are two components of pass-through and two separate estimations of each effect. The regression (2.21) with the producer specific pass-through coefficients could be estimated in the following form:[86]

$$\Delta p^l_{iplt} = \alpha_{it} + \tilde{\beta}^p_{[p]}\Delta e_{pt} \ - \tilde{\beta}^l_{[p]}\Delta e_{lt} + \left[\lambda^p_1 \Delta e_{pt} - \lambda^l_1 \Delta e_{lt}\right] S_{ipl\tau} + \left[\lambda^p_2 \Delta e_{pt} - \lambda^l_2 \Delta e_{lt}\right] S^2_{ipl\tau} \qquad (2.22)$$
$$+ \left[\mu^p \Delta e_{pt} - \mu^l \Delta e_{lt}\right] S^{EU}_{il\tau} + \left[\kappa^p \Delta e_{pt} - \kappa^l \Delta e_{lt}\right] V_{sp\tau} + \gamma \pi_{pt} + r_{iplt}$$

where the difference between coefficients associated with local currency and producer currency exchange rates represents the asymmetry of the corresponding channels. The results are presented in Table 2.3. Most observations represent export prices of the EA countries. As a result, the coefficients corresponding to local currency exchange rate ($-\Delta e_{pt}$) are close to the results based on a bilateral exchange rate; see column (4) in Table 2.2. Thus, the main interest is the coefficients corresponding to a producer currency and the asymmetry.

[86]Quadratic term μ_2 for EU market share is omitted as it is not statistically significant in any specification, see Table 2.2.

Table 2.4: Determinants' contribution to the asymmetry in pass-through

Exporting country	Asymmetry $\beta_p^l - \beta_p^p$	Contribution to the asymmetry by own price effect	competitors' price effect	imported inputs	Unexplained asymmetry $\tilde{\beta}_p^l - \tilde{\beta}_p^p$
CZ	.453***	.0017	.1040	.1709	.204*
HU	.641***	.0014	.1005	.1900	.375***
PL	.537***	.0016	.1080	.1307	.332***
RO	.566***	.0018	.0998	.0998	.391***
SE	.175***	.0031	.1121	.1197	-.030
HR	.795*	.0011	.1378	.1004	.598
GB	.155***	.0032	.0838	.1038	-.007
SK	.700***	.0013	.1109	.1642	.418**
Average	.503	.0019	.1071	.1350	.285

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The asymmetry is equal to the difference of the coefficients from Regression (2.20) without lagged exchange rates. The unexplained asymmetry is the one from Regression (2.22). Estimations of contribution are based on $\bar{S}_p$, $\bar{S_p^2}$, $\bar{S}_p^{EU}$, $\bar{V}_p$ and coefficients in Table 2.3.

First, *there is no evidence of the asymmetry in own price effect.*[87] However, the effect is significant only when local currency moves against the euro with the inversion point $(-\lambda_1^l/2\lambda_2^l)$ around 74%. Despite the fact local currency movement is a common shock for all exporting countries in the sample, the observed U-shaped dependence of pass-through on market share does not contradict the theory. In case there is only one EU member exporting to the market, a local currency movement is an exporter specific shock and we observe just the own price effect. If there are two (or more) exporting EU members, they suffer the same shock in the destination market. In that case the optimal pass-through is a combination of own price effect and competitors' effect provided by other EU exporters. This combination is also a U-shaped function of a producer market share in a destination market.

Second, *the competitors' price effect is asymmetric* ($\mu^p \neq \mu^l$). The cumulative market share of the EU exporters lowers producer currency pass-through and increases the local currency one. Thus, the presence of EU companies exporting to the market makes export prices (expressed in euro) more stable.

Third, *imported inputs affect only producer currency pass-through.* This result is consistent with theoretical predictions. Producer currency movements (against euro) change the relative prices of imported and domestic parts of value-added. If foreign inputs are coming from the Euro Area (or priced in euro), then producer currency appreciation against the euro increases the cost of domestic inputs only.

The strategic competition and imported inputs channels partially explain incompleteness of producer currency pass-through, and they have very limited influence on local currency one. Taken together,

[87] λ_1^p and λ_2^p are not statistically different from λ_1^l and λ_2^l, correspondingly.

the aforementioned channels account for roughly half of the observed asymmetry; see Table 2.4. They completely explain the asymmetry in the cases of the UK and Sweden, and a substantial part of it for other EU countries with floating exchange rates – the six Eastern European countries. The average observed asymmetry drops almost in half: from 0.50 to 0.28.

The use of imported inputs and the competitors' price effect (the cumulative market share of EU exporters) are the main sources of the asymmetry. On average, the former channel reduces producer currency pass-through by 16.1 percentage points (pp) and local currency one by 2.6pp. Thus, its overall contribution to the asymmetry is 13.5pp. The latter channel explains 10.7pp of the observed asymmetry: 8.0pp is coming from a decrease in producer currency pass-through and 2.6pp from an increase in local currency one. The own price effect has negligible influence on the asymmetry (+0.2pp) as it reduces both producer currency pass-through (-1.9pp) and local currency one (-1.7pp).

2.4.4 Robustness

This section discusses three additional robustness checks. The first one uses an alternative specification of the proxy for a producer market share: $\tilde{S}_{ipl\tau} = S_{ipl\tau} * S^{EU}_{\iota l\tau}$. This alternative measure of a producer market share provides similar results; see Tables B.5 and B.6. The main difference is that the coefficients $\tilde{\lambda}_1$ and $\tilde{\lambda}_2$ are bigger than λ_1 and λ_2 by the factors of nearly $\left[\mathbb{E}S^{EU}_{\iota l\tau}\right]^{-1}$ and $\left[\mathbb{E}(S^{EU}_{\iota l\tau})^2\right]^{-1}$, correspondingly. Moreover, the market share corresponding to the minimal pass-through shifts from the theoretically plausible value of 74% to 51%; see column (4) in Tables 2.2 and B.5. The symmetry of the competitors' price effect and the imported inputs one are rejected at the same significance levels; see Table B.6.

The second robustness check excludes the UK from the sample, as it is the biggest economy which is substantially different from the rest of the EU members with floating national currencies. It has little effect on the magnitude of the coefficients but substantially increases the standard errors as the number of observations with a national producer currency drops by nearly a third. As a result, only for the competitors' price effect I can reject (at 1% level) the null hypothesis that the effect is symmetric.

The last robustness check repeats the regressions in the main specification without the UK for the whole time period, i.e. including the Great Recession.[88] The regression results are close to the ones of the main specification, see Table B.7. Specifically, the imported inputs effect on producer currency pass-through is slightly lower (in absolute terms): .33* versus .42** in the main specification. Moreover, the competitors' price effect is statistically significant only when local currency moves against the euro, as the model predicts. The imported inputs and the competitors' price effects are asymmetric, as in the main specification. Thus, the results are not driven by the presence of the UK in the sample.

[88]To consider the whole time period is one of the few possibilities to increase the number of observations.

2.5 Conclusion

In this chapter I consider exchange rate pass-through for eight EU members with floating exchange rates under the dominant currency paradigm recently developed by Gopinath et al. (2020). Using detailed trade data over the period 2001-18, I analyse export price reactions, distinguishing between local and producer currency movements against the euro. Two facts emerge. First, the local currency pass-through into prices of exports to non-EU destinations is almost complete with no difference between the EU members with floating exchange rates and the Euro Area countries. Second, the producer currency pass-through is markedly lower. Thus, I find clear evidence of asymmetry in pass-through for a set of countries.

I isolate two equally important sources of the asymmetry in pass-through: (i) the use of foreign inputs in production and (ii) exporters' strategic competition in the destination market. Both channels reduce the degree of producer currency pass-through and have limited effect on the degree of local currency pass-through. These results are consistent with the theoretical predictions. The two channels fully explain the observed asymmetry in pass-through for the UK and Sweden (both advanced economies in the sample) and roughly half of the asymmetry for six Eastern European countries (emerging markets).

The results have a clear policy implication. Estimation of the degree of pass-through should focus on which currency—producer or local—actually moves. The export price reaction to producer currency movements against a dominant currency is lower than it would be based on the conventional estimations using bilateral (producer-local) exchange rates. In the case of producer currency movements, exporters limit price adjustment because of the foreign inputs used in production and competition for market share in destination markets. This expands the list of reasons why national currencies have a limited impact on international trade of small open economies that are deeply integrated with large economies or currency unions.

2.A Theoretical Appendix

More than one acting firm within trade flow

If there are more than one firm within a trade flow $(p - l - s)$, when the optimal price response could be rearranged in the following form:[89]

$$\frac{d\ p_{is}}{d\ e^b_{pl}} = \frac{1}{1+\Gamma_{is}}\frac{d\ mc_{is}}{d\ e^b_{pl}} + \frac{\Gamma_{is}}{1+\Gamma_{is}}\sum_{k\in p}\theta_{ks}\frac{d\ p_{ks}}{d\ e^b_{pl}} + \frac{\Gamma_{is}}{1+\Gamma_{is}}\sum_{j\notin p}\theta_{js}\frac{d\ p_{js}}{d\ e^b_{pl}} \tag{B.1}$$

It separates the effect created by other firms exporting from country p. Multiplying it by market share and summarizing the same equations for all exporters from country p, one may find the expression of the optimal response:

$$\frac{d\ p_{is}}{d\ e^b_{pl}} = \underbrace{\frac{1}{1+\Gamma_{is}}\frac{d\ mc_{is}}{d\ e^b_{pl}} + \frac{\Gamma_{is}}{(1+\Gamma_{is})\omega_{ps}}\sum_{k\in p}\left[\frac{\theta_{ks}}{1+\Gamma_{ks}}\times\frac{d\ mc_{ks}}{d\ e^b_{pl}}\right]}_{the\ cumulative\ own\ price\ effect \times marginal\ cost\ channel} + \underbrace{\frac{\Gamma_{is}}{(1+\Gamma_{is})\omega_{ps}}\sum_{j\notin p}\theta_{js}\frac{d\ p_{js}}{d\ e^b_{pl}}}_{the\ competitors'\ price\ effect}$$

$$where \quad \omega_{ps} \equiv 1 - \sum_{k\in p}\frac{\Gamma_{ks}\theta_{ks}}{(1+\Gamma_{ks})} > 0 \tag{B.2}$$

The first component represents an optimal price adjustment, holding constant an industry price level. The second term is the reaction to an industry price level shift after firms which export from country p change their prices. The last term is the competitors' price effect provided by firms exporting from other countries. Assuming there is the same pass-through into marginal cost for all firms within the trade flow:

$$\frac{d\ p_{is}}{d\ e^b_{pl}} = \underbrace{\left[\frac{1}{1+\Gamma_{is}} + \frac{\Gamma_{is}}{(1+\Gamma_{is})\omega_{ps}}\sum_{k\in p}\frac{\theta_{ks}}{1+\Gamma_{ks}}\right]}_{the\ cumulative\ own\ price\ effect}\frac{d\ mc_{is}}{d\ e^b_{pl}} + \underbrace{\frac{\Gamma_{is}}{(1+\Gamma_{is})\omega_{ps}}\sum_{j\notin p}\theta_{js}\frac{d\ p_{js}}{d\ e^b_{pl}}}_{the\ competitors'\ price\ effect} \tag{B.3}$$

Amiti, Itskhoki and Konings (2014) argue the bigger exporters more intensively use imported inputs, so this reduce their pass-through. Having no firm-level data about import intensity, I use the industrial sector average values of imported inputs shares in gross export. Thus, a market share partially captures the imported inputs effect, decreasing its estimation in absolute value. It affects only the evaluation of the linear term of the own price effect.

[89] In case there is only one acting firm the equation becomes identical to (2.9).

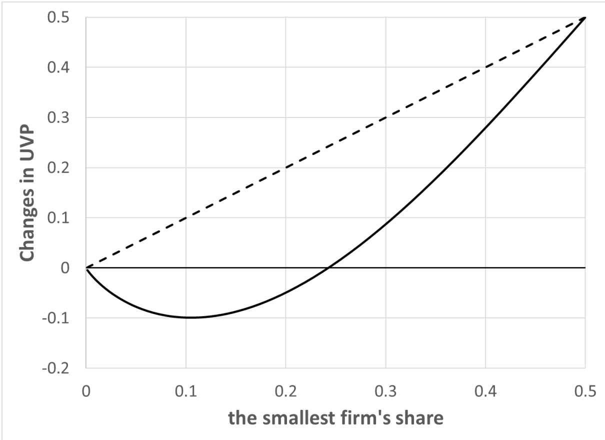


Figure B.1: The elasticity of unit value price to the relative prices

Note: The continuous line represents changes in unit value price; the dash line - changes in prices, weighted by firm's contribution to trade flow. The smallest firm's share is $\frac{\alpha^{1-\rho}}{1+\alpha^{1-\rho}}$.
Parameters: $\rho = 5$, $\alpha > 1$

Unit Value Price

There is an additional applied issue related to the used data. If there more than one acting firm within a trade flow, the unit value price index does not coincide with the weighted changes in prices. Without loss of generality, let's consider two firms with prices P_1 and P_2:

$$UVP = \frac{P_1Q_1 + P_2Q_2}{Q_1 + Q_2} = P_1\frac{1+\alpha^{1-\rho}}{1+\alpha^{-\rho}}, \qquad \alpha \equiv P_2/P_1 \tag{B.4}$$

$$dln(UVP) = dp_1 + \frac{\partial \frac{1+\alpha^{1-\rho}}{1+\alpha^{-\rho}}}{\partial ln(\alpha)} dln(\alpha) = dp_1 + \left(\frac{(1-\rho)\alpha^{1-\rho}}{1+\alpha^{1-\rho}} + \frac{\rho\ \alpha^{-\rho}}{1+\alpha^{-\rho}}\right)(dp_2 - dp_1) \tag{B.5}$$

Holding the bigger firm's price constant, the unit value price decreases then the smaller firm's price increases, see Figure B.1.[90] In all cases both firms adjust their prices after the exchange rate movements in the same direction. As a result, this property of the unit value price does not change the U-shape of the aggregated pass-through function, see Figure 2.2. The use of unit value price underestimate the degree of pass-through in most cases. The intuition of this conclusion is the following. The smaller firm, on average, have higher pass-through than the bigger one. In case of producer currency appreciation, it provides the increase of the smaller firm's price relative to the bigger one. This, in turn, shifts the composition of a trade flow to the cheaper good produced by the bigger firm. This decomposition effect embodied in the unit value changes provides underestimation of the changes in prices.

