Declared exchange rate and quality-driven pass-through to import prices

Evgenii Monastyrenko*

Very Preliminary. Please do not circulate.

December 2019

Abstract

This paper argues that the product quality is an important channel of price adjustments to the exchange rate changes. To support this view, I elaborate a model of monopolistic competition with heterogenous quality and sizes of trading firms. I further empirically test the role of quality for the exchange rate pass-through to import prices. I employ a highly detailed dataset that incorporates the universe of declarations submitted to Russian customs authorities on a daily basis, over the 2011 – 2015 period. The Russian Ruble has been largely volatile and sharply depreciated in 2014 – 2015, which generated large variance to explore. I compute import quality as the residual of the demand and introduce it to the standard exchange rate pass-through regression. I find that the higher product quality is associated with softer exchange rate pass-through. I further isolate the role of the invoicing currency. I make use of the declared exchange rates and conclude that corresponding pass-through is significantly lower than for the official exchange rates. Finally, I differentiate the pass-through with respect to the importers' characteristics, which I source from BvD Orbis. I conclude that when the importers are bigger, the pass-through is getting stronger. Meanwhile, the magnitude for the most productive importers is softer.

Keywords: Pass-through, Exchange rate, Quality, Firm-level trade, Invoicing
JEL Classification: F14, F31

*University of Luxembourg. E-mail: evgenii.monastyrenko@uni.lu, Tel.: +352 46 66 44 6305. 6, rue Richard Coudenhove-Kalergi L-1359 Luxembourg.
I thank participants of ETSG 2019.

1 Introduction

The recent and well-established literature on the pass-through has investigated the nexus between exchange rate and prices. Gopinath et al. (2011) is an early study of the exchange rate pass-through to producer and consumer prices. Amiti et al. (2014) differentiate the pass-through of the exchange rate with respect to the size of the trading firms. Bernini and Tomasi (2015) investigates the response of exporters to real exchange rate fluctuations. Corsetti et al. (2018) investigates a link between the destination-specific markup adjustment and currency of the trade invoicing. In this paper I aim to reveal the role of product quality for the exchange rate pass-through.

This study belongs to the strand of literature on the quality in the international trade. The quality of goods is an important component of consumer well-being. Meanwhile, the international trade studies acknowledging the quality are yet relatively scarce. Khandelwal (2010) was first to propose to measure the quality of traded goods as the residual of the demand. This approach has been further developed in the studies of Hallak and Schott (2011) and Khandelwal et al. (2013). Crozet et al. (2011) estimated the Melitz model combining direct measure of quality with firm-level data within wine industry. Based on Chinese customs data, Manova and Yu (2017) study the role of product quality for the multi-product firms. They demonstrate that the within-firm product quality ranking determines the allocation of activities across products and the export dynamics. The firms vary product quality by using the inputs at various quality levels. Disdier et al. (2018) in a partial equilibrium setup, study the impact of quality standards on the quality of individual firms.

This paper focuses on the quality of imported goods as the principal channel of the prices adjustments to the real exchange rate. The closely related study is Chen and Juvenal (2016), where they test the impact of the real exchange rate on the behaviour of firms. Their model predicts that for higher quality import the pass-through to pricing to market is higher and softer for the trade volumes. Auer et al. (2018) introduced a model with heterogenous in their income consumers buying products of different quality levels. They derive a number of theoretical predictions for the pass-through. They further test the cost pass-through into consumer prices with a data on European car industry.

I develop a simple monopolistic competition model that features endogenous markups, heterogeneous quality and firm sizes. It is largely based on the model proposed by Devereux et al. (2017). Similarly to Chen and Juvenal (2016), I introduce ranked quality as the distance from the ”core” variety produced by a firm. The model also accounts for the heterogeneity in efficiency, in the same way as in Berman et al. (2012). The model predicts that the exchange rate pass-through is a function of the sizes of trading firms.

This paper seeks to test the exchange rate pass-through with focus on the product

quality. I employ a highly detailed dataset of the daily import transactions to Russia between 2012 and 2015. Most importantly, the data contains the unit values, which are further translated into quality measure a la Khandelwal (2010). For each transaction the information on the invoicing currency and applied exchange rate is known. I merge this data with the firm-level data provided by BvD Orbis. During the period covered in the trade data, Russian national currency has been largely fluctuating. The Russian Ruble has further sharply depreciated in late 2014 – beginning of 2015. All this has created large uncertainties for the trading firms, and forced them to react with adjustments of ruble-denominated prices.

My empirical strategy revolves around the estimation of a standard exchange-rate pass-through proposed by (Gopinath et al., 2011). First, I estimate the pass-through of the IMF exchange rate. Second, I re-test the same specification with the declared exchange rates. I conclude that the pass-through is much less complete for the "internal" exchange rates agreed by trading firms. To the best of my knowledge, this result is brand new as compared to the related literature. The turn to use such exchange rates in order to overcome currency-related uncertainty. Thus, the resulting prices are less sesitive to the monetary shocks. Next, I estimate the interaction terms between exchange rate and quality. I conclude that the higher product quality is associated with lower exchange rate pass-through.

