Estimation of Import Demand Function in Russia

by

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ABSTRACT

Research is devoted to the analysis of import demand function in Russia. On the basis of the proposed methodology the author estimates econometric model for a full range of imported goods in the last decade (2000–2010). Product groups are ranked by the impact of customs duties and the real exchange rate fluctuations on import. The author proposes estimation of dynamics of import demand sensitivity to changes in the real effective exchange rate and to fluctuations in import prices.

Keywords: import demand, intertemporal choice, panel data.

JEL classification: C23, D91, F14.

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1. Introduction

Contemporary processes of global integration contribute to the increasing involvement of Russia in international trade: in the last decade, the share of Russian imports from global trading increased continuously from 0.67% in 2000 to 2.26% in 2010[1]. Imports have a significant impact on domestic consumption and production. In this regard, we need to determine the factors on which the level of imports depend, and how changes in the parameters of external economic regulation lead to changes in the structure and volume of imports. Thus, customs and tariff policy and the regime for managing real exchange rate have a significant impact on the competitiveness of domestic producers and, consequently, on the possibility of replacing foreign products with domestic ones.

Meanwhile, amongst Russian research papers there are very few works related to the detailed analysis of import demand function and the sensitivity of imports to fluctuations in the real exchange rate and to the regulation of foreign trade. One of them (Idrisov, 2010) analyses the import demand function for capital goods.

The present study focuses on an analysis of the demand for imports across the full range of products in the Russian market during 2000-2010 and has the following structure. In Section 2, we briefly discuss the major modern theoretical and empirical approaches to the analysis of the import demand function. Section 3 describes the methodology of the study. Section 4 deals with the immediate results of econometric estimates. The Conclusion indicates the main findings and proposals for economic policy.

2. Current approaches to analysis of the import demand function

Modelling the demand for imports is one of the oldest issues of economic science. The paper (Santos-Paulino, 2002) argues that the *empirical* study of import demand function is

[1] World Bank data http://databank.worldbank.org/ddp/home.do.

one of the most researched areas of international economics. The specification for the import demand function determines the quality of trade flow forecasting, planning and the formulation of international trade and economic policy objectives. Based on (Senhadji, 1998), one of the main reasons for the popularity of import demand function analyses is the ability to apply the results across a wide range of macroeconomic issues. These include the impact on the trade balance of altering the exchange rate control conditions; the extension of domestic shocks over other countries, which depends on the elasticity of demand for imports; the extent of impact of international trade flows on domestic growth; the use of tariff policy to limit the import flows which compete with domestic production, etc.

According to (Hong, 1999), the specification of the import demand function is based on either the theory of comparative advantages or the Keynesian approach, or on the so-called new international trade theory (the theory of trade under imperfect competition). The neoclassical theory of comparative advantages (the Heckscher-Ohlin theory) studies how the amount and direction of trade flows is affected by relative price movement, which in turn is explained by differences in the factor endowment of the trading countries. The neoclassical trade theory does not address the impact of changes in income on international trade, and the import demand function is derived from microeconomic problems of consumer choice and general equilibrium theory. Under the Keynesian approach, relative prices are assumed to be rigid, and labour to be variable. International capital flows equalise the trade balance. This approach focuses on the relationship of income and the demand for imports at an aggregate level. This ratio can be determined by several multipliers, such as the mean and marginal propensity to consume or the income elasticity of demand for imports. The new international trade theory relies on an analysis the intra-industry trade (which cannot be explained under the neoclassical theory), revealing the impact of the economies of scale, product differentiation and monopolistic competition on international trade, and provides a new explanation for the influence of income on international trade flows. Since international trade depends, *inter alia*, on the scale (size issue), while the level of income is a proxy for the level of scale, then trade will depend on the level of income. In addition, in (Hong, 1999) it is noted that "demand for imports in a market economy can be fully simulated using two main factors: income and relative prices. All other factors can be attributed to these two, at least in theory." The effect on the demand for imports of changes in such factors as the relative allocation of resources, factor endowment, tastes, market structure, market size, trade barriers, etc. will occur through changes in relative prices.