[90] It is true until the smaller firm is small enough, roughly 3 times smaller than the bigger one in the presented numerical example.

2.B Data Appendix

Table B.1: The list of destination (local) markets

ISO	Country	ISO	Country
AR	Argentina	MX	Mexico
AU	Australia	MY	Malaysia
BR	Brazil	NO	Norway
CA	Canada	NZ	New Zealand
CH	Switzerland	PH	Philippines
CN	China	RU	Russian Federation
HK	Hong Kong	SG	Singapore
ID	Indonesia	TH	Thailand
IL	Israel	TR	Turkey
IN	India	TW	Taiwan
IS	Iceland	US	United States
JP	Japan	ZA	South Africa
KR	Republic of Korea		

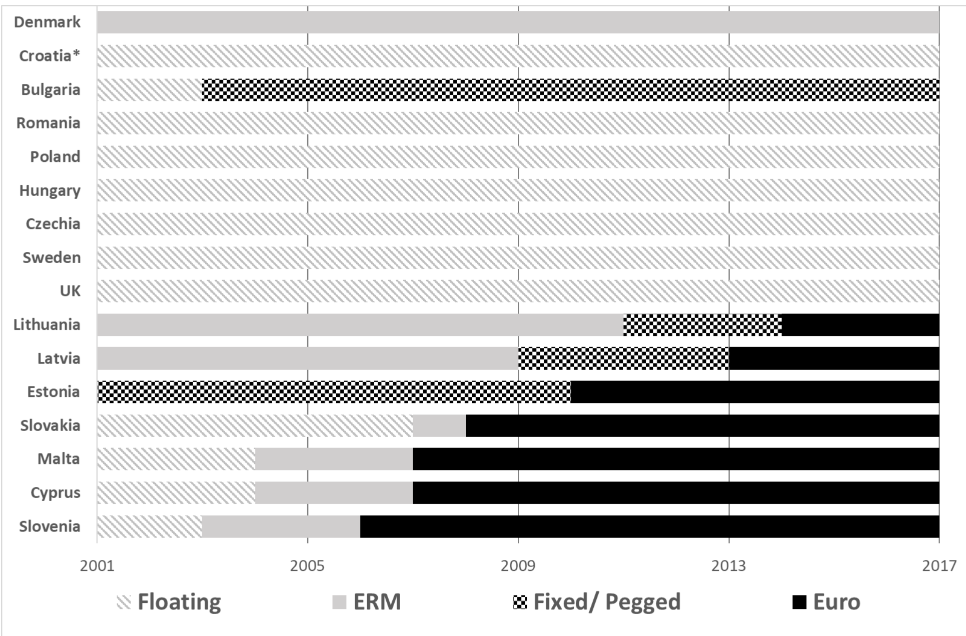


Figure B.2: The exchange rate regimes of the EU members, excluding EA12.

Note: Croatia *de jure* has floating exchange rate. Slovakia *de facto* had floating exchange rate (floating and later fixed with several substantial adjustments) till the end of 2008.

Table B.2: Summary statistics

Country		EU	CZ	HU	PL	RO	SE	HR	GB	SK
Δp^l, changes	mean	.007	.008	.006	.010	.010	.006	.006	.005	.009
in log-UVP	s.d.	.270	.238	.233	.242	.198	.265	.216	.313	.209
corr($\Delta p^l, \Delta e^b_{pl}$)		.143	.164	.147	.201	.185	.122	.131	.119	.207
corr($\Delta p^l, \Delta e_l$)		-.141	-.164	-.158	-.202	-.192	-.112	-.134	-.094	-.208
corr($\Delta p^l, \Delta e_p$)		.014	.008	.010	.000	.009	.034	-.022	.044	.013
S_{ipl}	mean	.288	.137	.101	.120	.141	.260	.081	.266	.093
	s.d.	.287	.215	.172	.172	.212	.275	.168	.273	.155
S^2_{ipl}	mean	.165	.065	.040	.044	.065	.143	.035	.145	.033
	s.d.	.258	.180	.123	.124	.169	.239	.126	.247	.107
$S^{EU}_{\iota l}$	mean	.449	.485	.469	.503	.465	.523	.642	.391	.517
	s.d.	.306	.297	.299	.298	.274	.310	.295	.287	.297
$(S^{EU}_{\iota l})^2$	mean	.295	.323	.309	.342	.292	.369	.500	.235	.356
	s.d.	.313	.311	.307	.314	.280	.336	.339	.281	.318
$V_{sp\tau}$	mean	.233	.486	.541	.372	.284	.341	.286	.295	.467
	s.d.	.097	.084	.104	.066	.084	.065	.062	.071	.092
Number of	25th per.	3	5	6	6	6	4	7	3	7
other exporting	50th per.	6	9	10	9	10	6	12	5	11
EU members	75th per.	10	13	14	13	15	10	16	9	15
Number of observations		6,191,187	161,455	75,118	172,938	39,469	347,500	6,468	465,032	45,723

Note: the sample includes all non-zero quarterly export flows at 8-digit HS level to 25 destination markets of all goods, except mining, agricultural and foodstuff products. The observations with more than twice changes in unit value prices (to the previous quarter) are dropped.

2.C Additional Tables

Table B.3: Bilateral pass-through: short-run (1Q) and long-run (2Y)

ISO	Exporting country (EU member)	Short-run $\beta_{[p]0}$	(s.e.)	Long-run $\sum_{k=0}^{7}\beta_{[p]k}$	(s.e.)
12 first Euro Area members					
AT	Austria	.940***	(.0119)	.900***	(.0208)
BE	Belgium	.888***	(.0132)	.866***	(.0190)
DE	Germany	.946***	(.00659)	.924***	(.00947)
ES	Spain	.945***	(.0144)	.907***	(.0132)
FI	Finland	.871***	(.0224)	.867***	(.0215)
FR	France	.863***	(.0137)	.884***	(.0140)
GR	Greece	.923***	(.0259)	.935***	(.0326)
IE	Ireland	.742***	(.0391)	.718***	(.0635)
IT	Italy	.921***	(.00842)	.920***	(.0113)
LU	Luxembourg	1.023***	(.0370)	1.053***	(.0620)
NL	Netherlands	.953***	(.0110)	.916***	(.0164)
PT	Portugal	.891***	(.0251)	.840***	(.0310)
EU members with floating ER agaist €					
CZ	Czechia	.816***	(.0181)	.835***	(.0210)
HU	Hungary	.741***	(.0206)	.798***	(.0319)
PL	Poland	.820***	(.0194)	.870***	(.0211)
RO	Romania	.762***	(.0408)	.847***	(.0384)
SE	Sweden	.836***	(.0184)	.842***	(.0247)
HR	Croatia	.723***	(.0728)	.833***	(.0996)
GB	United Kingdom	.892***	(.0130)	.791***	(.0220)
other EU members					
SK	Slovakia	.863***	(.0269)	.848***	(.0374)
MT	Malta	.839***	(.110)	.492	(.317)
CY	Cyprus	.735***	(.114)	.955***	(.146)
BG	Bulgaria	.939***	(.0212)	.917***	(.0376)
SI	Slovenia	.883***	(.0217)	.882***	(.0288)
LT	Lithuania	.964***	(.0257)	1.073***	(.0592)
LV	Latvia	.913***	(.0352)	.907***	(.0463)
EE	Estonia	.913***	(.0337)	1.041***	(.0516)
DK	Denmark	.855***	(.0196)	.782***	(.0238)
N-obs.		5,637,417			
R^2-adj.		.0517			

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Regression includes product-time fixed effects. Standard errors clustered at destination market-industry level are reported in parenthesis.

Table B.4: The asymmetry in pass-through: short-run (1Q) and long-run (2Y)

Exporting country	Short-run			Long-run		
	Local currency PT	Producer currency PT	Asymmetry	Local currency PT	Producer currency PT	Asymmetry
	$\beta^l_{[p]0}$	$\beta^p_{[p]0}$	$\chi_p \equiv \beta^l_p - \beta^p_p$	$\sum_{k=0}^{7} \beta^l_{[p]k}$	$\sum_{k=0}^{7} \beta^p_{[p]k}$	$\sum_{k=0}^{7} \chi_{[p]k}$
CZ	.879*** (.0115)	.367*** (.0335)	.512*** (.0351)	.922*** (.0270)	.154** (.0719)	.769*** (.0765)
HU	.850*** (.0159)	.304*** (.0309)	.545*** (.0328)	.877*** (.0369)	.254** (.116)	.620*** (.117)
PL	.941*** (.00966)	.417*** (.0172)	.524*** (.0181)	.923*** (.0237)	.385*** (.0488)	.537*** (.0507)
RO	.830*** (.0171)	.309*** (.0528)	.521*** (.0535)	.911*** (.0389)	.325*** (.0937)	.580*** (.0919)
SE	.876*** (.00947)	.650*** (.0219)	.226*** (.0226)	.880*** (.0248)	.441*** (.0511)	.437*** (.0501)
HR	.769*** (.0561)	.160 (.354)	.610* (.354)	.839*** (.125)	1.180 (.991)	-.342 (1.016)
GB	.945*** (.0112)	.728*** (.0194)	.216*** (.0201)	.905*** (.0260)	.516*** (.0383)	.387*** (.0412)
SK	.889*** (.0181)	.333*** (.116)	.558*** (.118)	.975*** (.0433)	-.0708 (.138)	1.047*** (.150)
N-obs.	6,178,669					
R^2-adj.	.0506					
Average	0.872	0.409	0.464	0.904	0.398	0.504

* * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table represents the result of Regression (2.20). Regression includes product-time fixed effects and inflation rates in exporting countries. Robust standard errors are reported in parenthesis.

Table B.5: Robustness check to Table 2.2 – alternative specification of a producer market share

	β - nonspecific		β_p - producer-specific		β_l - destination-specific	
	(1)	(2)	(3)	(4)	(5)	(6)
Alternative producer market share: $\tilde{S}_{ipl\tau} = S_{ipl\tau} * S^{EU}_{\iota l\tau}$:						
$\tilde{S}_{ipl\tau} \times \Delta e^b_{plt}$ - linear term ($\tilde{\lambda}_1$)	-.0607***	-.1555***	-.0861***	-.2324***	-.0576***	-.1763***
	(.0165)	(.0409)	(.0173)	(.0430)	(.0169)	(.0414)
$(\tilde{S}_{ipl\tau})^2 \times \Delta e^b_{plt}$ - quadratic term ($\tilde{\lambda}_2$)		.1543		.2292***		.1866***
		(.0554)		(.0567)		(.0558)
EU market share $S^{EU}_{\iota l\tau}$:						
$S^{EU}_{\iota l\tau} \times \Delta e^b_{plt}$ - linear term (μ_1)	.0659***	.1519***	.0754***	.1703***	-.0121	-.0124
	(.0105)	(.0368)	(.0107)	(.0372)	(.0132)	(.0392)
$(S^{EU}_{\iota l\tau})^2 \times \Delta e^b_{plt}$ - quadratic term (μ_2)		-.0887**		-.0951***		.0042
		(.0364)		(.0365)		(.0390)
Imported inputs: $V_{sp\tau}\Delta e^b_{plt}$ (κ)	-.2104***	-.2202***	-.0635	-.0665	-.2333***	-.2420***
	(.0235)	(.0238)	(.0472)	(.0472)	(.0238)	(.0240)
Inflation: π_{pt}	.1484***	.1492***	.1540***	.1544***	.1468***	.1477***
	(.0240)	(.0240)	(.0240)	(.0240)	(.0240)	(.0240)
N-obs. .	6,191,187	6,191,187	6,191,187	6,191,187	6,191,187	6,191,187
R^2-adj.	.0257	.0257	.0257	.0257	.0258	.0258
Inversion point S: $-\lambda_1/2\lambda_2$		*0.503*		*.506*		*.472*

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Regression (2.21) results with the alternative measure of a market share. All regressions include $(S_{ipl\tau} * S^{EU}_{\iota l\tau}), V_{ip\tau}, S^{EU}_{il\tau}$, regressions (2), (4) & (6) also include $(S_{ipl\tau} * S^{EU}_{\iota l\tau})^2, (S^{EU}_{il\tau})^2$. All corresponding coefficients are statistically insignificant.

Table B.6: Robustness check to Table 2.3 – alternative specification of a producer market share

Two components of ER:	producer currency (1)		local currency		Symmetric
Alternative producer market share: $\tilde{S}_{ipl\tau} = S_{ipl\tau} * S^{EU}_{\iota l\tau}$					
Alt. Producer Market Sh × ER	$\tilde{\lambda}^p_1$	-.258 (.213)	$\tilde{\lambda}^l_1$	-.235*** (.0478)	
Alt. Producer Market Sh^2 × ER	$\tilde{\lambda}^p_2$	.398 (.279)	$\tilde{\lambda}^l_2$	.190*** (.0623)	
EU Market Sh × ER	μ^p	-.143*** (.0485)	μ^l	.0921*** (.0126)	NO***
Imported Inputs Sh × ER	κ^p	-.420** (.175)	κ^l	-.0699 (.0571)	NO**
N-obs:	4,895,052				
R^2-adj.	.0263				

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Regression (2.22) with the alternative measure of a market share. The regression includes inflation in producing country (γ = .106***, s.e.(.0286)), coefficients for $(S_{ipl\tau} * S^{EU}_{\iota l\tau}), (S_{ipl\tau} * S^{EU}_{\iota l\tau})^2, V_{ip\tau}, S^{EU}_{il\tau}$ are not statistically significant.