I further test the firm-level predictions of the model. I re-estimate the same specification for the pass-through with firm characteristics. I find that the biggest (in terms of total assets) importers has promoted the pass-through. This effect is clearly revealed after controlling for the origin-year unobservables. It has been repeatedly assumed in the literature that the biggest firms are also the most productive ones. However, in practice it is not necessarily the case. Ceteris paribus, bigger firms are better able to enjoy the economies of scale. Meanwhile, the management inefficiencies and principal-agent problem might cause the decline of productivity for the biggest firms. Thus, I compute the productivity using a well-referenced Levinsohn-Petrin approach, and differentiate top 10% of the most productive importers. The results point to the larger pass-through for the most productive firms, which contradict the findings for the biggest firms. Observing the depreciation of the national currency, top performers turn to import products of higher quality.

I further focus on the role of the invoicing currency channel. Chen et al. (2019) basing on the UK transaction-level trade data study the relationship between currency of invoicing and response of import prices to exchange rate changes. This paper uses similar data for Russia. Bonadio et al. (2016) investigate the impact of exchange rate shock to Swiss Franc. They conclude that for the import transactions invoiced in foreign currency (Euro) the pass-through is complete, whereas the ones in the national currency lead to partial pass-through. Note that the variation in exchange rate of Russian Ruble is much larger

that the one of British Pound of Swiss Franc. Contrary to Chen et al. (2019), I find that for the transactions invoiced in a currency different from the one of trading partners, the pass-through is lower. Meanwhile, when one of the two major currencies – USD or EUR – is employed as a vehicle currency, the pass-through gets stronger.

The remainder of this paper is organized as follows. In section 3 I provide the picture on the depreciation of Russian ruble in 2014-2015 and change in the import statistics. In section 4 I provide the empirical analysis of the pass-through Finally, section 5 concludes the paper.

2 Simple model

In this section, I develop a simple monopolistic competition model that features endogenous markups, heterogeneous quality and firm sizes. This model is based on the model of Devereux et al. (2017). After establishing of the baseline theoretical setup, I derive predictions which I further test empirically in section 4.

The world is composed of two countries, home (H) and foreign (F).

In each sector there are N products and every producer (and exporter) $i \in N$ has a monopoly over one product. Each importer $j \in M$ buys some quantity of every product supplied by each exporter within a sector. The demand elasticity across all sectors is $\eta > 1$. The inner demand elasticity $\rho_j > 1$ is specific to each importer. I further assume that the elasticity of demand for each product is greater than the elasticity of demand in the aggregate sector: $\rho_j > \eta$. Exporters establish a unique price for each importer, thus they follow the strategy of first-degree price discrimination. The importers are price-takers.

The marginal production costs of an exporting firm i is a constant returns to scale function expressed in terms of exporter's currency.

$$c(y_{ij}, w_i, a_i) = y_{ij}\phi(w_i, a_i) \tag{1}$$

Here y_{ij} are sales to importer j, w_i is a vector of input costs, and a_i is a vector of technology efficiencies of all varieties produced by exporter i. I assume that $\phi(w_i, a_i)$ is an increasing function of all components of w_i and decreasing in all a_i. Following Chen and Juvenal (2016), I model the production efficiency a_{ik} of a distinct variety k as follows:

$$a_{ik}(\Phi, q, r) = \Phi_i q_k^r \tag{2}$$

with $q > 1$ and $r \geq 0$. Each firm produces the core product with core efficiency Φ that is randomly taken. Some of them are multi-product producers and produce non-core

varieties (of the same product) with lower quality. I characterize these varieties by quality rank r, which is the distance from the "core". Each firm is the most efficient in production of their core product, i.e. the one with $r = 0$. Similarly to Berman et al. (2012), varieties with smaller r are of higher quality, but are produced with lower efficiency $a_{ik}(\Phi, r)$.

The market price index for importer j could be written as follows:

$$p_j = \left[\sum_{i=1}^{N} p_{ij}^{1-\rho_j} \right]^{\frac{1}{1-\rho_j}} \tag{3}$$

Each importer j manifests demand for imported good i in the following form:

$$x_{ij} = p_{ij}^{-\rho_j} p_j^{\rho_j - \eta} X_j \tag{4}$$

Here X_j is an importer's market share, which is proxy for the size. I assume that the cost efficiency determines the size heterogeneity. Note that the heterogeneity in individual importers' demand elasticities ρ_j is caused by the variation in sizes.

The profits of an exporter i is as follows:

$$\pi_i = \sum_{j}^{M} p_{ij} x_{ij} - \sum_{j}^{M} y_{ij} e_i \phi(w_i, a_i) \tag{5}$$

I assume that the exchange rate e_i is importer-specific. It is expressed in the units of country H's currency per a unit of country F's currency. In the equilibrium the demand for imported good i (x_{ij}) equals its supply by the exporter i (y_{ij}).