According to (Goldstein, Khan, 1985), modelling the demand for imports, *inter alia*, is subject to the following factors of international trade: the type of goods traded; the intended use of those tradable goods, the institutional environment in which the trade occurs, the research objectives and available data. However, according to (Xu, 2002), there are two general models dominating the literature on international trade: the model of 'perfect substitutes' and model of 'imperfect substitutes'. The first model is used only for traditional commodities, such as oil, gas and sugar, for which demand and supply will not depend on differences in domestic prices, and will be mainly determined by their prices in global markets.

The key assumption of the 'imperfect substitutes' model (as applied to the vast majority of empirical research) is that neither exports nor imports are perfect substitutes for domestic goods. There are two bases for this assumption. First, if foreign and domestic goods were perfect substitutes, then: a) either domestic or foreign goods would swamp the entire market, where each of these goods is produced at constant (or decreasing) cost, and b) each country either exports or imports a specific product, but does not do both (Rhomberg, 1973). Both assumptions are contrary to the actually existing order, where imports match the domestic turnout, so the hypothesis of perfect substitution must be rejected. Second, many empirical studies (Isard, 1977) have shown that even on a highly disaggregated level the law of one price is not met either between countries or within them. In models of imperfect substitutes the import demand is usually derived by solving the problem of utility maximization (which depends on the consumption of domestic and imported goods) through the typical consumer. If imported goods are intermediate products, the demand for them is derived from the task to maximize the profit by the producer and depends on their relative prices and the increase in gross value added (see, e.g. (Kohli, 1982)).

Traditionally, the import demand function is specified as a linear logarithmic function of relative import prices and of real income. The study (Carone, 1996) also mentions that the most widely used procedure for estimating the aggregate import demand function in a model of imperfect substitutes is to build the Marshallian demand function, where the import depends on the real income of the country, as well as on the prices of imported goods and domestic goods, as substitutes measured in the same currency. As described in (Marquez, 1994), most econometric studies of U.S. imports were based on the following linear logarithmic terms:

$$\ln q_i = \alpha_i + \eta_i \ln\left(y/P\right) + \sum_j \varepsilon_{ij} \ln p_j + \xi_i, \tag{1}$$

where q_i is the import of the *i*-th product; p_i is the import price of the *i*-th product (p_n is the price of a domestic product); $y = \sum_j p_j q_j$ — total revenue; P — aggregated price index; η_i — income elasticity; ε_{ij} — compensated import elasticity of the *i*-th product at the price of the *j*-th product, $\sum_j \varepsilon_{ij} = 0$; ξ_i – random error.

In later works (Marquez, 2000, 2002) it has been shown that evaluation of the long-term import demand function (for time intervals of 30 or more years) should consider some factors that may affect the formation of trade flows in the long-term, for example, the influx of immigrants affecting preferences, and, as a consequence, the demand function. At the same time, for time intervals up to 20 years, specification (1) is quite acceptable. Analysis of the import demand function for disaggregated data can be found in the works of (Masih, Masih, 2000; Hamori, Matsubayashi, 2001).

Thus, empirical analysis of the import demand function performed by various authors (see, for example, (Houthakker, 1960; Isard, 1977; Thursby, Thursby, 1984; Deaton, 1986; Theil, Clements, 1987; Ghei, Pritchett, 2001; Boyd *et al*., 2001; Chinn, 2005)) shows that, despite many variations of the econometric equations and specifications, the main determinants of the demand for imports are consumer income (or income of producers consuming capital goods) and the price of imported goods and substitutes. The main problems of estimating are usually associated with the quality of statistics and the choice of the estimated equation specification. Thus, in the empirical analysis of import demand equations the greatest difficulty is the search for indices which adequately reflect the price levels.

3. Research methodology

To estimate the import demand function two basic econometric equations are modelled. The first equation is based on the standard microeconomic conditions arising from the problem of utility maximization by customers (for end use, and consumption products) or the manufacturer's profit maximization/cost minimization (for capital and intermediate goods). It shows the change in imports over time in response to changes in price over time. The second equation has a microeconomic foundation based on inter-temporal choice by the consumer and shows the change in imports relative to their mean value in response to changes in price relative to its mean value.

Suppose that Russia imports some goods j_k belonging to commodity group j (allocation of goods into aggregated commodity groups can be defined in various ways). In the following legend, t is the time index.