Table B.7: Robustness check to Table 2.3 – the whole time period sample without the UK

Two components of ER:	producer currency (1)		local currency		Symmetric
Producer Market Sh × ER	λ^p_1	-.399** (.173)	λ^l_1	-.120*** (.0389)	NO*
Producer Market Sh^2 × ER	λ^p_2	.271 (.213)	λ^l_2	.0735* (.0410)	
EU Market Sh × ER	μ^p	-.0108 (.0424)	μ^l	.0675*** (.0135)	NO*
Imported Inputs Sh × ER	κ^p	-.331* (.187)	κ^l	-.0223 (.0709)	NO*
N-obs:	5,364,723				
R^2-adj.	.0337				

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Regression (2.22) includes inflation in producing country (γ = .109***, s.e.(.0389)), coefficients for $S_{ipl\tau}, S^2_{ipl\tau}, V_{ip\tau}, S^{EU}_{il\tau}$ are not statistically significant.

CHAPTER 3

The Effect of Russia's Food Import Ban on Import and Consumer Prices

Russia banned the import of some foodstuff and agricultural (listed) goods from the EU, the US, Australia, Canada and Norway – the target states – on August 7^{th}, 2014. The ban implementation coincided with the period of a substantial depreciation of the Russian ruble. Before the ban, the target states' share in Russia's import and total consumption varied across product groups in a wide range. Exploiting that heterogeneity, I disentangle the ban's influence on prices from the depreciation's one. The ban's effect on import prices of the listed goods increased in the second half of 2014 and then gradually declined. The average effect on consumer prices of the affected product groups peaked at 3.9p.p. in Q4 2014 and disappeared shortly after. The comparison of Russian and EU trade data indicates the violation of the ban regime mainly through Belarus and Serbia. However, it has a limited effect on prices.

3.1 Introduction

After the escalation of conflict in Eastern Ukraine in 2014, the US, the EU and some other countries imposed sanctions against some Russian authorities and companies. The initial restrictions started in early 2014 and affected several Russian and (former) Ukrainian authorities. The broader industrial sanctions against the key Russian banks and companies were implemented shortly after the crash of the Malaysia Airlines Flight on July 17th, 2014. In response, three weeks later, on August 7th, the Russian government banned imports of some foodstuff and agricultural products from the European Union, the USA, Canada, Norway and Australia. The list of these (sanctioned) products contains meat, fish, milk, dairy products, vegetables, fruits, nuts, sausages and some other food, see Table C.1. Thus, the ban was an unexpected supply shock for importers and domestic producers. Later in 2015, the ban was expanded to less significant suppliers: Albania, Iceland, Lichtenstein, Montenegro, and Ukraine.

The purpose of sanctions imposed by the group of "Western countries" was to change the situation in Eastern Ukraine through economic pressure on the Russian government. On the contrary, the declared reason for Russia's import ban was import substitution in agriculture and foodstuff industries for improving national security. That makes it difficult to challenge the ban in the WTO.

Extensive literature considers the efficiency and political effectiveness of economic sanctions as an instrument of international relations. One of the key theoretical hypothesis is that "the sanctioner is more likely to succeed if it has the support of the sanctioned country's major trading partners", McLean and Whang (2010). It implies the "Wester" economic sanctions against the Russian government have a high chance of success. The opposite situation is expected for the ban imposed by Russia as it is not an important trade partner for any of the affected countries except Ukraine. It is worthy to mention that the purpose of this chapter is not related to the evaluation of political effectiveness. The main question is the effect of the unexpected trade restriction on prices and social welfare in Russia. However, the relatively smaller number of articles discusses the economic cost of sanctions for target states and imposing countries, Caruso (2003).

The import ban, as well as other trade restrictions, in general, distorts resource allocation within an economy resulting in wealth losses. Moreover, trade (import) restrictions lead to losses in both target and restriction-imposing countries, Kaempfer and Lowenberg (2007). Early (2009) emphasizes that higher import and consumer prices and domestic production growth (in the affected industries) should be expected in imposing states, while for target countries, lower export prices and a decline in domestic production are forecasted. My estimation results are in line with these predictions, at least in the short run.

The case of Russia's import ban is an important example of a trade restriction, as the banned suppliers covered a significant part (roughly 40%) of Russia's imports of the listed foodstuff and agricultural products. Moreover, imports from the target states had substantial shares in domestic consumption of some foodstuff products before the ban, for example, cheese (30%), pork (30%), beef (16%), etc. It is evident that the unpredicted ban on the imports from the target states affected a considerable part of the total consumption, and thus created a shortage on the Russian market. On the one hand, the normal price stickiness limits the speed of movement to the new market-clearing equilibrium. On the other hand, unsatisfied demand in the Russian market through higher import prices motivated firms to intensify trade flows from (and through) the third parties to Russia. However, in the case of the foodstuff products, this is a quite slow process as each new foreign supplier (firm) has to receive a number of sanitary or phytosanitary certificates from the Russian authorities. In most cases, the procedure requires a visit of Russian specialists to a farm or factory. Nevertheless, the new long-run equilibrium will be achieved and its properties could be predicted. Being a relatively small destination market, Russia could not significantly affect the world prices for these products except for perishable goods (fresh meat or fish, dairy, eggs).[91] Thus, the long-run foreign supply curve is (almost) horizontal. Subsequently, controlling for other factors, the new long-run equilibrium prices of imported foodstuff products are expected to be quite close to the initial price level.

The observed wave-like dynamics of import and consumer prices do not contradict the economic intuition provided above. In addition, I show that the exchange rate was the main determinant of import and consumer prices due to the substantial depreciation of the Russian ruble that also happened in the second half of 2014. And omitting control for the ruble exchange rate may bias estimations.[92] The issue arises as the ban covers mainly the products that had (i) a higher share of target states in imports and (ii) a higher share of imported products in total consumption. Thus, such products suffer higher price increase due to both events: the ban and the ruble depreciation. For isolating these effects, I apply the weighted difference-in-difference (DD) method along with the standard one. I analyze the ban effect on the import price index (MPI) and consumer prices using Russia's custom data and the consumer price statistics.

For the MPI, the standard DD uses the other (not-affected) foodstuff products imported from third parties as a control group for the affected products imported from them. The weighted DD does not require the control group. It assumes that the ban's effect is proportional to the target countries' share in Russia's import of an affected group. Both methods show wave-like dynamics of MPI. The import prices of the affected goods had been increasing during the second half of 2014. On average, a product group, which had had the 10p.p. higher share of the target countries in import, faced 3p.p. higher MPI in Q4 2014. Since Q1 2015, the ban's effect gradually declined and disappeared by the end of 2015.

For consumer prices, the standard DD method uses other foodstuff products as a control group. It shows the similar short-run effect of the ban — consumer prices of the affected products temporary deviated from prices of the control ones. The difference peaked at 11% in Q1 2015 (the half-year after the ban was imposed) and disappeared by the middle of 2016. The weighted DD method assumes that the

[91]Markets for such products are the geographically segmented due to transportation costs and short shelf life.

[92]The reason is that the exchange rate pass-through into import and consumer prices is incomplete, see the review article by Burstein and Gopinath (2014).

higher share of target states' import had been in domestic consumption of a product, the bigger was the ban effect on consumer prices of the product. This method directly controls for the exchange rate effect including the measure of imports' share in total consumption of a product group. The measure suffers from data limitations that reduces the number of product groups. Nevertheless, the main conclusion is preserved – the import ban had the short-run boosting effect on consumer prices.

Hinz and Monastyrenko (2019) provide quite similar results for consumer prices. Using a standard DD method, the authors also indicate wave-like dynamics of the ban effect on the affected groups' prices with the maximum in January 2015. At the end of 2016, the import ban's effect disappeared when the affected groups are compared with other foodstuff products. However, it persisted when they are compared with all consumer goods and services. As I mentioned above, such results could be driven by the Russian ruble depreciation, which differentially pushed up prices for tradable goods depending on import shares in total consumption. Moreover, the exchange rate has a weaker effect on services than goods.

The next research question is the ban violation as banned goods may enter the Russian market through the third countries. The import restriction provided excess supply in the target states, resulting from the loss of the Russian market. I consider the EU — the most important affected supplier. The ban provided a moderate decrease in EU export prices and the increase in import prices on the Russian border. This created an opportunity for profitable freightage of EU goods to Russia through third parties. Comparing the EU exports and Russian imports, I reveal (probable) trade flows of EU products going through Belarus, which has the biggest share in trade-through activity (61%), and some Balkan states. This result is quite predictable. First, Belarus is on the way from the EU to the central part of Russia. Second, there is no custom border between Belarus and Russia. The detected trade-through volumes cover up to 6.7% of Russian import of the affected products from the all considered third counties (8% for Belarus). Thus, the violation is limited probably due to the ruble depreciation which has reduced the demand for imported goods.

To my knowledge, few existing works consider Russia's foodstuff import ban that are discussed in Section 3.5. Some of them apply the assumed or separately estimated elasticities (CGE models), for example, Boulanger, Dudu, Ferrari and Philippidis (2016) and Kutlina-Dimitrova (2017). Others use regression analysis of the (reduced form) equations for consumer prices (Hinz and Monastyrenko, 2019) or trade volumes (Fedoseeva, 2016). Volchkova and Kuznetsova (2019) apply the partial equilibrium framework.

My contribution to the literature is the following. First, I empirically estimate the effect of the incomplete import ban on import and consumer prices. It allows me to compare the magnitude of changes and dynamics of import and consumer prices. The results are in line with the hypothesis that the ban affects consumer prices changing import supply, in turn, import prices. Second, I show that the exchange rate was a key determinant of the observed dynamics of import and consumer prices. Third, I analyse the violation of the ban regime through the third parties. The estimate concludes that circumventing trade flows was relatively weak and had a small effect on import prices.

The chapter proceeds as follows. Section 3.2 reviews the main events and summary statistics. Section 3.3 discusses the empirical method and data. Section 3.4 presents the results. Section 3.5 discusses the welfare loss and compares the finding with results found in the literature. Section 3.6 concludes.

3.2 Overview of the Ban

This section provides a brief overview of the sanction chronology, summarizes the degree of import coverage by the ban and other trade restrictions, and discusses the importance of other economic events and policy measures in Russia.

3.2.1 The Chronology

The first stage of the confrontation started in early 2014 when the President of Ukraine Yanukovych lost power, and the new Ukrainian government lost control over Crimea.

- On March 6th, 2014, the US imposed personal sanctions — travel ban and freezing assets — against some Ukrainian and Russian authorities.
- On March 16th, 2014, the referendum in Crimea happened.
- In response, the EU (March 17th), the US (March 20th) and Australia (March 19th) imposed (expanded) personal sanctions against several Russian authorities.
- The Russian government symmetrically introduced personal sanctions against some US and EU authorities. It was a formal action without any economic consequences for these countries.

The second stage began after the crash of the Malaysia Airlines Flight over Eastern Ukraine on July 17th, 2014. At that time, the conflict between the Government of Ukraine and pro-Russian separatists was a military confrontation involving heavy weapons. Western countries decided that pro-Russian troops shot down the airplane.

- The US immediately imposed some form of transactions ban on the leading Russian banks (Gazprombank and VEB) and companies (Rosneft, Novatek) controlled by the Government.

- Later (July 31st), the Council of the EU also imposed a transaction ban on the Russian banks (Sberbank, Gazprombank, VEB, VTB, Rosselkhozbank). The Russian stock indices collapsed.

- In response, on August 7th the Russian government banned imports of some agricultural products, raw materials, and foodstuff products from the United States, countries of the European Union, Canada, Australia, and Norway, see Table C.1.

3.2.2 Import Shares Covered by the Ban and Other Restrictions

The food import ban was announced as "certain special economic measures to ensure the security of the Russian Federation". It is considered one of the main events of confrontation between Russia and Western countries. This restriction covered 5.6% of the total import flows from the target states to Russia ($155 bln).

Before the ban, Russia imposed similar restrictions on imports of foodstuff and agricultural products. For example, Russia banned the import of fresh pork, beef and poultry meat from Germany since February 2013. It also forbade the import of pigs and pork from the EU in January 2014. The EU pork ban was a considerable restriction, and it affected agricultural exports of some EU members (Germany) to Russia more than the (main) food import ban, (Fedoseeva, 2016).

The ban imposed in August 2014 cut the substantial part of Russia's import of listed products: roughly 40%, or $9.0 bln out of $22.2 bln (on average in 2012-2013). The ban coverage rates for different products are presented in Table 3.1. It cut pork imports by three-quarters, import flows of milk and dairy, fish, poultry and other meat nearly by half and the foreign supply of fruits and vegetables by one-third.

The EU member states had produced 70% ($6.2 bln) of the banned imports. Russian foodstuff market was important for Norway ($1.07 bln, or 11% of the country's export of the listed products) and the following EU members: Lithuania ($1.05 bln, 44% of country's export to non-EU destinations), Finland ($ 375 mln, 37%), Estonia ($ 102 mln, 17%), Poland ($ 951 mln, 9%), Latvia ($ 56 mln, 9%); other members exported no more than 6% of the listed products to Russia. Unsurprisingly, the Russian market was more important for countries which share borders with Russia than for more remote countries.

3.2.3 Import Quotas and Tariffs

Russia uses the system of import tariffs and quotas for most of the listed products for import from outside the Eurasian Economic Union (EAEU), which includes Armenia, Belarus, Kazakhstan, Kirgizia, and Russia. The applied tariffs and quotas are relatively stable since 2012.

Since 2012, the quota for import of pork is 430 thousand tons (per year), the import tariff is 0% within

Table 3.1: Imports of different products before the ban, average for 2012-13

Product group	Russia's import ($ mln)	Russia's import from the target states[a] ($ mln)	Target states' share[a]	Russia's import from the EU ($ mln)	EU share in Russia's import from all target states[a]
Meat, including:	6 260	2 680	43%	1 515	57%
Pork	2 296	1 716	75%	1 152	67%
Beef	2 929	445	15%	189	42%
Poultry	853	440	52%	101	23%
Other meat and sausages	181	79	44%	73	92%
Milk and dairy products	3 646	1 625	45%	1 589	98%
Fruit	6 351	1 823	29%	1 613	88%
Vegetables	2 642	845	32%	836	99%
Fish	2 621	1 496	57%	214	14%
Other	682	555	81%	459	83%
Total	22 202	9 025	41%	6 226	69%

[a] For the initial list of target states: the EU, USA, Canada, Norway and Australia

the quota and 65% for values above the quota. Imports exceeded the quota the last time in 2013 (by 170 thousand tons). The share of domestic production in pork consumption went up from 76.7% in 2012 to 98.1% in 2018, (Eurasian Economic Commission, 2018). Thus, domestic production substituted imports not only from the target states but also from the third parties. The subsidy for pork production was estimated at 1.2% of production costs in 2013, (Eurasian Economic Commission, 2015*b*), but declined since then.