Since an exporter is a monopolist, she freely establishes the price maximizing the profit:

$$p_{ij} = \frac{\epsilon_{ij}}{\epsilon_{ij} - 1} e_i \phi(w_i, a_i) \tag{6}$$

For each variety k, this expression can be re-written as follows:

$$p_{ijk} = \frac{\epsilon_{ij}}{\epsilon_{ij} - 1} e_i \phi(w_{ik}, \Phi_i q_k^r) \tag{7}$$

3 Data and Stylized facts

I use the detailed dataset on the universe of the daily import trade transactions to Russia. The data is provided by the Russian Customs. Only the transactions accounted for in the

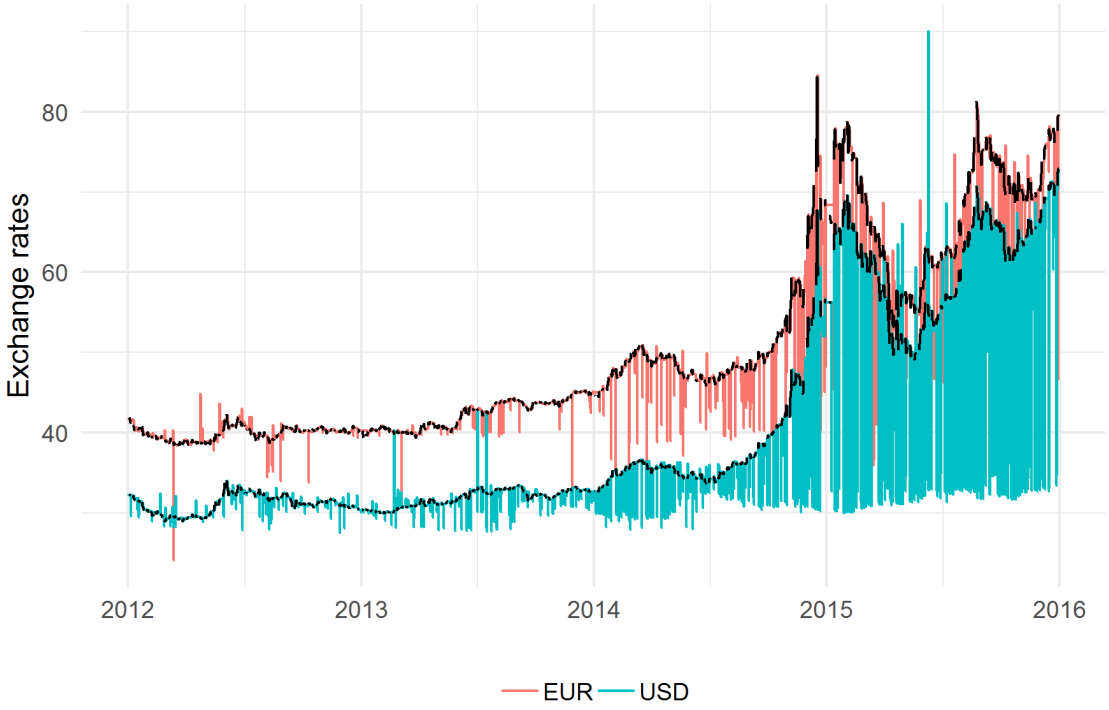

Figure 1: The exchange rates as declared by the importers and establised by IMF

aggregated customs statistics are left in the dataset. The observations with missing HS code are dropped. The final dataset comprises 79,854,452 observations. This paper is devoted to the analysis of changes in import structure between 2012 and 2015. During this period the total imports to Russia has declided by 1.74 times. The sectoral composition of Russian imports in 2012 and 2015 are represented in appendix in Table A1 and Table A2, respectively. The aggregated statistics suggest that the share of import of vehicles other than railways has dropped from 14.77% to 8.64%.

It should be noted that ruble has sharply depreciated to major currencies (USD, EUR), whereas it remained relatively stable with respect to the currencies of developing countries. The exchange rates included to the declarations are plotted on Fig. 1. The daily exchange rates sourced from the International Monetary Found (IMF) are plotted in bold. The upper bounds of the declared exchange rates perfectly fit the IMF exchange rates. One should further note that in the second half of 2014 and 2015 the exchange rates in the declarations highly deviate from the official ones. At the same time, the ruble has demonstrated growing volatility with respect to both USD and EUR. In some cases the declared rates overshoot the rate that was established at the currency exchange markets. One might hypothesis that the trading partners have been aiming to anticipate wither decline of the national currency and hedge the related risks.

The depreciation of the rouble would stronger impact the transactions that are invoiced

in the most stable currencies. The use of currencies in import invoices is reported in Table B1 (see Appendix). The most frequent invoice currencies in my dataset are USD (40.1%), EUR (34.5%) and RUB (22%). It is expected that the depreciation of rouble had a limited impact on the import transactions that were invoiced in rouble. Less popular currencies are JPY, GBP, SEK, PLN, CHF and CNY. All of these currencies together account for 2.4% of observations.

I construct the dummy for the vehicle currency.[1] This currency is the one that is different from currencies of trading countries. I systematically compare the declared invoice currency with the currencies of Russia and importer. While constructing this variable, the particular attention is devoted to the switch of currencies for Latvia and Lituania. They started using Euro since 1st January 2014 and 1st January 2015, respectively. Thus, I consider EUR as the vehicle currency before the official date of the introduction. The vehicle currency has been used in 46.77% of all import transactions in my dataset. This number is in line with findings of Chen et al. (2019) for import to UK.

This paper aims at quantifying the outcomes of shock on the quality of imports. I compute the measure of quality by closely following the approach of Khandelwal et al. (2013). For the sake of comparability, we will also employ a recently developed instrumental variable approach à la Piveteau and Smagghue (2019). Within their methodology, the import weighted real exchange rates are used as an instrument for export prices. Then, the quality equals the residual export variations in a regression after controlling for prices. These authors argue that such measure of quality has the advantage since it is free of the productivity variation.