1.The first equation, showing the demand for imports is an 'imperfect substitutes' model, which assumes an absolutely inelastic export supply curve, i.e. a condition under which the Russian market cannot influence the global price, and simply accepts it. This assumption is very important, as it allows us not to have to specify a separate supply equation, and therefore not to face the problem of identifying the evaluation of such econometric models.

Factors affecting the demand are the standard ones: income of the importing country and price of imported goods and domestic substitutes. The (theoretical) demand function is assumed for each imported product for the entire period.

It is assumed that the elasticity of import prices is the same for all goods within each product group:

$$\ln Im_{j_k,t} = \alpha_{ij_k} + \gamma^{(1)} \ln \frac{Y_t}{Y_{t-1}} + \beta_j \ln p_{j_k,t} + \delta_j \ln REER_t + \varepsilon_{j_k,t}, \tag{2}$$

where $Im_{j_k,t}$ — imports to Russia (in terms of value) of the goods j_k from product group j within the period t (a year within the time interval T being considered); Y_t — level of income in Russia in real terms within the period t; $p_{j_k,t}$ — specific price of the goods j_k from product group j imported to Russia within the period t; $REER_t$ — real effective exchange rate of the Russian ruble; α_{ij_k} — Individual constant effects on the goods j_k.

Specification (2) requires a separate discussion. Firstly, the model provides for a variable price for the goods. Naturally, the number of tradable goods is immense, so for econometric estimates using publicly available data, the word "goods" means an aggregated product group, preferably as homogeneous as possible, and requires the unit cost of purchase to be used as a proxy for the price. Secondly, a real effective exchange rate variable is used instead of domestic substitute prices. This variable includes the Russian price level dynamics and the price level dynamics of its trading partners. In this case, Russian prices move faster than the global ones, so this variable may be considered a proxy for the average dynamics of the domestic prices for goods competing with imports. Of course, it would be better to use the price indices of the domestic substitutes for each j_k commodity, but such data are unavailable. In addition, the real exchange rate is (at least in the short term) a controlled macroeconomic variable, so, based on estimates from the type (2) equation we can make some recommendations for economic policy. Thirdly, the growth variable is used as a proxy for income, rather than using the actual level, as, on the one hand, for capital goods it represents a logic accelerator model, and on the other hand, in recent years, Russia's GDP has increased simultaneously with the real exchange rate that generates strong multicollinearity with estimates of the import demand function.

Applying the standard inter-conversion (*within*) to equation (2), we have:

$$\ln Im_{j_k,t} - \frac{1}{T}\sum_{t=1}^{T} \ln Im_{j_k,t} = \gamma^{(1)} \left(\ln \frac{Y_t}{Y_{t-1}} - \frac{1}{T}\sum_{t=1}^{T} \ln \frac{Y_t}{Y_{t-1}} \right) +$$

$$+\beta_j \left(\ln p_{j_k,t} - \frac{1}{T}\sum_{t=1}^{T} \ln p_{j_k,t} \right) + \delta_j \left(\ln REER_t - \frac{1}{T}\sum_{t=1}^{T} \ln REER_t \right) + \tilde{\varepsilon}_{j_k,t}. \tag{3}$$

Thus, for product group j *a 1%* price change to their geometric mean value for the period causes a change in the ratio of imports to its geometric mean value of β_j% at any given time. Similarly, for product group j a 1% increase in the ratio of the real effective exchange rate to its geometric mean value for the period will increase the ratio of imports to its geometric mean value by δ_j% at any given time, and equation (3) can be rewritten as follows:

$$\ln\frac{Im_{j_k,t}}{\sqrt[T]{Im_{j_k,1}\times\ldots\times Im_{j_k,T}}}=\gamma_1^{(1)}\ln\frac{\frac{Y_t}{Y_{t-1}}}{\sqrt[T]{\frac{Y_1}{Y_0}\times\ldots\times\frac{Y_T}{Y_{T-1}}}}+\beta_j\ln\frac{p_{j_k,t}}{\sqrt[T]{p_{j_k,1}\times\ldots\times p_{j_k,T}}}+\delta_j\ln\frac{REER_t}{\sqrt[T]{REER_1\times\ldots\times REER_T}}+\tilde{\varepsilon}_{j_k,t},$$

which shows that $\dfrac{\partial\ln\frac{Im_{j_k,t}}{\sqrt[T]{Im_{j_k,1}\times\ldots\times Im_{j_k,T}}}}{\partial\ln\frac{p_{j_k,t}}{\sqrt[T]{p_{j_k,1}\times\ldots\times p_{j_k,T}}}}=\beta_j$ и $\dfrac{\partial\ln\frac{Im_{j_k,t}}{\sqrt[T]{Im_{j_k,1}\times\ldots\times Im_{j_k,T}}}}{\partial\ln\frac{REER_t}{\sqrt[T]{REER_1\times\ldots\times REER_T}}}=\delta_j\ \forall t.$