Since 2013 the quota for import of beef is 530 thousand tons (per year), the import tariff is 15% within the quota and 50% for values which exceed quota, (Eurasian Economic Commission, 2015*a*). The import volume went down from 582 thousand tons in 2013 to 226 thousand tons in 2016, decreased more than by the share of the target states (15%).

The import tariffs for almost all milk and dairy products are 15% since 2015. They declined slightly since 2013 by 0-10p.p. The import value (from non-EAEU countries) of milk and dairy products dropped from $2.55bln in 2013 to $298mln in 2016. The drop exceeds the import flow from the target states in the pre-ban period, (Eurasian Economic Commission, 2016). The import tariffs for vegetables are in the range from 5% to 15%, for fruits - up to 10%, for fish from 3% to 10%.

3.2.4 Dynamics of the Main Economic Parameters

Along with the ban and the sanctions, the oil price had been falling in 2014. As a result, the Russian ruble exchange rate fell by almost half. The strong relationship between the oil price and the ruble exchange

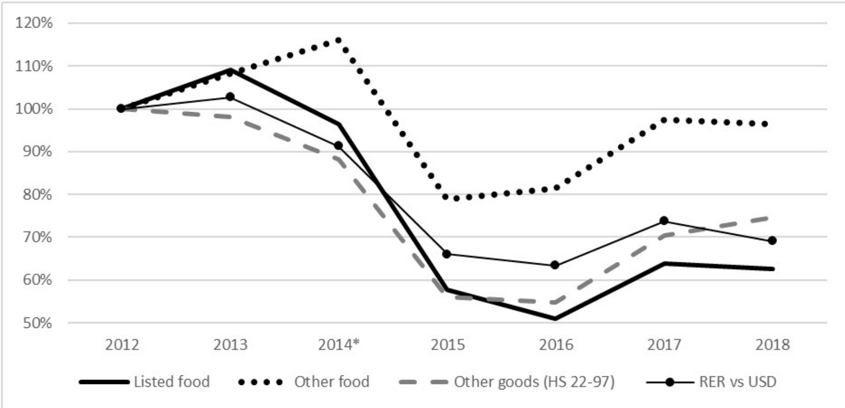


Figure 3.1: The dynamics of the import values ($) and ruble real exchange rate

Note: the listed products include all foodstuff and agricultural HS positions from the list (see Table C.1) imported from all countries; other food include the other products from HS 01 - 21; the other goods — all imported products from HS 22- 97; RER vs USD — the Russian ruble exchange rate against the US dollar; *- the ban was imposed.

rate against the US dollar is the well-known empirical fact[93]. It significantly affected import prices and volumes. The US dollar value of total Russia's imports also fell roughly by half (-42% in 2015 relative to 2013). The decline in imports of listed products (from all countries) was slightly bigger (-47%) despite the fact the target countries supplied 40% ($9.0bln) of these groups of products in the pre-ban period, in 2013. Thus, the Russian ruble depreciation (and other macroeconomic factors) determined the dynamics of import values for the listed foodstuff products, other food and non-food imports (HS 22-97), see Figure 3.1 .

The decline in imports complicates the evaluation of the ban effect. The ban was to decrease the dependence of consumption on the import of foodstuff and agricultural products. As a result, the average import share in the consumption of the listed groups is higher than for the other foodstuff products. Consequently, the exchange rate pass-through into consumer prices is expected to be higher for the former groups. For example, an import share (from all countries) in consumption was higher for affected pork (37%) than for non-affected canned meat (19%). As a result, the bigger increase in the consumer prices of pork than the one of canned meat could be explained by both: (i) the ban of import from the target states; and (ii) a stronger effect of the rubble depreciation on consumer prices because of a higher import share in pork consumption. Thus, control for import shares in consumption and the exchange rate is crucially important.

Domestic demand was also affected by the crisis of 2014-16. During this period, the change in real GDP was negative or slightly positive and the real disposable income has been declining since 2014, see

[93] "On some occasions we have registered the [oil] elasticity [of the exchange rate] ratio at 0.9, it has even reached 1.0 during short periods." Source: Statement by Bank of Russia Governor Elvira Nabiullina, 24 March 2017.

Table C.3. The overall inflation rate (CPI based) was below food inflation in 2013-15, and above it in 2016-17.

One may argue that a government subsidy shifted domestic supply to the right. However, the value of the subsidy is quite stable: from 255 to 298 bln rubles per year, or in the range of 5-8% of agricultural output. The current "national project" (subsidy program) for the agricultural industry started in 2013, replacing previous subsidy programs. Being stable, the subsidy program cannot explain the wave-like consumer price dynamics of the products which were affected by the ban. Although the program focuses on import substitution (first of all, in meat and dairy industries) it may have a bigger long-run effect on agricultural companies which were also protected by the import ban. Consequently, in the empirical estimation, the dummy for the affected (by the ban) product groups may correlate with the subsidy effect. If it is true, the dummy coefficient for the affected products should be negative in the pre-ban period as, it would capture the decreasing effect of the subsidy program on consumer prices. However, the results do not provide any evidence of such bias.

3.3 Data and Empirical Specification

3.3.1 Empirical Specification

This section explains the econometric specification used in the estimation of the ban effects on import and consumer prices. In both cases the difference-in-difference (DD) method for product-level panel data are applied. Two options of the DD method are used: the standard one and the weighted DD. [94] Both DD methods estimate the effect of some event on the treatment group and use pre-and post-treatment indicators. The difference between these methods is in the concept of the control group.

The standard DD estimates the average effect of an event on all treatment objects (the listed products). The dynamic of the treatment group's indicator (price) is compared with the one for the control group. The accuracy of the assessment depends on the similarity of the characteristics of the treatment and control groups.

The weighted DD could be used if the treatment effect is heterogeneous across affected products. In the case of the import ban, the ban effect on import and consumer prices depend on price elasticities of demand and the size of a supply shock. The last one equals the share of the target countries' goods in Russia's import (Table 3.1) and consumption of these products (Table C.4). The target countries' share in Russia's import varies from almost 0% (for bananas and some other fruits) to 75% (for pork). As a result,

[94] The more detailed explanation of the method could be found in Wooldridge (2007).

the size of supply shock is very heterogeneous across product groups and could be measured with high accuracy. However, the own-price elasticities of demand for foodstuff and agricultural goods are in the narrower range, see Table C.5. For four affected groups (meat, fish, dairy and fruits & vegetables) average price elasticities in the group of middle-income countries are from 0.65 to 0.73, (Cornelsen et al., 2015). For the same four groups, the price elasticity of demand for domestic products in Russia are estimated in the range between 0.50 and 0.70 and for foreign products between 0.96 and 1.1, (Kadochnikov et al., 2019). Consequently, the relative variation of the supply shock size is much higher than that of the demand price elasticities. Thus the variation in the ban effect on prices is mainly driven by the differences in the size of a supply shock. Moreover, the opportunity to evaluate price elasticities of demand is quite limited, mainly because of the paucity of data on domestic production and consumption. For these reasons, in the weighted DD I assume that the treatment effect is proportional to the size of supply shock (in the percentage of the initial supply). Despite all mentioned limitations, the applied specification of the weighted DD is more accurate than the standard DD, which measures an average treatment effect for all affected groups, implicitly assuming homogeneity across all groups[95].

The general form of the applied econometric specification combines the DD method for panel data (Wooldridge, 2007) and the DD method with the dynamic effect of the event (Mora and Reggio, 2012):

$$y_{it} = \beta_\tau w_i + X_{it}\gamma + Z_t\sigma + \{\lambda_t\} + \{\alpha_i\} + e_{it} \tag{3.1}$$

In our case, y_{it} is the import price index (MPI) or consumer prices (CP) for a commodity group i or a final consumer product k in month t; w_i — the treatment indicator or the treatment variable. In standard DD, w_i is a binary indicator that is equal to 1 for the affected product groups. In the weighted DD, w_i is heterogeneous among the affected objects as it is discussed above. I assume that it is equal to the target countries' share in Russia's import a commodity group i (for MPI) and in consumption of a final product k (for CP). X_{it} is a vector of group-specific control variables, Z_t is a vector of common control variables which is just the time-invariant part of X_{it}. In non-structural specification Z_t is replaced by λ_t — a dummy-variable for each period. The use of λ_t is preferable in case we are not interested in the value of the common factors' effects. α_i is a group-specific dummy that could be omitted by normalizing the prices to the initial level.

The dynamic of the ban effect is measured by the time-specific import ban coefficient β_τ[96]. The pre-

[95] If the treatment effect $Z_i = X_i * Y_I$ depends on a size of the supply shock X_i and an elasticity Y_i, which are independent $X_i \perp Y_i$, and relative variation of X_i is bigger than the relative variation of Y_i ($\sigma_X > \sigma_Y$), then the variation of the ban effect Z_i depends more on X_i (supply shock) than Y_i (elasticity). So it's reasonable to approximate $Z_i \approx X_i * \bar{Y}_i$. The standard DD assumes that $Z_i = \bar{Z}$

[96] The notation τ emphasizes that pre- and post-treatment coefficients may cover more than one month each. In most regressions τ represents a quarter.

treatment coefficients check the common trends before the event. The ban cannot affect prices until it was announced and imposed as it was a sharp and unpredictable trade restriction.[97] As a result, the presence of a pre-treatment effect obviously would reject the assumption that the control group is a correct one. In the case of weighted DD, the significant pre-treatment coefficients would show the treatment variable w_i captures some other effects, for example, because of omitted variables like control for the government subsidies. However, they are mainly stable and around 4-8% of agricultural output. I did not find any significant pre-treatment coefficients. The exogeneity of w_i is a crucial assumption for the estimation of the equation (1): correlation between w_i and the error term u_it causes inconsistency. The pre-treatment coefficients check at least some possible reasons for endogeneity.

3.3.2 Data and Variables

The sources of the data and their structure are presented in Table C.2.

The Import Price Index (MPI) calculation requires the definition of a product and data cleaning. The product j is a pair $\{p - c\}$ of an 8-digit HS product p and a country of origin c[98]. The product group i is a basket of products within 4-digit HS product group which were imported from all third parties[99]. As far as some products produced in the target states have been banned, they must be considered separately from imports originating in the third parties. Otherwise, sharp and substantial changes in a basket composition may technically create a gap in the price index (ILO, IMF, OECD, Eurostat, UN and WB, 2009).

Data editing contains the following steps. First, I delete observations whose values are less than \$2 000 or volumes do not exceed 1 ton[100]. Second, some groups are excluded as they contain very heterogeneous products with enormous volatility in unit value price (UVP), like seeds or embryos. Third, following Import Export Price Index Manual (ILO et al., 2009) I apply Tukey algorithm for deleting outliers[101]. Forth, following (WTO, 2007) I analyse the degree of heterogeneity of items within one product j using the relationship of median, average and quantile UVP. The products containing heterogeneous items are excluded from the sample as they cannot be used for constructing the import price index.

The cleaned sample covers about 67% of import value (of agricultural and foodstuff products). I constructed Import Price Indexes for Russia's import flow using 2012 as a base year. It is known that Paasche and Laspeyres price indexes provide different estimations for the same trade flows. The difference

[97] As discussed earlier, the crash of MH17 airplane was the main trigger of the second round of the sanctions and Russia's respond. The period between the crash and the ban implementation was 20 days only.

[98] In some cases, a product J is defined as an 8-digit HS product p regardless of a country of origin.

[99] Product groups imported from the target states are denoted as i^B

[100] Similar filters are applied for the US trade data statistics.

[101] Details are described in ILO et al. (2009) p. 266

has a systematic nature coming from the price elasticity of import quantities (ILO et al., 2009). I applied log-Fisher Price Index as the simplest superlative one. Both Paasche and Laspeyres price indexes are used in robustness check. The main conclusions became unchanged: the estimated magnitude and wave-like dynamics of the ban effect are mainly the same for all three indexes.

The vector of the group-specific control variables X_{it} should capture the global supply shocks or the global price index (GPI) as it affects the Russian MPI. One of the common ways to control the GPI is to use the stock prices like the IMF "The Pink Sheet"[102]. For our purpose, it significantly reduces the number of product groups, especially the number of groups which were affected by the import ban. In the current work, the import price index for the US proxies the global price index. Firstly, I calculate it using the same data editing procedure. As a result, the (expected) positive relationship between Russian and the US MPIs increases the credibility of the constructed indexes. Second, the US is chosen, as it is the biggest importer in the world. Moreover, the import ban covers an insignificant share of US exports of the listed products (1.9%) that limits its effect on the US MPI. Third, the US data structure is quite similar to one of the Russian Federal Customs Service (FCS) data and both are denominated in US dollars.

All types of Indexes (Paasche, Laspeyres and Log-Fisher) show high correlation between Russian and the US MPIs. Regression of Russian MPI on US MPI predicts that, considering all foodstuff products together (HS groups 01-23), 10% higher US MPI (GPI) is associated with 4.6% increase in Russian MPI (for import from the third parties)[103]. This coincides with the economic intuition. One may mention that markets of some goods like dairy products are geographically separated. Nevertheless, the positive correlation between Russian and US MPIs may arise because of common seasonality of these agricultural products.

w_i is a treatment indicator in the standard DD method and a treatment variable in the weighted DD one. The ban effects on MPI and CPI are analyzed using both methods. B_i is the binary treatment dummy that is equal to 1 if an imported product group i is mentioned in the ban list, see Table C.1. B_i is used in the standard DD estimations of the ban effect on MPI. $TarSh_i$ is the treatment variable that is equal to the target countries' share in Russia's imports of product group i in 2012. It is calculated using FCS database, it is presented for aggregated product groups in Table C.4, column B. Both B_i and $TarSh_i$ are time and importer-country invariant variables.