Redding and Weinstein (2018) demonstrate that the large portion of the variation in the price indices should be attributed to the varieties and quality. I assume that the preferences of consumers are dependent on the quality.

Thus, the demand could be represented as follows: $q_c(\phi) = \lambda_c^{\sigma-1}(\phi)p_c^{-\sigma}(\phi)P_c^{\sigma-1}Y_c$. The logarithm transformation yields the following reduced-form equation:

$$ln\, q_{fkot} = -\sigma ln\, p_{fkot} + FE_k + FE_{ot} + \epsilon_{fkot}$$

The prices p_{fkot} are the unit values. FE_k are the HS4 product fixed effects, FE_{ot} are the origin-month fixed effects. I source the elasticities of substitution σ from Imbs and Mejean (2015). They have reported estimations of these elasticities following Feenstra's approach. Since they report results for ISIC3 classification of product, I use the WITS concordance tables to map with HS 2007 products. In my data, there are in total 10890 unique HS10 sectors. I proceed matching with elasticities data first at the HS6 level, at which 9757 sectors have been assigned the value of σ. Then, the matching for unmatched

[1]The definition of the vehicle currency was introduced by Chen et al. (2019).

sectors has been re-iterated consequently for HS4 and HS2 sectors. Finally, there are 199 HS10 sectors left (1.8% of total), to which I have assigned the mean value across all sectors (-5.38).

The quality measure corresponds to the residual of the OLS estimation. The key underlying intuition is that ceteris paribus, and conditional on prices, the product with higher quantity has higher quality. The variance of quality measures across different dimensions is reported in Table 1. The variance is in line with the one documented by Piveteau and Smagghue (2019) for French exports. However, the variation across importer X product HS4 X origin and importer X product HS4 X year dimensions is lower. In further analysis I focus on importer X product HS4 X origin and importer X product HS4 X year dimensions, which represent important variation.

Table 1: Variance decomposition of quality

Set of fixed effects	R^2
importer	0.23
importer X product HS2	0.34
importer X product HS2 X origin	0.39
importer X product HS4	0.47
importer X product HS4 X origin	0.51
importer X year	0.24
importer X product HS4 X year	0.48

Notes: Table reports R^2 corresponding to OLS regressions of Khandelwal's quality measure on different sets of fixed effects.

One of the possible channels of firm-level adjustments to the depreciation of national currency is change of composition of import. I hypothesize that the importers react by switching to other HS6 products within the same HS4 broader categories. I test this hypothesis by comparing the composition of imports in August – June 2014 with the one in December 2014 – January 2015. In the former period the ruble was stronger comparing to the later period. During these periods, there were 329,859 unique importer-HS4 product combinations. However, only 40.6% of them were traded during both periods. There were more of importer-HS4 pairs that stopped trading (107,263) than the ones that has freshly appeared in the declarations (88,644). This clearly signals to the shrink of Russian trade.

Comparing average quality at certain levels of exchange rates should serve as the motivation to pursue the empirical analysis. The intuition suggests that when the exchange rate grows, the quality should decrease, and vice versa. For each important turning points of the trend of exchange rate in 2012-2015, I compute the average quality. This piece of the motivation is reported in Table 2. I differentiate between aggregated agriculture and mining products, as they are defined by ISIC classification. One should note the the expected patterns in change of quality are respected.

Table 2: Quality change at different times

Period	average ER	expected Δ	agriculture	mining
May-June 2014	34.48		0.114	0.1089
December 2014 - January 2015	50.4	$\downarrow$	0.0193	-0.1391
May 2015	43.42	$\uparrow$	0.0316	-0.0931
August - September 2015	51.13	$\downarrow$	-0.1231	-0.1241
December 2015	60.28	$\downarrow$	0.0971	-0.1753

Notes: Table reports quality levels for some select extreme values of RUR/USD exchange rate.

Based on the subsample of importer-HS4 cases registered in both periods, I investigate the inter-period change of quality. I compute the simple mean of Khandelwal quality across all HS6 products within the same HS4 category. Next, using the simple paired T-test, I compare the mean quality of the two periods. First, I sub-sample the observations for which in the period with weaker national currency the number of HS6 varieties within same HS4 decreases (19,920 obs.). The results (not reported) suggest that the mean quality of this sub-sample is lower than the one in the base period. Second, I compare the mean quality of the sub-sample with higher number of HS6 products (16,061 obs.). I conclude that when the import becomes more diverse, the mean quality increases.

I further match the transactions import data to the geographical locations. For each transaction, the address of buyer is reported. In total there are 341,519 unique addresses. I write a script that uses Google Maps Geocoding API to search for buyers' locations using the address. For vast majority of cases, this address contains postal code. For those cases, I proceed to search using the request of the type "Russia + postal code". For the cases without postal code, the search request contains initially reported address. As the result, I obtain 341,461 unique Global Positioning System (GPS) coordinates of Russian importers and unified formatted address in English.

I further investigate the variation in the change of quality of imported goods across Russian regions. The map on Fig. 2 illustrates the changes in quality between July-August 2014 and August-September 2015. This map suggests that the quality has depreciated in most of the regions. It is worth noting that the in Eastern part of Russia the drop of quality has been most important. However, some regions are outliers.