OLS estimates from the above equation (3) are consistent estimators of the parameters $(\gamma^{(1)}\ \beta_j\big|_{j=1}^{J}\ \delta_j\big|_{j=1}^{J})$, where J is the number of product groups in equation (2). Equation (3) estimates the elasticity, where the price varies over time during the period T. This is an average value for all goods in the product group.

2. The second equation has the following theoretical foundation. Suppose that a reasonable consumer chooses between two products (the model can be extended to any finite number of products, but this will not change the qualitative conclusions). Now, however, it is assumed that the consumer is guided by a certain planning horizon and maximizes the expected reduced (according to geometric discounting) utility consumption not only of current, but also of future periods:

$$\mathrm{E}_t\sum_{k=0}^{\infty}\beta^k u(C_{t+k}^{(1)},C_{t+k}^{(2)})\to\max \tag{4}$$

with the restriction $\dfrac{B_{t+1}}{1+r}=B_t+I_t-p_t^{(1)}C_t^{(1)}-p_t^{(2)}C_t^{(2)}$,

where $u(\cdot)$ — a one-period utility function; $p_t^{(i)}$ and $C_t^{(i)}$ — price and amount of consumption of goods i, $i\in\{1;2\}$, within the period t, $t\in\{1;2;\ldots\}$; B_t — opening assets t; I_t — assets at point t; r — interest rate; β — discount factor; E_t — expectation function under the condition of all available information within the period t.

If we assume that customer expectations are static in nature, i.e. expectations of future values of the variables are equal to their current values, and that the individual does not carry-over consumption between periods, the problem reduces to the standard problem of consumer choice determining the consumption function, and analysis of comparative statics leads to equations of type (3).

For (4) the Bellman equation can be written as follows:

$$V_t(B_t) = \max_{C_t^{(i)}}\{u(C_t^{(1)}, C_t^{(2)}) + \beta \mathrm{E}_t V_{t+1}[(1+r)(B_t + I_t - p_t^{(1)}C_t^{(1)} - p_t^{(2)}C_t^{(2)})]\}, \tag{5}$$

where the first-order condition $\frac{\partial u(C_t^{(1)}, C_t^{(2)})}{\partial C_t^{(i)}} = \beta(1+r)p_t^{(i)}\mathrm{E}_t V'_{t+1}(B_{t+1})$ and envelope theorem $V'_t(B_t) = \beta(1+r)\mathrm{E}_t V'_{t+1}(B_{t+1})$ lead to Euler equations $\frac{\partial u(C_t^{(1)}, C_t^{(2)})}{\partial C_t^{(i)}} = \beta^k (1+r)^k p_t^{(i)} \mathrm{E}_t \left[\frac{\frac{\partial u(C_{t+k}^{(1)}, C_{t+k}^{(2)})}{\partial C_{t+k}^{(i)}}}{p_{t+k}^{(i)}} \right]$.

This shows that the relationship between the current and expected levels of demand will be a function of the ratio of the current and expected price levels, for example $\frac{C_t^{(i)}}{\mathrm{E}_t C_{t+k}^{(i)}} = f\left(\frac{p_t^{(i)}}{\mathrm{E}_t p_{t+k}^{(i)}}\right)$.

If we assume that the consumer does not often revise his expectations (for example, does not regularly monitor prices), then, based on certain expectations he will change his actual demand in relation to that expected, depending on how prices change relative to their expected values. If his expectations are static, his forecast will be for prices to remain at the same level over the next period. After that, if he sees prices different from those of the previous period, the consumer will respond with a change in demand, as in the case with comparative statics of the standard model. In the above structure, it is assumed that the expected level of prices is not static. Therefore, it is the ratio of current *consumption* to its expected value which is determined by the ratio of the current price to its expected value, rather than the ratio of current *consumption* to that of the previous period (as determined by the ratio of current *prices* to their value in the previous period).