Analogously, D_k is equal to 1 if a consumer product k is directly affected by the import ban. The last happens when the banned imports had embodied in k. I compared the list of consumer foodstuff

[102] IMP "The Pink Sheet" contains information about stock prices of the main commodities, including some agricultural goods.

[103] Paasche and Laspeyres inedes provide similar estimations of the coefficient: 0.464 and 0.434, correspondingly.

products k for which Rosstat (Russian Federal State Statistics Service) publishes consumer prices with the list of banned products. As a result, 58 out of 113 products k could be identified as products directly affected by the import ban. The treatment variable $TarShC_k$ is equal to the share of the (lately banned) imports from the target states in total consumption of aggregated products S in 2012 ($k \in S$). The limitation of this variable is that Rosstat calculates import shares in total consumption (MCS) only for 12 (16)[104] aggregated products S, see Table C.4, column A. Moreover, these aggregated products cover only 55 (out of 113) consumer foodstuff products k. For this reason, the weighted DD for consumer prices is less preferable.

Other control variables include: GDP_q – quarterly log-changes in real GDP; MC_S – annual import shares in consumption for 16 aggregated products S; CP_{kt} – monthly consumer prices. The monthly average nominal and real exchange rates of the Russian ruble against the US dollar (NER_t and RER_t) are taken from the Central Bank of Russia. Consumer prices and exchange rates are normalized to the base level (December 2012 = 100%).

3.4 Empirical Results

This section gives different estimations of the ban effect on import and consumer prices. Section 3.4.1 considers import prices. First, I show the wave-like dynamic of the ban effect on MPI applying the standard DD method that is the initial part of the analysis. Second, I discuss the role of the exchange rate, precisely the ruble depreciation. Third, using the heterogeneity of target countries' share in the import of different product, I apply the weighted DD method that is an advanced version of the standard one. Section 3.4.2 studies consumer prices. Similarly, I apply the standard DD method and compare results with the weighted one. The main issue is that available aggregated data limits the accuracy of shares of target countries' products in consumption. Section 3.4.3 studies the violation of the ban regime due to trade-through third parties. First, I detect the negative effect of the on EU- members export prices. Second, I provide a special algorithm that compares EU export to a third party and Russia's import from this third party. Third, I apply regression analysis for revealing trade-through activity.

[104] I added 4 aggregated products (fruits) with negligible domestic production in Russia

3.4.1 Import Prices

The standard DD equation for estimation of the ban effect on the border prices of the affected product groups imported to Russia (from all countries except the target states):

$$MPI_{bt} = \beta_{\tau} B_b + \lambda_t + e_{bt} \tag{3.2}$$

MPI_{it} is log-Fisher Import Price Index for Russia's import flows, $b = \{0, 1\}$ is an indicator for a basket of the listed products or the other food; B_b – a binary treatment dummy showing a product group is in the ban list (regardless of the country of origin); λ_t – a dummy variable for each monthly period; β_{τ} – a dynamic coefficient of the import ban effect, τ is a six-month period[105].

The results (see Table C.6) show that the ban effect jumped in the second half of 2014, when the ban was imposed, increased MPI by 9.2p.p. and had been gradually declining in 2015. However, the pre-treatment ban effect is significant and positive (5.65p.p.). This result questions the validity of the control group – foodstuff products, which were not affected by the embargo. The used control group and the target one have different price dynamics before the ban. One of the reason for that is the ban on import of EU pork imposed at the beginning of 2014 (half-year before the main import ban). There are several possible solutions. First, the same regression excluding pork from the sample provides a substantially lower estimation of the pre-treatment effect. Second, as it was discussed above, the target states had different shares in imports of the listed products. It allows us to use the weighted DD method which does not require the control group. Before going to it, I will discuss the role of the exchange rate.

A lot of studies shows that exchange rate pass-through into international (import or export) prices are far from complete. Burstein and Gopinath (2014) stated that border prices respond partially to exchange rate shocks at most empirically estimated horizons. The main explanation under CES models (Dornbusch, 1987) assumes that firms having market power prefer to adjust their mark-ups for saving market shares, (Atkeson and Burstein, 2008). Usually, this pricing-to-market effect is considered for manufactured goods. However, a similar incompleteness of the exchange rate pass-through into import prices exists also for agricultural and foodstuff products, (Devereux, Dong and Tomlin, 2017)[106]. Nevertheless, the ability of the firms to absorb exchange rate fluctuation in mark-up is limited in case of large devaluations, (Burstein, Eichenbaum and Rebelo, 2007). In such a situation, the degree of pass-through is higher but it is still incomplete, even adjusting for product quality[107].

[105] The use of a shorter period increasing the number of coefficients and expanding the standard errors provides statistically insignificant results for all periods.

[106] Using firm-level data for Canadian import prices, Devereux, Dong and Tomlin (2017) find the exchange rate pass-through for foodstuff product is 0.45 and for fruits and vegetables is 030.

[107] Burstein, Eichenbaum and Rebelo (2007) control for the effect of switching from higher-quality goods to lower-quality

Moreover, the degree of pass-through depends on the currency of invoicing that is endogenous, (Gopinath, Itskhoki and Rigobon, 2010). Notwithstanding price adjustments, international prices are more stable in currencies they are denominated in, (Gopinath et al., 2010). The key role of the US dollar in international pricing increases the degree of pass-through in case of national currency of an importer movements against the US dollar[108]. Russia's import contracts are mainly priced in USD and Euro that is common for emerging markets. Nevertheless, for Russia, the exchange rate pass-through into import prices is incomplete and around 0.79-0.83, (Bussière, Gaulier and Steingress, 2020). This is close to my estimation of the pass-through into import prices of the listed agricultural and foodstuff products[109], that are discussed below.

In the weighted DD form of the equation (3.2), I consider only affected product groups ($i \in I(1)$) on the disaggregated level:

$$MPI_{it} = \beta_Q TarSh_i + \gamma GPI_{it} + \varepsilon RER_t + \delta GDP_Q + e_{it} \tag{3.3}$$

β_Q – a (quarterly) dynamic coefficient of the import ban effect; $TarSh_i$ – a share of the target states in Russia's imports of product group i in 2012; i – a 4-digit HS product group mentioned in the list (Table C.1); GPI_{it} – log-Fisher Import Price Index for US which proxies Global Price Index; RER_t – the ruble real exchange rate against the UD dollar; GDP_Q – quarterly log-changes in real GDP. Table 3.2 contains coefficients for the Global Price Index, Real Exchange Rate, GDP and some treatment coefficients β_Q – one pre-treatment and six post-treatment periods.

A full set of coefficients of the import ban effect on MPI for the full sample of the third parties is presented on Figure 3.2. The ban effect became statistically significant (at 5% level) in Q3 2014 – the period when the embargo was imposed (August 2014). The effect peaked at 26% in Q1 2015 – on average, a product group, which had the 10p.p. higher share of the target countries in Russia's import in 2012, faced 2.6p.p. higher MPI in Q1 2015. The effect had been decreasing in 2015.

The result above is sensitive to the exclusion of Belarus from the sample. Belarus is a special case for Russian trade. First, its economy is deeply integrated with the Russian one. Second, there is no proper border control between Russia and Belarus. Third, roughly two-thirds of the ban violating trade flows are going through Belarus. Thus the estimation compares prices of import flows from Belarus that contain the EU goods coming through Belarus with the base prices of Belarusian goods (before the ban). As a result, the increase in prices of Belarusian export to Russia may partially capture the fact that the

ones or "flight from quality"

[108] It was discussed in details in Chapter 2.

[109] According to the results in Table 3.2 the degree of pass-through is from 0.64 to 0.76 – it is equal to 1 - reported coefficients for the ruble real exchange rate index.

Table 3.2: The weighted DD estimation of the ban effect on import prices for the listed products from non-target states

MPI – denominated in US dollar	(1)	(2)	(3)	(4)
Definition of a product j	country specific		not country specific	
Trade-through:	with Belarus	without Belarus	with Belarus	without Belarus
The ban effect in:				
Q2 2014	0.0636 (0.0495)	0.0899** (0.0429)	0.0365 (0.0523)	0.0570 (0.0479)
Q3 2014 – the ban was imposed	0.131*** (0.0474)	0.115*** (0.0413)	0.0943* (0.0503)	0.0791* (0.0462)
Q4 2014	0.201*** (0.0573)	0.184*** (0.0493)	0.208*** (0.0600)	0.181*** (0.0545)
Q1 2015	0.253*** (0.0505)	0.203*** (0.0439)	0.296*** (0.0531)	0.234*** (0.0488)
Q2 2015	0.133*** (0.0455)	0.0917** (0.0396)	0.116** (0.0483)	0.0534 (0.0445)
Q3 2015	0.140*** (0.0498)	0.107** (0.0431)	0.0930* (0.0527)	0.0422 (0.0482)
Q4 2015	0.104** (0.0506)	0.0300 (0.0438)	0.0503 (0.0533)	-0.0256 (0.0488)
Global Price Index – US MPI	0.162*** (0.0180)	0.125*** (0.0172)	0.187*** (0.0186)	0.231*** (0.0187)
Quarterly changes in real GDP	1.073 (0.754)	0.605 (0.713)	0.685 (0.753)	-0.0742 (0.750)
Ruble real exchange rate index	0.361*** (0.0412)	0.237*** (0.0392)	0.341*** (0.0413)	0.235*** (0.0414)
Number of obs.	2,723	2,637	2,729	2,615
R2	0.234	0.217	0.284	0.229

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table represents the result of regression (3.3) that includes product-fixed effects.

EU goods being accounted for (since the ban) in that flow have better quality and higher prices. Section 3.4.3 discusses the trade-through issue in detail.

I applied two methods to check that. The simpler one is to run the same regression without Belarus, see column(2) in Table 3.2 and Figure C.1. The main conclusion is the same. However, Belarus accounts for a significant share of imports of the listed products from the third parties: 9.3% in the pre-ban period and 20.1% since the ban was imposed.

The second method is to define a product $j\{p\}$ as an 8-digit HS position regardless of a third party it originating from. There is a trade-off: the wider definition of a product ($j\{p\}$) increases the index stability but reduces the homogeneity of a product. On the one hand, the definition of a product $j\{c-p\}$ as a pair of an 8-digit HS position and a country of origin may increase the accuracy of the index in case product quality depends on the producer country. However, it will worsen the situation if products of other quality appear in a trade flow from a country. Moreover, in case some products (defined as a pair $\{c-p\}$) were not imported from a country c in the base period, their appearance will not affect MPI. On the other hand, the general rule is the following: the wider the product definition, the more

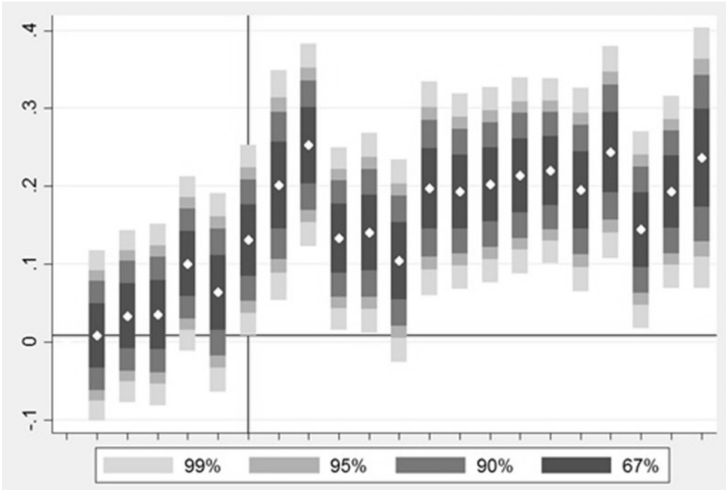


Figure 3.2: The import ban effect on MPI of the listed products, product-country-specific j

Note: the vertical line represents the quarter when the ban was imposed (Q3 2014).
One pre-treatment and six post-treatment coefficients are reported in Table (3.2), column (1).

stable the index. This method also suffers from the trade-through activity because it considers illegally imported goods as the ones originating in third parties. However, it is less sensitive to the bias provided by trade-through activity: the results that include and exclude Belarus provide similar conclusions about the lifetime of the ban effect on MPI, see Figure C.1 and Figure C.2, correspondingly.

The following results (column (3) in Table 3.2 and Figure C.1) are obtained for the specification of MPI that includes Belarus and uses the aggregated across exporting countries product $j\{p\}$. The import ban effect becomes significant in Q3 2014 when the ban was imposed. It increased to 29.6p.p. in Q1 2015 and was declining later in 2015. Thus, on average, a product group, which had had the 10p.p. higher share of the target countries in import, faced 3% higher MPI in Q1 2015. The other three specifications described above estimate the ban effect on the MPI in Q1 2015 in the range from 20 to 25p.p. All specifications agree on that the effect started in Q3 2014 and reached the maximum value in Q1 2015, see Table 3.2.

Results show MPI depends on the Global Price Index (US MPI) and the ruble real exchange rate, but not on the changes in real GDP. The main specification, column (3) in Table 3.2, shows that a 10% increase in global prices leads to 1.9% higher import prices in Russia; a 10% ruble depreciation decreases import prices (denominated in the US dollar) by 3.4%. As a result, the ruble exchange rate pass-through into import prices of the listed products is around 0.66. The estimated degree of pass-through is between the one for total Russian import (0.8, Bussière and Peltonen (2014)) and that for agricultural products and foodstuff imports in Canada (0.30-0.45, Devereux et al. (2017)).

The separate regressions for different groups of agricultural products provide the following results.