Next, I associate each firm location with a Russian region. The data on the shapes of administrative boundaries of Russia is sourced from freely available DIVA-GIS database. The addresses within Crimean Peninsula represent a certain complication since the internationally recognized databases do not identify Crimea as part of the territory of the Russian Federation. For such cases (0.27% of total), I proceed to associate this region using the keywords in the initial address line. The simple descriptive statistics across regions suggest that top 10 regions account for 71.64% of all locations of importers. A large part

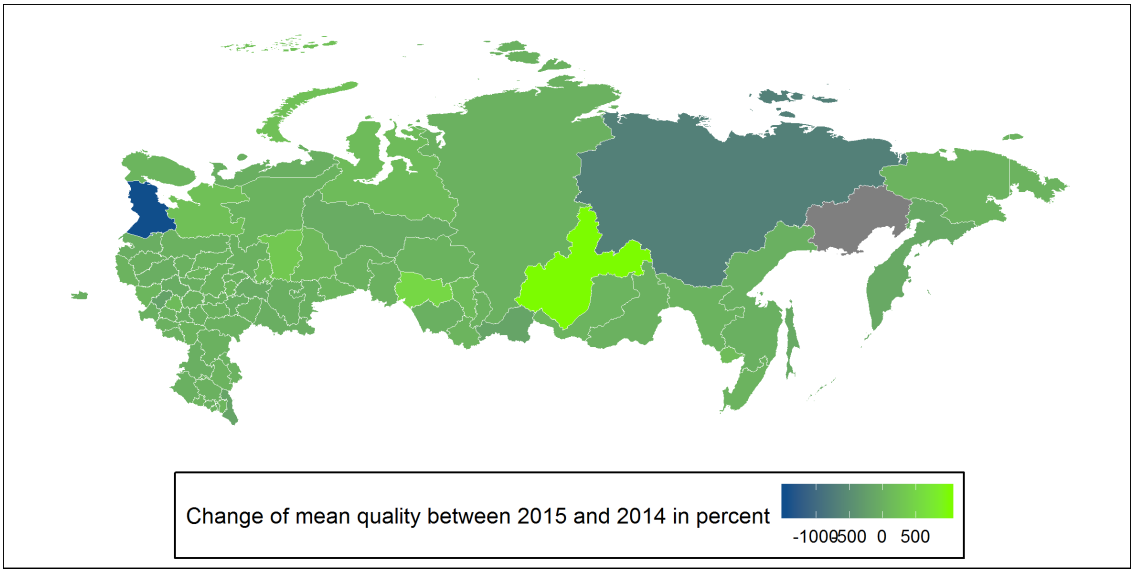

Figure 2: Change in average prices of embargoed products by region, June 2014 to June 2015.

of the active importers are located in two cities having status of federal regions: Moscow City (29.5%) and St. Petersburg (13.71%). The three most active regions are regions of Moscow (8.62%), Kaliningrad (4.69%) and Primorsky Krai (3.96%).

I source the firm-level characteristics from BvD Orbis database. The matching with trade data has been completed using the Russian Tax Identification Numbers. Some of the firms sourced from Orbis had the same Tax Ids. This happens when a large firm has numerous subsiduaries or branches. In order to pick the most appropriate case among similar ones, I proceed in the following order: (i) For each id, pick the case with known total assets in 2012; (ii) For each id, pick the case with known total assets in 2015; (iii) Drop the cases for which values of most important variables are missing or equal to zero; (iv) For cases with same firm name, pick the first case summing number of branches and number of subsidiaries; (v) Within the same tax id, merge branches with other types of entities; (vi) For what is left (5 X 2 cases), pick the first one, summarize over most important variables. The final sample consists of 118,307 firms with unique Tax id.

The key characteristic of the importers is their size. I take the total assets in 2012 and 2015 as proxy for firm size. On Fig. 3, I plot the distribution of these variables . One should note that between 2012 and 2015 the distributions did not evolve much, despite slight move to the right. What is more interesting, there is a certain pick at the left pick of the distribution.

The next important characteristic of a firm is its productivity. I compute the firm-level productivity following the well-known approach of Levinsohn and Petrin (2003). The operating revenue turnover is chosen as the output variable. The intermediate inputs

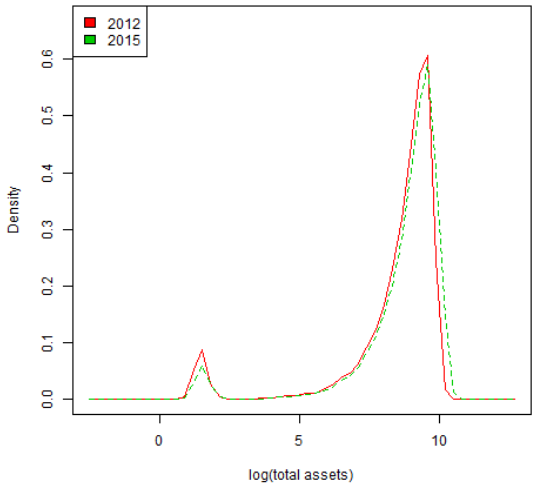

Figure 3: Distribution of importers' sizes.

are labor (number of employees) and capital (total assets). The costs of goods sold are introduced to the productivity estimation in order to serve as proxy for unobserved productivity shocks. This variable is expected to capture the costs of intermediate inputs used in the production.