If we assume that the expected levels of variables can be described by the mean values over the period, then we can write the following equation:

$$\ln Im_{j_k,t} - \frac{1}{T}\sum_{t=1}^{T}\ln Im_{j_k,t} = \gamma^{(2)}\left(\ln\frac{Y_t}{Y_{t-1}} - \frac{1}{T}\sum_{t=1}^{T}\ln\frac{Y_t}{Y_{t-1}}\right) +$$

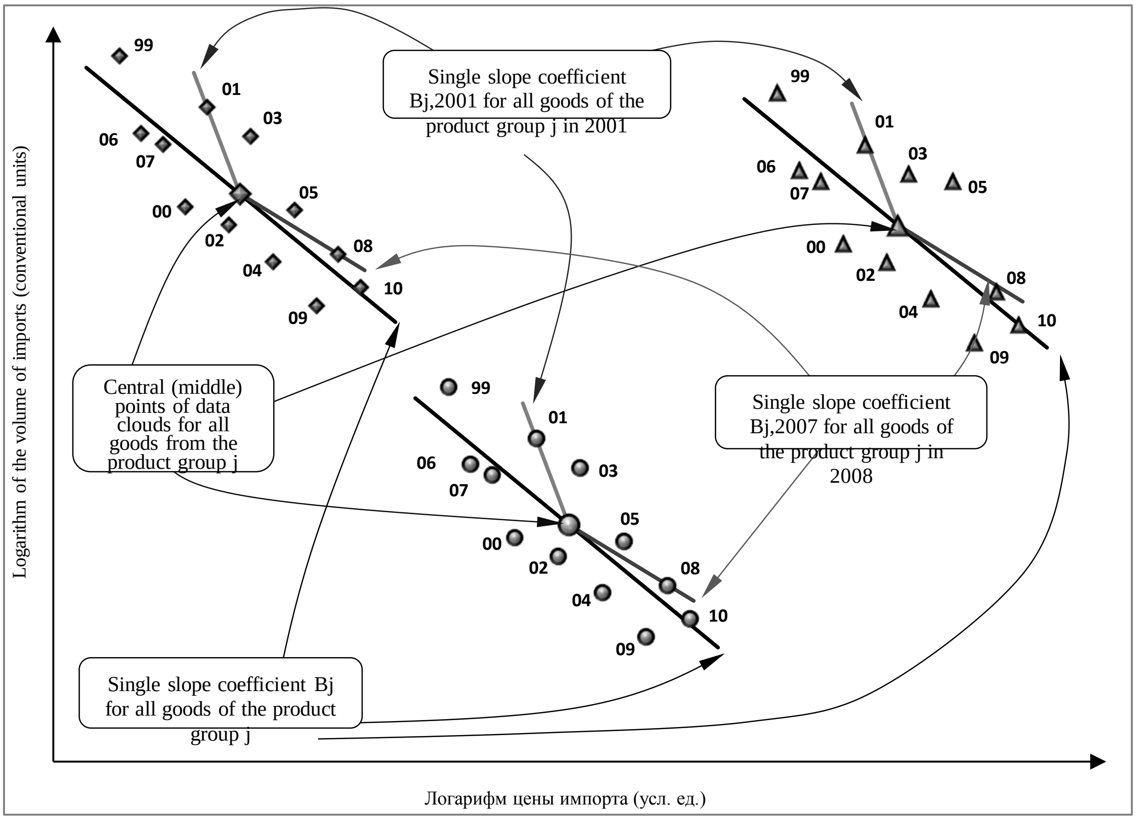
$$+\beta_{j,t}\left(\ln p_{j_k,t} - \frac{1}{T}\sum_{t=1}^{T}\ln p_{j_k,t}\right) + \delta_{j,t}\left(\ln REER_t - \frac{1}{T}\sum_{t=1}^{T}\ln REER_t\right) + \tilde{\xi}_{j_k,t}\,. \tag{6}$$