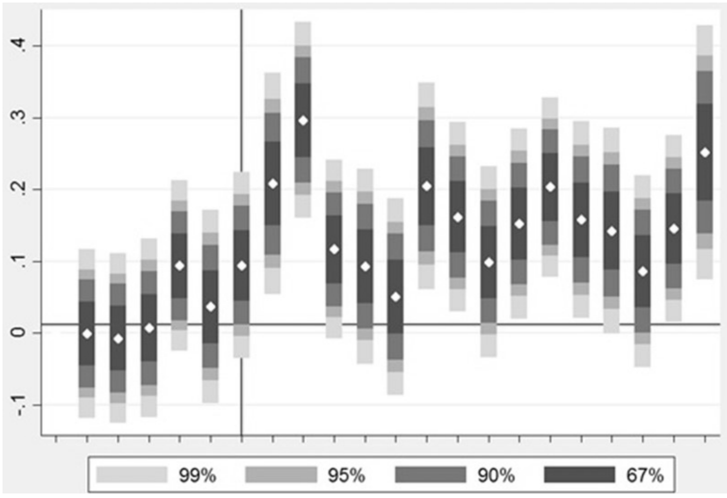


Figure 3.3: The import ban effect on MPI of the listed products, product-specific j

Note: the vertical line represents the quarter when the ban was imposed (Q3 2014).
One pre-treatment and six post-treatment coefficients are reported in Table (3.2), column (3).

Import prices of meat jumped twice: after the EU pork ban in Q1 2014 and after the main import ban in Q3 2014. Both effects disappeared by the end of 2015. MPI of fish suffered from the short-run effect (until the end of 2015). Moreover, the fish import price index went up the second time because of a shift in global prices of fish. The ban has a long-run effect on import prices of dairy products. It comes from a permanent increase in prices of cheese, probably, because of the appearance of relatively expensive EU cheeses embodied in trade flows from the third parties (Belarus). There is not any statistically significant effect of the ban for vegetables. Fruit import prices experienced short-run increase but then disappeared by the middle of 2016.

The comparison of the exchange rate pass-through effect and the ban effect on prices shows that the exchange rate was the key determinant of import prices. Firstly, consider MPI expressed in US dollars. The ruble depreciation dropped MPI by nearly 20.0% [110] and the ban increased the MPI of listed products on average by 12.6%[111] at its peak in Q1 2015. Thus, the ban effect on import prices of the listed products from the third parties, on average, was lower than the effect of the Russian ruble depreciation. It had comparable magnitude only in Q4 2014 and Q1 2015. However, when import prices are expressed in rubles, the estimated ban effect is the same (up to +12.6%), but the exchange rate pass-through into import prices (denominated in rubles) is +53.9% or four times bigger than the ban effect.

[110] The cumulative depreciation of Russian ruble in 2014-2015 was 48%.
[111] The coefficient of the ban effect in the weighted DD is 0.296 in Q1 2015 and the average share of banned imports is 40%

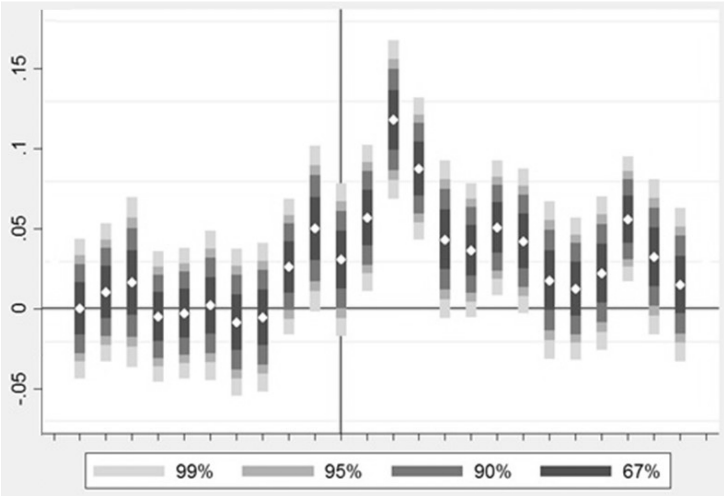


Figure 3.4: The ban effect on consumer prices of the affected products

Note: the vertical line represents the quarter when the ban was imposed (Q3 2014).

3.4.2 Consumer Prices

The core question is how this effect on import prices transmitted into consumer prices. The standard DD equation for estimation of the ban effect on consumer prices of the affected products is:

$$cp_{kt} = \alpha_Q D_k + \lambda_t + c_k + e_{it} \tag{3.4}$$

cp_{it} is a consumer price (denominated in rubles) of a final product k in period (month) t; D_k – a binary treatment dummy (indicator). The affected (treatment) group contains 58 products which are similar to the listed HS positions (Table C.1) and the control one – 55. α_Q – a (quarterly) dynamic coefficient of the ban effect on the consumer prices. λ_t – a dummy variable for each monthly period; c_k – a final product dummy.

The regression results for the ban effect α_Q are presented on Figure 3.4. First, the absence of the pre-treatment effect supports the assumption that the treatment and the control groups had similar price dynamics before the embargo. The only violation in Q2 2014 relates to the EU pork ban. Second, the post-treatment dynamics are consistent with the ban effect on import prices of similar products. This strongly supports the hypothesis that consumer prices of the treatment group deviated from the price dynamics of other goods because of the import ban.

The disappearing effect of the ban on consumer prices is consistent with the dynamics of the ban effect on MPI. On average, the product groups affected by the ban had 11% higher prices comparing to the control groups in Q1 2015.

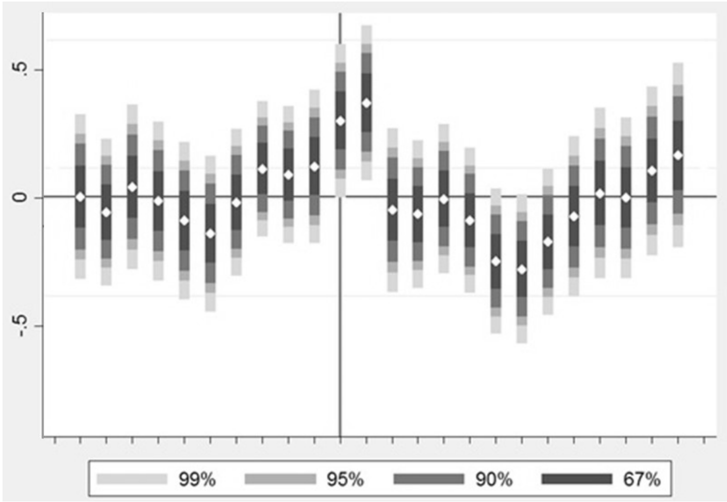


Figure 3.5: The ban effect on consumer prices of the affected products, controlling for import share in consumption

Note: the vertical line represents the quarter when the ban was imposed (Q3 2014).

One may argue that the ruble depreciation biases the estimation of the effect dynamics presented above. The ban was imposed to improve national security by decreasing Russian dependence on the imported food. Consequently, the higher import share in total consumption was the more probable this product group was included in the ban list (see Table 3.1). As a result, the exchange rate has a bigger influence on these groups. Analogously to the analysis of MPI, it is possible to apply the weighted DD method considering the treatment variable. The weighted DD equation for estimation of the ban effect on consumer prices:

$$cp_{kt} = \alpha_Q TarShC_k + \chi_t MShC_k + \lambda_t + c_k + e_{it} \tag{3.5}$$

$TarShC_k$ - is the treatment variable - the share of the (lately banned) imports from the target states in total consumption in 2012[112]. It measures the importance of the ban for a particular final product. As it was mentioned above, the size of the supply shock has a higher relative variation than the price elasticity of demand (see Table C.5). As a result, a share of the target countries' products in consumption is a primary determinant of the variation in the magnitude of the ban effect across product groups.

$MShC_k$ – an import share in consumption is included as a control for the exchange rate effect that is heterogeneous among products: the higher import share in consumption, the higher pass-through into consumer prices. As a result, the regression separates the ban effect from the exchange rate one.

[112]Despite the fact these shares are specific for a product industry S (there are 12 + 4 industries), I use the index $k \in S$ that represents one of 55 final products.

Coefficients χ_t may be replaced by the constant coefficient multiplied by the exchange rate $\varepsilon * ER_t$. However, the exchange rate pass-through takes time (up to two years) and the lagged exchange rate variables necessary, (Burstein and Gopinath, 2014). For this reason, it is easier to replace the exchange rate and its lagged values by the time specific coefficient χ_t. A time specific dummy λ_t controls other common factors (like changes in disposable income or an overall inflation rate). Figure 3.5 shows α_Q – the estimation of the ban effect dynamics on the consumer prices .

As mentioned before, the use of an import share in consumption $MShC_k$ and a share of the (lately) banned import in consumption $TarShC_k$ reduce the number of final products from 113 to 55. Figure 3.5 shows that the ban affected consumer prices only in the second half of 2014. The maximum effect was 0.32 in Q4 2014. Thus, on average, a product that had a 10p.p. higher share of the (lately banned) import from the target countries in consumption in 2012, faced 3.2% higher consumer price in Q4 2014. The magnitudes of the effect differ from the one in case of the standard DD estimation. Nevertheless, both methods find the short-run effect of the ban on consumer prices.

The important point is that the ban effect on consumer prices estimated by the weighted DD is substantially lower than that obtained from the standard DD. For example, the highest share of target states' products in consumption equals 30% for cheese and pork. It gives 9.6% higher prices for these product groups because of the ban. Thus, the estimated effect for the most affected group is lower than the average in the standard DD approach (11%). The ban list includes, on average, the products with higher import share in consumption. As a result, these products suffer both the ban effect and the higher exchange rate pass-through into consumer prices because of a higher import share in consumption. The regression in the previous subchapter estimates that the ban effect on ruble import prices roughly four times lower than the effect of the ruble depreciation. The unweighted average share of import from the target countries in consumption is 12%, and the average ban effect on consumer prices of the affected groups is +3.9p.p. in Q4 2014. That is 3 times lower than in case of the standard DD, which does not take into account the higher degree of exchange rate pass-through for the affected groups.

3.4.3 Violation of the Ban

Several characteristics increase the possibility of a third country to become a way for sanction smugglers: the size of its economy, openness of third-party's economy and the share of the targeted party in the third party's trade, (Early, 2009). The last one is negatively correlated with the distance between the states. The transportation costs are relatively important for agricultural goods and some of these markets are geographically separated. This assumes that the banned goods are more likely to go through the third parties which are closest to Russia and the target states. The EU is the main target partner which produced 70% of the banned import (before the ban) and had sent 15% of (extra-EU) exports to Russia. As a result, the European and North African states are the most probable candidates for the sanctions-busting as they are the states close to both Russia and the main suppliers of banned products.

The analysis of trade-through activity contains the following steps. First, I consider the effect of the ban on the EU export prices using the weighted DD approach. Second, I show that EU export data (Eurostat) and Russian import data (FCS) fit each other well. At the next stage, I compare two trade flows: 1) the one from the target countries (EU) to a third party and 2) a trade flow from a third party to Russia. I restrict the consideration by the EU because of the data availability and the fact that Russia was the important destination market of the listed products only for several EU members, Ukraine and Norway. The comparison is provided in two ways. The first one checks similar shipments from the EU to a third party and from it to Russia at a disaggregated level. It provides clear examples of trade through other countries. The second method compares the total flows of the listed products from the EU to a third party and from that country to Russia.

The following empirical equation estimates the ban effect on the EU export prices of the listed product groups[113]:

$$XPI_{icdt} = \beta_y B_i * RuSh_{ic} + \lambda_{it} + e_{it} \tag{3.6}$$

XPI_{icdt} – log-price of 8-digit HS product group i exported from a country c to a destination market d in period t, normalized to the price in a base period; β_y – a dynamic (yearly) coefficient of the ban effect on the EU-members' export prices; $RuSh_{ic}$ – average share of Russian market in a EU member's export of product i in 2012; B_i — a dummy which equals 1 if the product group is mentioned in the ban list, see Table C.1; λ_{it} – a control for the overall price dynamics of product i.

Results show Russia's share in EU member's export of the listed products has a negative effect on export prices to other destinations in 2013-2016, see Table C.7. An EU member for which Russia had 10p.p. higher share in exports of the listed products in 2012, on average, had 0.9p.p. lower export prices of this good in 2014. There is no such effect for non-listed foodstuff products. On average, only 3.3% of the listed products were exported from EU members to Russia. Thus, the estimated effect of the ban on EU export prices is below 0.5%. However, for countries like Finland, for which Russia was the main destination market of the listed products (37%), suffer a considerable drop in export prices (around 7%). These results along with the positive ban effect on Russia's import prices provide evidence that the ban

[113]Observations are weighted by the values of trade flows in 2012 so the corresponding coefficients could be interpret as the ban effect on the EU export price index.

created a measurable (unusual) difference in EU export and Russian import prices. This led to (increase in) trade through third parties which is described below.

The algorithm of trade-through detection uses the EU's monthly export data and Russia's import data at the 4-digit HS commodity level, see Table C.2. First, I check that Eurostat and FCS monthly datasets fit each other. I regress monthly trade flow from EU to Russia based on FTS data on the same trade flows provided by Eurostat[114]. There are two different periods: before the ban (01.2012-07.2014) and after it (09.2014-08.2016). The regression results (skipped) conclude that EU and Russian trade statistics fit each other relatively well[115]. Thus, the EU export data and the Russian import data could be used together.

In the case analysis, the Russia's import flow (at 4-digit HS commodity group) from a third party is considered as trade-through if it satisfies all the following conditions:

- Its volume is bigger than the base level – the average amount of the same trade flow in the corresponding months in 2012 and 2013.
- Its volume is comparable to the EU's export to this third party in the same month or in the previous month. Comparable means that the ratio of Russia's import volume to EU's export one is bigger than 0.5, but lower than 2.
- Its unit value price is higher than the one of EU's export of the same product to this third party in the same month or the previous month. The idea of this condition is that the prices of re-exported goods should increase (going through a third party) at least because of additional transportation costs.

The share of cases that satisfy the conditions 1-3 in Russia's total import of the listed food from this group of third parties (European and North African countries) went up from 2.7% (before the embargo) to 6.7% (since). The presence of the trade-through cases during the pre-embargo period has two possible explanations. The first one is that the algorithm also may provide a false-positive conclusion based on these conditions. Each of the conditions could be satisfied randomly, so the probability that all rules are satisfied accidentally (without trade-through) is non-zero. The second possible explanation is that trade-through was the common practice even before the embargo. The reason for that could be temporary restrictions on import of some food from the EU because of sanitary regulations (like the EU pork ban imposed in January 2014) or import tariff quotas for some goods (like beef and pork).