4 Estimations

At the first step of empirical estimations, I replicate a standard pass-through regression (Gopinath et al., 2011). A Russian firm *i* at date *d* in the year *y* import a product *p* from origin *o*. The employed dataset consists of daily import transactions *r*. I source from IMF daily bilateral exchange rates $e_{o,d}$ between Russian Ruble and 51 currencies. For the dates when a given pair of currencies has been not traded, the exchange rate is set to as equal to the last known daily rate. Note that all rates are expressed as RUR per a unit of foreign currency. The inflation rates at the origin of import $pi^*_{o,y}$ are computed by the World Bank at the annual frequency. First, I replicate the standard pass-through for the unit values:

$$\log(\text{UV}_{iop,d}) = \alpha_0 + \sum_{n=0}^{N} \beta_n ln(e_{o,d}) + \gamma_1 \pi^*_{o,y} + FE_{iy} + FE_{op} + \varepsilon_{iop,d} \tag{8}$$

I employ the OLS estimator with high dimensional fixed effects. The fixed effects are *importer-year* (FE_{iy}) and *origin-HS6 product* (FE_{op}). The results in Table 3 confirm previously documented incompleteness of the pass-through between exchange rate and unit values.

Table 3: Baseline estimations

Dependent variable:	Declared exchange rate				IMF exchange rate			
Unit values (RUR/kg)	Full sample		Vehicle currency		Full sample		Vehicle currency	
ln(Exchange rate)	0.116***	0.104***	0.949***	0.941***	0.865***	0.836***	0.994***	0.952***
	(0.001)	(0.001)	(0.003)	(0.004)	(0.002)	(0.006)	(0.002)	(0.007)
ln(Inflation)	0.000	0.001	0.000	-0.002	0.005***	0.004***	0.020***	0.018***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
ln(Exchange rate) w-1		0.007***		0.003***		0.027***		0.068***
		(0.001)		(0.001)		(0.008)		(0.009)
ln(Exchange rate) w-2		0.002***		0.000		0.054***		0.077***
		(0.000)		(0.001)		(0.009)		(0.009)
ln(Exchange rate) w-3		0.004***		0.001		-0.019*		-0.030***
		(0.000)		(0.000)		(0.009)		(0.010)
ln(Exchange rate) w-4		0.003***		0.001		-0.012		-0.030***
		(0.000)		(0.000)		(0.009)		(0.010)
ln(Exchange rate) w-5		0.003***		0.000		-0.054***		-0.035***
		(0.000)		(0.000)		(0.009)		(0.010)
ln(Exchange rate) w-6		0.004***		0.002***		0.052***		0.026***
		(0.000)		(0.000)		(0.009)		(0.010)
ln(Exchange rate) w-7		0.003***		-0.001		-0.031***		-0.057***
		(0.000)		(0.000)		(0.009)		(0.010)
ln(Exchange rate) w-8		0.007***		0.001***		-0.002		-0.032***
		(0.000)		(0.000)		(0.007)		(0.007)
Observations	23992241	15113949	20298314	12729187	27124999	26248493	20298933	19633555
R^2	0.855	0.857	0.861	0.863	0.847	0.847	0.861	0.861

Notes: Robust standard errors in parentheses, with ***, ** and * denoting significance at the 1%, 5% and 10% level respectively. The fixed effects are $importer \times year + Origin \times HS6$.

I explicitly compare pass-through for specifications with declared exchange rates (columns 1-4) and the official ones (columns 5-8). The results suggest that the use of mutually agreed exchange rates leads to incomplete pass-through. The magnitude (11.6%, column 1) approximately correspond to the lower bound of estimates in the established literature (e.g. Devereux et al., 2017). Meanwhile, the pass-through is significantly higher when the official IMF exchange rates are accounted for. The corresponding estimated marginal effects get up to 86.5%.

At the next step of the empirical analysis, I run the same regressions on a subsample of transactions using vehicle currency. The results are jointly reported in Table 3. The pass-through is getting to be nearly complete for these cases. In fact, when the national currency is largely fluctuating, the transactions invoiced in foreign currency involve higher risks. Thus, trading firms tend to adjust import prices in accordance.

Table 4: Estimation of pass-through with respect to quality of imported products

	Dependent variable: Unit values			
	(1)	(2)	(3)	(4)
ln(IMF Exchange rate)	0.930***		1.035***	
	(0.002)		(0.003)	
ln(Quality) x ln(IMF ER)	-0.089***		-0.072***	
	(0.000)		(0.000)	
ln(Declared Exchange rate)		0.203***		0.969***
		(0.001)		(0.004)
ln(Quality) x ln(dec ER)		-0.083***		-0.072***
		(0.000)		(0.000)
ln(Inflation)	0.012***	0.007***	0.029***	0.009***
	(0.001)	(0.001)	(0.002)	(0.002)
Observations	13545293	11830778	10021490	10021229
R^2	0.880	0.885	0.888	0.889
Fixed effects:				
$importer \times year + Origin \times HS6$				

Note: Robust standard errors in parentheses, with ***, ** and * denoting significance at the 1%, 5% and 10% level respectively.