[114] EU export values are converted into US dollars using monthly average exchange rates.
[115] The regression coefficient for the listed products (before the ban) is equal to 1.074 (s.d. = 0.016) for volumes and 1.062 (0.014) for values

Table 3.3: Evaluation of the ban violation by main third parties

Third party	Number of cases	Volume (mln USD)	A share of Russia's import from TP
Belarus	834	675	8%
Serbia	336	183	19%
Armenia	110	45	25%
Turkey	122	29	1%
Kazakhstan	215	26	15%
Switzerland	61	26	23%
Greenland	13	24	12%
Morocco	80	23	2%
Bosnia	80	22	35%
Moldova	72	11	3%
Faroe Islands	14	10	1%
TOTAL (08/14-08/17)	2129	1098	6.7%
TOTAL before the ban (01/13-07/14)	795	297	2.7%

Source: author's calculation based on Eurostat and FCS data.

The list of third parties which are involved in trade-through is quite predictable. According to calculations more than a half of the banned goods have gone through Belarus (61%) and one third – through Serbia. Import of the listed products from the target countries was $9.0 bln in 2013. Total import to Russia from all countries went down by 43% (2015 to 2013) because of the ruble depreciation and other factors. The hypothetical import of such goods from the target countries (if the ban would have never imposed) could be estimated at around $5 bln per year.

The evaluation of trade-through gives only 5-8% of the potential import (in case of the absence of the ban). The trade-through would explain the observed increase in import prices only in case the prices of these goods were in times higher than the one of products originating in the third parties. The previous chapter shows the sustainability of the MPI dynamics after excluding the main channel of the trade-through (Belarus). Thus, the increase in import prices is primarily determined by the increase in prices of products originating in the third parties but no by trade through third parties.

The additional possible way to detect trade-through is to regress Russian import from a third party on EU export to this country:

$$RU\_IM_{ict} = \alpha + \beta_c EU\_EX_{ict} + e_{ict} \tag{3.7}$$

RU_IM_{ict} – Russia's import volume of 6-digit HS product group i from third party c in month t; EU_EX_{ict} – EU export volume of product i to c. I run regression both in levels and in changes. The first one uses current volumes, the second one - the differences between the current volumes and that in the base (pre-ban) period. The regression coefficient β_c is positive and statistically significant in both regressions for only two (!) countries out of 255: Belarus and Serbia. In the regression in levels, the coefficient for Belarus is 0.411 (s.e.0.003) and the one for Serbia is 0.193 (0.01). In regression in changes, the coefficients are 0.440 (0.016) and 1.130 (0.122), correspondingly.

Trade-through Belarus is visible even on the aggregated data of EU export of all listed products to Belarus and Russia's import of the same goods from it. The sharp increase in EU export and Russia's import happened simultaneously just after the ban was imposed, see Figure C.3. However, the EU export value to Belarus of the listed products in 2014-2016 exceeded the corresponding export value in 2012-2013 only by €250mln (by €290mln when compared with 2012). It supports the view that trade-through activity is relatively weak and has a limited effect on import and consumer prices.

3.5 Discussion

The oil prices fell in 2014 caused almost two-fold depreciation of the Russian ruble. The results show that the exchange rate was the key determinant of both import and consumer prices dynamics. The estimated degree of exchange rate pass-through into import prices is in the range between 0.64 and 0.77 that does not contradict empirical findings in the literature[116]. The ruble depreciation dropped the dollar import price index, on average, by 20%. The ban effect on the import prices of the listed products did not exceed this value even at its peak in Q1 2015 (12.6%). Moreover, consumer prices depend on the dynamics of import prices expressed in rubles and other factors such as an import share in consumption. Ruble import prices jumped, on average, by 54% (in 2015 relative to 2013) because of the exchange rate movements. Thus the rubble depreciation had a four-time bigger effect on import prices of the listed products than the ban had at the peak. The higher border prices of the listed products imported from the third parties in Q3 2014- Q4 2015 caused \$1.25bln additional costs (assuming the same import volumes) or 69.2bln rubles.

I analysed how observed wave-like dynamic of import prices (caused by the ban) affected consumer prices. First, the standard DD method, which compares consumer prices of the affected products and other products, overestimates the ban effect. The estimated value of the ban effect on consumer prices of the affected products is even higher than the impact on import prices. This happens because the ban list includes products with a higher import share in consumption, see Table C.4. The affected products suffer both (i) the supply shock because of the ban, and (ii) the higher exchange rate pass-through into consumer prices because of a higher import share in consumption. As a result, the simple comparison of the affected groups and other product groups captures not only the ban effect but also some part of the exchange rate pass-through. I checked that directly, applying the weighted DD method. By including

[116]See, for example, the pass-through coefficient for Russia's import by Bussière, Gaulier and Steingress (2020) and Bussière and Peltonen (2014).

import shares in consumption of different product groups, the method controls for heterogeneity in the degree of exchange rate pass-through into consumer prices.

Controlling for such heterogeneity across affected groups, the ban effect on consumer prices was significant only in Q3 2014 (+3.0%) and in Q4 2014 (+3.9%). The share of the affected product groups in the total households' expenditure was around 20% in 2014 or 5 198 bln rubles. Using these numbers, I evaluate the consumer loses due to the ban as the additional expenditure on the same products.

The consumer welfare loss during the second half of 2014 was 90 bln rubles ($2.1bln). It is worth mentioning that this value and the additional expenditure on import of the listed products (70 bln rubles) are estimated independently. These values are comparable, and the difference does not exceed the accuracy of the initial estimations.

The exchange rate determines import prices (in national currency), import volumes and, as a result, import share in consumption. It, in turn, affects the magnitude of the ban effect on consumer prices. This factor is crucially important for numerical simulations. Nevertheless, it is not often discussed in detail.

Using the partial equilibrium framework, Volchkova and Kuznetsova (2019) estimate the welfare losses in 445bln rubles each year. The authors use demand elasticities for the affected products from the estimations for other countries. The other possible reason for the such difference in the results is that I use controls for the world price level and the exchange rate effect on prices.

Boulanger, Dudu, Ferrari and Philippidis (2016) simulate the ban effect based on the CGE model with the reduced factor mobility (the short-run effect) and the exogenous changes in consumer preferences. The changes in preferences among products from different countries of origin are used to incorporate the incomplete import restriction into the model. However, it is difficult to provide an economic explanation for such changes in preferences. Authors predict an increase in domestic prices up to 10% and estimate the losses around $3,4 bln, which is comparable with the annual value of banned import (before the ban was imposed). The main part ($2,4 bln) of estimated losses is going from the consumer losses because of the lower variety of products. Under the authors' assumption of exogenous changes in preferences, this conclusion is disputable. The losses because of the changes in terms of trade is estimated at only around $50 mln, the other $900 mln is related to the inefficient resource allocation.

Kutlina-Dimitrova (2017) using the CGE model simulates welfare losses around $5.8 bln that exceeds an expected annual value of banned import (in case of absence of the ban). The author uses a more classical method to simulate import ban incorporating the enormously large import tariff into the CGE model. Nevertheless, some part of the result is difficult to explain, for example, the reduction in US export is estimated in 0.03% (around $1 bln) that also exceeds US import flows of banned food to Russia (before the ban). The possible reason for such results is the fact that CGE predictions could be sensitive to the elasticities used for simulations. This raises the concern about the predictive power of the CGE model for Russia at that period. The model implicitly assumes that elasticities of substitution are constant. It is calibrated on the small deviations from the equilibrium. However, it is difficult to say that the ruble depreciation and import ban was a small shock. As a result, the use of the same elasticities requires additional discussion.

One additional factor which is often omitted in simulations and regression analysis is a violation of the import ban regime. Some banned products reach the market disguised as the third parties' products. In the case of simulation, omitting the violation of the ban regime may lead overestimation of the restriction on imports from target states (the ad-valorem equivalent of the ban). In my estimations, imports from the target states dropped by 92-96%: some goods from target states reach the market through third parties, mainly Belarus and Serbia. As a result, the effective import tariffs in the model should be lower than entirely restrictive. In the case of regression analysis, the banned products (which are imported through third parties) are mixed with goods produced in third parties. This might provide a bias in the estimation if the initial (normal) price of the illegally imported product was higher than the products produced in a third party. For example, it could be the case for cheese as the target states (EU members) supplied the most expensive kinds: if EU cheese is imported through Belarus, it leads to an overestimation of import prices.

3.6 Conclusion

The food import ban imposed in August 2014 had a short-run wale-like effect on prices: import and consumer prices of the affected groups jumped in the second half of 2014 and had been gradually declining during 2015.

The strongest effect on import prices was in Q1 2015. On average, a product group, which had had a 10p.p. higher share of the target countries in import, faced 3.0%. higher prices in Q1 2015. The shares of target countries in total import varied by commodity groups in the range from 0% to 93%. Specifications without Belarus and with the alternative definition of the product groups provide similar results.

There was a similar dynamic of the ban effect on the consumer prices with the maximum in Q4 2014. This supports the hypothesis that the import ban causes the dynamics of the prices for the affected product groups. On average, a product that had a 10p.p. higher share of the (lately banned) import from the target countries' in consumption in 2012, faced a 3.2% higher consumer price in Q4 2014.

For both import and consumer prices, the effect of the ruble depreciation that happened in the second half of 2014 played a key role. Omitting control for the exchange rate causes overestimation in the ban effect on consumer prices. The consumer welfare loss during the second half of 2014 is estimated at 90 bln rubles ($2.1bln). The additional expenditure on the import of the listed products was 70 bln rubles ($ 1.25bln)[117].

Violation of the ban regime (trade-through activity) is considered separately. I compared the EU exports to the third parties with Russian imports from them. The share of detected trade-through flows in total Russia's import of the listed foodstuff products from the third parties went up from 2.7% (before the ban) to 6.7% (after). Predictably, Belarus has the biggest share in the detected trade-through activity (61%), Serbia has the second biggest one (17%). Trade-through covers up to 6.7% of Russian import of listed products. Deleting the main route of trade-through activity (Belarus) from the sample of third parties provides quite similar results.

[117]The effective average exchange rates of the Russian ruble against the US dollar are different in the estimation of the consumer welfare loss and the additional expenditure on the import of listed product. There are two reasons for this: (i) non-identical dynamics of the ban effect on import and consumer prices and (ii) a very high volatility of the Russian ruble exchange rate in that period.

3.A Data Appendix

Table C.1: List of agricultural products, raw materials and foodstuffs originating from the United States, the European Union, Canada, Australia and Norway, and that are banned for imports to the Russian Federation

HS CODE	List of products [a]
0201	Meat of bovine animals, fresh or chilled
0202	Meat of bovine animals, frozen
0203	Pork, fresh, chilled or frozen
0207	Meat and edible offal of the poultry indicated in line 0105, fresh, chilled or frozen
Out of 0210[b]	Meat salted, in brine, dried or smoked
Out of 0301[b]	Live fish (excluding hatchlings of salmon (Salmo salar) and trout (Salmo trutta))
0302, 0303, 0304, 0305, 0306, 0307, 0308	Fish and crustaceans, molluscs and other aquatic invertebrates
Out of: 0401[b], 0402[b], 0403[b], 0404[b], 0405[b], 0406[b]	Milk and dairy products (excluding lactose-free milk and lactose-free milk products)
0701 (exc. 0701100000), 070200000, 0703 (exc. 0703101100), 0704, 0705, 0706, 070700, 0708, 0709, 0710, 0711, 0712 (exc. 0712901100), 0713 (exc. 0713101000), 0714	Vegetables, edible roots and tubers (exc. seed potatoes, seed onion, sugar maize hybrid for planting, peas for planting)
0801, 0802, 0803, 0804, 0805, 0806, 0807, 0808, 0809, 0810, 0811, 0813	Fruit and nuts
160100	Sausages and similar products of meat, meat offal or blood; final food products based thereon
Out of: 1901901100[b], 1901909100[b] Out of: 2106909200[b], 2106909804[b], 2106909805[b], 2106909809[b]	Food or finished products (exc. biologically active supplements; vitamin-mineral complexes; flavour additives; protein concentrates (of animal and plant origin) and their mixtures; food fibers; food additives (including complex ones))

[a] For the purposes of the application of this list, one should be guided solely by the HS CODE, name of product is shown for convenience. Except for goods destined for baby food.

[b] For the purposes of the application of this position, one should be guided both by a HS CODE, and the name of the product.