I further account for the role of quality of imported products. To do so, I introduce to the specification the interaction terms between Khandelwal quality measure and exchange rate. The results are reported in Table 4. The results in columns 1-2 correspond to the full sample, whereas in columns 3-4 I operate with transactions using vehicle currency. The results suggest that the higher product quality is associated with softer exchange rate pass-through.

I further differentiate the effects across the heterogeneous importers. I create dummies for 10% biggest and 10% most productive importers. I interact these dummies with nominal IMF exchange rate. The results of OLS regressions are reported in Table 5. The specifications in columns (1) and (3) include only fixed effects for HS2 products. The ones in columns (2) and (4) include the fixed effects as follows: $HS8 \times Origin \times year$. The results suggest that the biggest importers tend to establish lower prices. Note that this result is opposite for less sophisticated set of fixed effects. Following the depreciation of national currency, they tend to further decrease the import prices. The completely opposite picture is observed for the most productive firms.

Table 5: Role of firm size and productivity

	Dependent variable: Unit values			
	(1)	(2)	(3)	(4)
ln(exchange rate IMF)	0.151***	0.864***	0.145***	0.862***
	(0.000)	(0.002)	(0.000)	(0.002)
Big importer	0.193***	-0.023***		
	(0.001)	(0.001)		
ln(exchange rate IMF) × Big Importer	-0.060***	-0.014***		
	(0.000)	(0.000)		
Most productive			0.236***	0.191***
			(0.002)	(0.002)
ln(exchange rate IMF) × Most productive			-0.041***	0.012***
			(0.001)	(0.001)
Observations	72189056	72099210	72189056	72099210
R^2	0.511	0.730	0.510	0.730
Fixed effects:				
$HS2$	Yes		Yes	
$HS8 \times Origin \times year$		Yes		Yes

Note: Robust standard errors in parentheses, with ***, ** and * denoting significance at the 1%, 5% and 10% level respectively.

I further investigate the role of the nature of traded goods. The trade in inputs represent particular type of trade. The importers might have special requirements for the products that will be used in their production. I obtain the classification of tradable goods from the UNCTAD. According to different stages of processing, there are intermediate goods, raw materials, capital and consumer goods. I pool together intermediate goods and raw materials and create a dummy "Intermediary input". I further interact it with the nominal exchange rates, with respect to USD and EUR.

The results are reported in Table 6. In case of trade in intermediary inputs, pass-through is lower. Furthermore, the impact of depreciation of national currency aggravates. However, the test on the sub-sample consisting of only agri-food products shows that

Table 6: Role of intermediary inputs

	Dependent variable: Unit values			
	(1)	(2)	(3)	(4)
ln(USD/RUR)	-0.084***		-0.262***	
	(0.003)		(0.024)	
ln(EUR/RUR)		-0.054***		-0.205***
		(0.003)		(0.026)
Intermediary input	-0.781***	-0.642***	-0.869***	-0.584*
	(0.024)	(0.029)	(0.232)	(0.239)
ln(USD/RUR) × Intermediary input	-0.048***		0.167***	
	(0.006)		(0.027)	
ln(EUR/RUR) × Intermediary input		-0.081***		0.078***
		(0.007)		(0.030)
Observations	64971222	64971222	3213308	3213308
R^2	0.512	0.512	0.510	0.510
Fixed effects:				
$importer \times HS4 \times Origin \times year$	Yes	Yes	Yes	Yes
Sample	full	full	agri-food	agri-food

Note: Robust standard errors in parentheses, with ***, ** and * denoting significance at the 1%, 5% and 10% level respectively.

importing of intermediate products softens the impact of depreciation of the rouble.

5 Concluding remarks

The quality of the imported goods has recently turned to receive attention by the international trade literature. This paper acknowledges the role of quality in shaping of the exchange rate pass-through. I elaborate a simple monopolistic competition model, which drafts the direction of the impact of quality. I also specifically underline the role of invoicing. I account for the invoicing at the mutually agreed exchange rate and in a currency of third country. I further empirically test the predictions of the model both for invoicing and quality.

This paper also contributes to the fast growing literature on the heterogeneity of both imports ans exporters. My sets of descriptive statistics also suggest that the importers' sizes and their productivity as the key dimensions of the international trade transactions. I differentiate the transactions made by top 10% firms of productivity and sizes distributions. I find that the fluctuations in exchange rates cause some adjustments in the compositions of the imported goods. Bigger and more productive firms are more likely to timely accomplish such arrangments.

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Appendix

Appendix A. Russian import statistics

Table A1: Imports to Russia in 2012 by aggregated HS2 categories (top 25)