Source: the Resolution of the Russian government of 7 August 2014 No.778

Table C.2: Sources of data

Data	Structure	Source
Russian international trade data	monthly data: direction (im/ex), partner, value (USD), volumes (tons), quantity (tons, units, e.g.), commodity group (2/4/6/8/10-digit HS)	FCS (Russian Federal Custom Service)
US International trade data	monthly data: direction (im/ex), partner, value (USD), volumes(tons), commodity group (2/4/6/8-HS)	Bureau of Labor Statistics
EU international trade data	monthly data: direction (im/ex), reporter (EU member), partner, value (EURO), volumes (100 kg), commodity group (2/4/6/8-digit HS)	Eurostat: EU Trade Since 1988 By HS6
Production and consumption data	annual data: production (tons), consumption, stock, share of import in consumption (for 16 different agricultural products)	Rosstat(Russian Federal State Statistics Service): The use of resources in Russia
Consumer prices	monthly data: prices for 700+ products and services	Rosstat: consumer prices
Exchange rates	monthly data: nominal and real ER	The Central Bank of Russia: the main indicators of the exchange rates
Real GDP	Quarterly data	Rosstat: GDP

Table C.3: Annual dynamics of various Russian economic indicators

Indicator	2012	2013	2014	2015	2016	2017	2018	2019
Real GDP, changes (%)	3.7	1.8	0.7	-2.5	0.3	1.6	2.3	1.3
Real disposable income, changes (%)	4.6	4.0	-0.7	-3.2	-6.0	-1.1	-0.1	0.8
Inflation rate, (%)	6.6	6.5	11.4	12.9	5.4	2.5	4.3	3.0
CPI of food, (%)	7.5	7.3	15.4	14.0	4.6	1.1	4.7	2.6
CPI of non-food products, (%)	5.2	4.5	8.0	13.6	6.5	2.7	4.1	3.0
Nominal ER vs USD, changes (%)	-5.5	-2.4	-16.2	-37.4	-9.3	14.7	-6.7	5.6
USD Import Value, changes (%)	5.5	-0.6	-9.1	-36.2	-0.3	24.5	4.9	2.2
Agricultural output (bln rubles, cur. pr.)	3160	3458	4031	4794	5112	5109	5348	5907
Subsidy for agricultural industry, (bln rubles)	262	234	244	241	284	245	287	325
Subsidy, in % of output	7.8	6.3	6.1	5.0	5.6	4.8	5.4	5.5
Import share in food consumption (%)	34	36	34	28	23	23	24	25

Source: Rosstat (The Russian Federal State Statistics Service) and the Central Bank of Russia

Table C.4: The import shares in the final consumption by product groups

Final goods	The import share in consumption in 2012	The target states' share in total imports in 2012	The target states' share in consumption in 2012	Under the ban	The banned goods' share in final consumption in 2012
	A	B	C =A*B	D	E=C*D
Beef, including offal	62%	26%	16%	1	16%
Pork, including offal	37%	80%	30%	1	30%
Poultry meat, including offal	14%	65%	9%	1	9%
Milk and dry cream	42%	14%	6%	1	6%
Animal fats	35%	28%	10%	0	0%
Bananas[a]	100%	0%	0%	1	0%
Oranges[a]	100%	6%	6%	1	6%
Lemons[a]	100%	14%	14%	1	14%
Grapes[a]	100%	9%	9%	1	9%
Flour from grain and leguminous crops	1%	18%	0%	1	0%
Groats	1%	3%	0%	0	0%
Vegetable oils	16%	20%	3%	0	0%
Canned meat	19%	71%	14%	0	0%
Sugar	5%	10%	1%	0	0%
Confectionery	12%	35%	4%	0	0%
Cheese	48%	63%	30%	1	30%

Source: author's calculation based on FCS(The Russian Federal Customs Service) and Rosstat (The Russian Federal State Statistics Service) database.
[a] – domestic production is negligible.

Table C.5: Average own price elasticities in the group of the middle-income countries and Russia

Product group	Own price elasticities of demand	Own price elasticities of demand for domestic products	Own price elasticities of demand for import products
Source of the data	Cornelsen, Green, Turner, Dangour, Shankar, Mazzocchi and Smith (2015)	Kadochnikov, Chentsov and Knobel (2019)	
Countries:	11 middle-income countries[a]	Russia	
Fruits and vegetables	-0.65	-0.65	-0.96
Meat	-0.72	-0.68	-1.10
Fish	-0.73	-0.50	-1.00
Dairy	-0.72	-0.70	-1.05

[a] Based on meta-analysis of 18 studies for Brazil, Bulgaria, Hungary, Latvia, Lithuania, Mexico, Romania, Saudi Arabia, Slovenia, South Africa and Turkey.

3.B Additional Tables and Figures

Table C.6: The standard DD estimation of the ban effect on import prices for listed/other foodstuff from all non-target states, excluding Kazakhstan and Belarus

MPI	(1)	(2)	(3)
The ban effect B_τ in:			
Second pre-treatment period 08/2013 – 01/2014	0.0233 (0.0201)	0.0225 (0.0228)	
First pre-treatment period 02/2014 – 07/2014	0.0565*** (0.0201)	0.0546** (0.0228)	
First post-treatment period 08/2014 – 01/2015	0.0861*** (0.0201)	0.0916*** (0.0228)	0.0674*** (0.0212)
Second post-treatment period 08/2014 – 01/2015	0.0831*** (0.0201)	0.0758*** (0.0228)	0.0495** (0.0212)
Third post-treatment period 02/2015 – 08/2017	0.0516*** (0.0155)	0.0477*** (0.0175)	0.0253* (0.0138)
Dummy for the treatment groups	0.0416*** (0.0137)	0.0416*** (0.0155)	0.0651*** (0.0104)
Nominal ER	-0.0168 (0.0259)		
Dummy for each monthly period		YES	YES
Number of obs.	112	112	112
R^2	0.912	0.941	0.926

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table represents the result of regression (3.2) that includes product-fixed effects.

Table C.7: The ban effect on EU export prices for listed products

EU export prices	Exporting countries			
	All EU members	EU without Germany	12 Euro Area members	Non-listed foodstuff products from All EU members
The ban effect in:				
2012 (pre-ban)	-0.0122 (0.0184)	-0.00467 (0.0160)	-0.0164 (0.0401)	0.0353 (0.0229)
2013 (pre-ban)	-0.0870** (0.0350)	-0.0791** (0.0367)	-0.0883* (0.0452)	0.0637 (0.0596)
2014	-0.0946** (0.0433)	-0.0647** (0.0289)	-0.188** (0.0849)	0.0539 (0.0707)
2015	-0.109** (0.0509)	-0.0680*** (0.0225)	-0.255** (0.106)	0.0510 (0.0661)
2016	-0.132*** (0.0299)	-0.110*** (0.0220)	-0.223*** (0.0658)	0.0980 (0.0883)
2017	-0.0137 (0.0397)	0.00572 (0.0318)	-0.131* (0.0596)	0.0831 (0.0859)
2018	-0.0615* (0.0321)	-0.0400 (0.0241)	-0.165* (0.0856)	0.131* (0.0661)
N-obs	4,357,497	3,853,831	3,072,703	6,852,753
R2	0.167	0.181	0.156	0.151

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table represents the result of regression (3.6) that includes product-fixed effects.

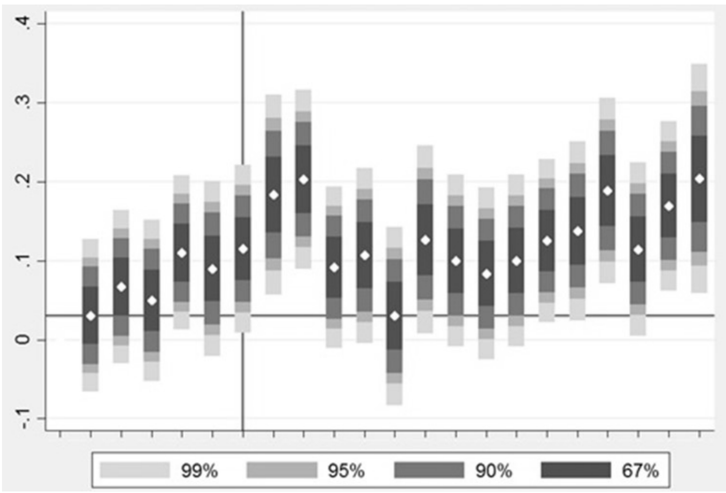


Figure C.1: The import ban effect on MPI of the listed products, product-country-specific j, excluding Belarus

Note: the vertical line represents the quarter when the ban was imposed (Q3 2014).
One pre-treatment and six post-treatment coefficients are reported in Table (3.2), column (2).

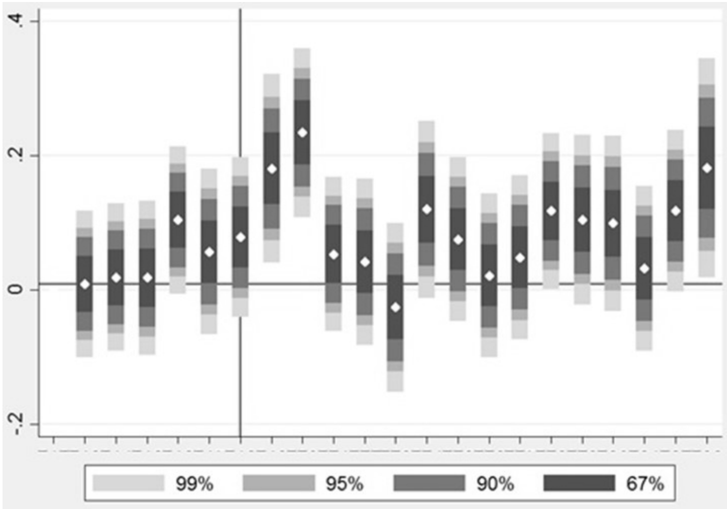


Figure C.2: The import ban effect on MPI of the listed products, product-specific j, excluding Belarus

Note: the vertical line represents the quarter when the ban was imposed (Q3 2014).
One pre-treatment and six post-treatment coefficients are reported in Table (3.2), column (4).

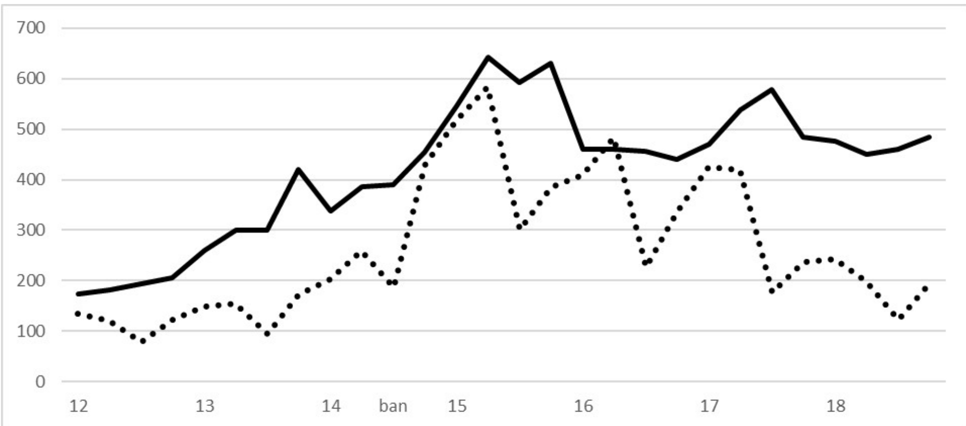


Figure C.3: The trade volumes of the listed products exported by EU to Belarus and imported by Russia from Belarus.

Note: dotted line – EU export volumes of the listed products to Belarus; solid line – Russian import volumes of the listed products from Belarus.

Conclusion

The thesis considers various determinates of the degree of the international price reaction to exchange rate shocks from different perspectives for the diverse country samples.

Chapter 1 analyses the effects of foreign inputs and an exporting country share in a destination market on the overall degree of exchange rate pass-through into export prices. In the theoretical framework, I apply a classical model of oligopolistic competition – a nested CES demand model – with equal-size firms that may use foreign inputs in production. I consider industry-level data for a broad set of countries: 35 advanced economies and 22 developing countries. The results support theoretical predictions that the use of foreign inputs reduces exchange rate pass-through into export prices and an exporting country share increases the degree of export price reaction. The empirical estimations apply different measures of exchange rates: a bilateral one, a real effective exchange rate and exchange rates against a world benchmark currency, like USD or the Special Drawing Rights. All these measures of exchange rates support the theoretical predictions for advanced economies. However, only the estimations based on real effective exchange rates provide evidence in favour of the effect of foreign inputs for the set of developing countries. There is a strong negative correlation between a foreign inputs share embodied in gross exports and an exporting country share on destination markets as both shares depend on exporting country size. Thus, it is important to control both channels – omitting one induces a substantial bias in the other's estimation. The results also show foreign inputs reduce the degree of export price adjustment through the cost channel: they lessen the pass-through only in case of producer's currency exchange rate movements, but not an importer one.

This provides a link to Chapter 2 where I show that the degree of pass-through is asymmetric and depends on what currency—the producer's or importer's —actually moves. Applying the same nested CES framework, the model considers firms that are heterogeneous in market shares and import intensity. The novelty is that I explicitly distinguish producer currency shocks from local currency ones in the model. Using this decomposition of a bilateral exchange rate, I isolate the role of imported inputs and strategic competition and show that both channels are sources of the asymmetry. That is, they have a greater effect on the degree of the producer currency pass-through than on the local (importer) currency one. Using detailed trade data of the EU exports, I analyse export prices focusing on eight members with floating national currencies. These are clear-cut examples of small open economies for which the euro—neither a producer nor a local currency—plays a dominant role. Two facts emerge. First, the local currency pass-through into prices of EU exports to non-EU destinations is almost complete with no difference between the EU members with floating exchange rates and the Euro Area countries. Second, the degree of the producer currency pass-through is markedly lower than the degree of local currency one for all eight considered countries. Thus, I find clear evidence of the asymmetry in pass-through for the set of small open economies integrated with a currency union.

Next, I empirically investigate the foreign inputs and strategic competition channels, distinguishing between two components of a bilateral (producer–importer) exchange rate. The results show that these channels lower the producer currency pass-through and having limited influence on the importer currency one. Together channels account for roughly half of the observed asymmetry for six Easter European EU members (emerging markets) and explain the asymmetry completely for both advanced economies in the sample.

Chapter 3 considers Russia's partial import ban, distinguishing its influence on prices from the effect of the Russian ruble depreciation happened at the same time. Here I use the very detailed Russian import data. The key aspect of this empirical chapter is the generalized dif-in-dif method that applies the variation of the target states' share in Russian import and consumption among affected product groups. The results detect a wave-like shape dynamics of the ban effect on import and consumer prices: prices of the affected groups jumped just after the ban – in Q3 2014 – and had been gradually declining during 2015. The strongest ban effect on prices of products imported from third parties was in Q1 2015, on the consumer prices of these products – in Q4 2014. An interesting finding is that the effect of the ruble depreciation on prices was several times greater than the effect of the ban, and it is persistent over time. Omitting control for the exchange rate causes substantial overestimation in the ban effect on prices. The consumer welfare loss during the second half of 2014 is estimated at 90 bln rubles ($2.1bln); the additional expenditure on imports of the listed products — 70 bln rubles ($ 1.25bln). Violation of the ban regime (trade-through) is considered separately. Comparing the EU exports to the third parties with Russian imports from them, I evaluate trade-through flows in $ 1.1 bln in three years of the ban regime. Predictably, Belarus was the primary path of the bypass trade, Serbia – the second biggest one.

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