HS2	Description	Imports, mln. USD	Share, %
84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	53740.62	18.47
87	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof	42979.54	14.77
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles	32988.31	11.34
30	Pharmaceutical products	13240.45	4.55
39	Plastics and articles thereof	10491.38	3.61
90	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof	9331.45	3.21
02	Meat and edible meat offal	7404.43	2.54
73	Articles of iron or steel	7180.93	2.47
08	Edible fruit and nuts; peel of citrus fruit or melons	6352.72	2.18
72	Iron and steel	5798.95	1.99
40	Rubber and articles thereof	4406.44	1.51
94	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, not elsewhere specified or included; illuminated signs, illuminated nameplates and the like; prefabricated buildings	4238.87	1.46
88	Aircraft, spacecraft, and parts thereof	4148.32	1.43
64	Footwear, gaiters and the like; parts of such articles,	4079.92	1.40
33	Essential oils and resinoids; perfumery, cosmetic or toilet preparations	3536.22	1.22
48	Paper and paperboard; articles of paper pulp, of paper or of paperboard	3560.13	1.22
61	Articles of apparel and clothing accessories, knitted or crocheted	3339.45	1.15
62	Articles of apparel and clothing accessories, not knitted or crocheted	3337.81	1.15
86	Railway or tramway locomotives, rolling-stock and parts thereat railway or tramway track fixtures and fittings and parts thereof; mechanical (including electro-mechanical) traffic signalling equipment of all kinds	3324.59	1.14
29	Organic chemicals	3238.39	1.11
22	Beverages, spirits and vinegar	3049.46	1.05
28	Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, of radioactive elements or of isotopes	2946.21	1.01
03	Fish and crustaceans, molluscs and other aquatic invertebrates	2895.72	1.00
27	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes	2689.19	0.92
07	Edible vegetables and certain roots and tubers	2565.53	0.88

Table A2: Imports to Russia in 2015 by aggregated HS2 categories (top 25)

HS2	Description	Imports, mln. USD	Share, %
84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	32597.18	19.58
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles	20332.64	12.21
87	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof	14391.15	8.64
30	Pharmaceutical products	8574.19	5.15
39	Plastics and articles thereof	6893.63	4.14
90	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof	4878.73	2.93
08	Edible fruit and nuts; peel of citrus fruit or melons	3804.10	2.28
73	Articles of iron or steel	3671.70	2.20
88	Aircraft, spacecraft, and parts thereof	3151.99	1.89
02	Meat and edible meat offal	3105.36	1.86
72	Iron and steel	2690.28	1.62
33	Essential oils and resinoids; perfumery, cosmetic or toilet preparations	2579.88	1.55
29	Organic chemicals	2560.97	1.54
40	Rubber and articles thereof	2565.88	1.54
62	Articles of apparel and clothing accessories, not knitted or crocheted	2560.00	1.54
28	Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, of radioactive elements or of isotopes	2323.45	1.40
61	Articles of apparel and clothing accessories, knitted or crocheted	2305.24	1.38
64	Footwear, gaiters and the like; parts of such articles,	2278.29	1.37
48	Paper and paperboard; articles of paper pulp, of paper or of paperboard	2224.12	1.34
38	Miscellaneous chemical products	2128.63	1.28
94	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, not elsewhere specified or included; illuminated signs, illuminated nameplates and the like; prefabricated buildings	2108.82	1.27
89	Ships, boats and floating structures	2095.51	1.26
07	Edible vegetables and certain roots and tubers	1749.65	1.05
03	Fish and crustaceans, molluscs and other aquatic invertebrates	1686.64	1.01
22	Beverages, spirits and vinegar	1625.19	0.98

Appendix B. Invoice currencies

Table B1: Invoice currencies as reported in declarations

Invoice currency	n	% Total	% Total Cum.
USD	32641355.00	40.88	40.88
EUR	27565404.00	34.52	75.40
RUB	17607189.00	22.05	97.44
JPY	537406.00	0.67	98.12
GBP	526795.00	0.66	98.78
SEK	245449.00	0.31	99.08
PLN	242713.00	0.30	99.39
CHF	207975.00	0.26	99.65
CNY	140837.00	0.18	99.83
CAD	40856.00	0.05	99.88
LTL	15929.00	0.02	99.90
NOK	10800.00	0.01	99.91
UAH	10717.00	0.01	99.92
KRW	9441.00	0.01	99.94
AUD	8711.00	0.01	99.95
HUF	8298.00	0.01	99.96
DKK	6725.00	0.01	99.97
CZK	5893.00	0.01	99.97
SGD	3620.00	0.00	99.98
INR	2715.00	0.00	99.98
UZS	2571.00	0.00	99.98
KGS	595.00	0.00	99.98
TRY	479.00	0.00	99.98
AMD	190.00	0.00	99.99
NZD	146.00	0.00	99.99
HKD	142.00	0.00	99.99
AED	130.00	0.00	99.99
ZAR	97.00	0.00	99.99
BGN	67.00	0.00	99.99
AZN	54.00	0.00	99.99
MYR	36.00	0.00	99.99
THB	27.00	0.00	99.99
TMT	27.00	0.00	99.99
MDL	21.00	0.00	99.99
IDR	20.00	0.00	99.99
BRL	11.00	0.00	99.99
IRR	10.00	0.00	99.99
TJS	10.00	0.00	99.99
RSD	9.00	0.00	99.99
MAD	9.00	0.00	99.99
LVL	8.00	0.00	99.99
LKR	7.00	0.00	99.99
BYR	6.00	0.00	99.99

Invoice currency	n	% Total	% Total Cum.
GEL	4.00	0.00	99.99
ILS	3.00	0.00	99.99
RON	3.00	0.00	99.99
HRK	2.00	0.00	99.99
VND	2.00	0.00	99.99
KWD	1.00	0.00	99.99
SYP	1.00	0.00	99.99
QAR	1.00	0.00	99.99
PKR	1.00	0.00	99.99
<NA>	10934.00	0.01	100.00