Equation (6) is interpreted as follows. If we consider two products in any commodity group, the increased in the logarithm of the price of one product relative to its mean value over the period will cause a similar increase in the logarithm of imports of this product with respect to its mean value. This will be the case for other products in this group with the logarithm of their prices exceeding its mean value by the same amount. For a product in product group j at a time t a change of 1% in the ratio of its price to its geometric mean value over the period, will change the ratio of imports to their geometric mean value by $\beta_{j,t}\%$. Similarly, for a product in product group j at the time t an increase of 1% in the ratio of the real effective exchange rate to its geometric mean value over the period will increase the ratio of imports to their geometric mean value by $\delta_{j,t}\%$, and in this case

$$\frac{\partial \ln \dfrac{Im_{j_k,t}}{\sqrt[T]{Im_{j_k,1}\times\ldots\times Im_{j_k,T}}}}{\partial \ln \dfrac{p_{j_k,t}}{\sqrt[T]{p_{j_k,1}\times\ldots\times p_{j_k,T}}}}=\beta_{j,t}\,,\quad \frac{\partial \ln \dfrac{Im_{j_k,t}}{\sqrt[T]{Im_{j_k,1}\times\ldots\times Im_{j_k,T}}}}{\partial \ln \dfrac{REER_t}{\sqrt[T]{REER_1\times\ldots\times REER_T}}}=\delta_{j,t}\,.$$

OLS estimates of equation (6) are the consistent estimators of the parameters $(\gamma_1^{(2)},\ \beta_{j,t}\big|_{j=1,t=1}^{J,T},\ \delta_{j,t}\big|_{j=1,t=1}^{J,T})$. Equation (6) defines exactly the same function within a single product group for each time point, for any deviations of the variables from the mean value, while the deviation from its mean value of the estimate of elasticity of imports, caused by the deviation of their price from its mean value, is made by separately averaging the estimates for all goods within the product group for each period (year) t. Thus, equation (6) estimates the elasticity when the price change is measured, not between two points in time, but between the value at the time t and mean value for the period. Averaging in this case is made separately for each year, for all goods within the product group. In other words, model (6) examines the change in the volume of imports at the time t compared to the mean value for the period, under the influence of the *price change* at time t from its mean value for the period, rather than the change in the volume of imports at the time t compared to $t-1$ under the influence of the price changes at the time t as compared to $t-1$. Thus, the model estimation reduces to OLS estimates of regressions (3) and (6). Fig. 1 shows exactly what tilting angles β_j and $\beta_{j,t}$ are averaged under the estimates of equations (3) and (6). The single factor b_j for goods from product group j means that the tilting angle is averaged for all clouds of goods within this product group. Single factor $\beta_{j,t}$ for goods from product group j for the year t means that the slope is averaged for all pairs of the following points: the observed point of goods belonging to product group j for the year and the central (middle) point of the data cloud of this product. Corresponding coefficients apply for factors δ_j and $\delta_{j,t}$, except that the slopes are positive.

Figure 1. Estimate of slope coefficients β_j and $\beta_{j,t}$ for optional product group *j*.
(Different markers denote different products in the product group *j*.)



As already noted, each item provides for its own import demand function. In the first model, these functions have different individual characteristics (the elasticities are averaged) selected as fixed, for the following reasons.

There is a problem with the dimensions of the physical volume of imports. For example, meat is measured in kilograms, vehicles - in pieces, shoes - in pairs. Generally, if you buy multiple items, the unit cost of purchase (used as an approximation for the price of the imported goods) of one product is not comparable with the unit cost of purchase of a different product. In fact, the unit cost of purchase for each product also has its own dimensions (for example, the dollars per kilo cost of Norwegian fish and the dollars per kilo cost of Japanese shellfish are different dimensions). Despite different dimensions for different products, elasticity is a dimensionless quantity, as it shows the percentage change in one variable in response to a one-percent change in the other. Equal elasticity means the same curve slope coefficients estimated logarithmically. In the case of fixed effects, the slope coefficients reflect the reaction of the dependent variable changes in response to changes in the independent variable over time. This is why it is necessary to apply fixed effects for econometric estimation with such models: in contrast to models with random effects, they determine a demand function for each commodity.

Thus far, in the present study, the problem of different dimensions has been solved by using the deviations of logarithmic variables from their mean values (as in the first and second models).

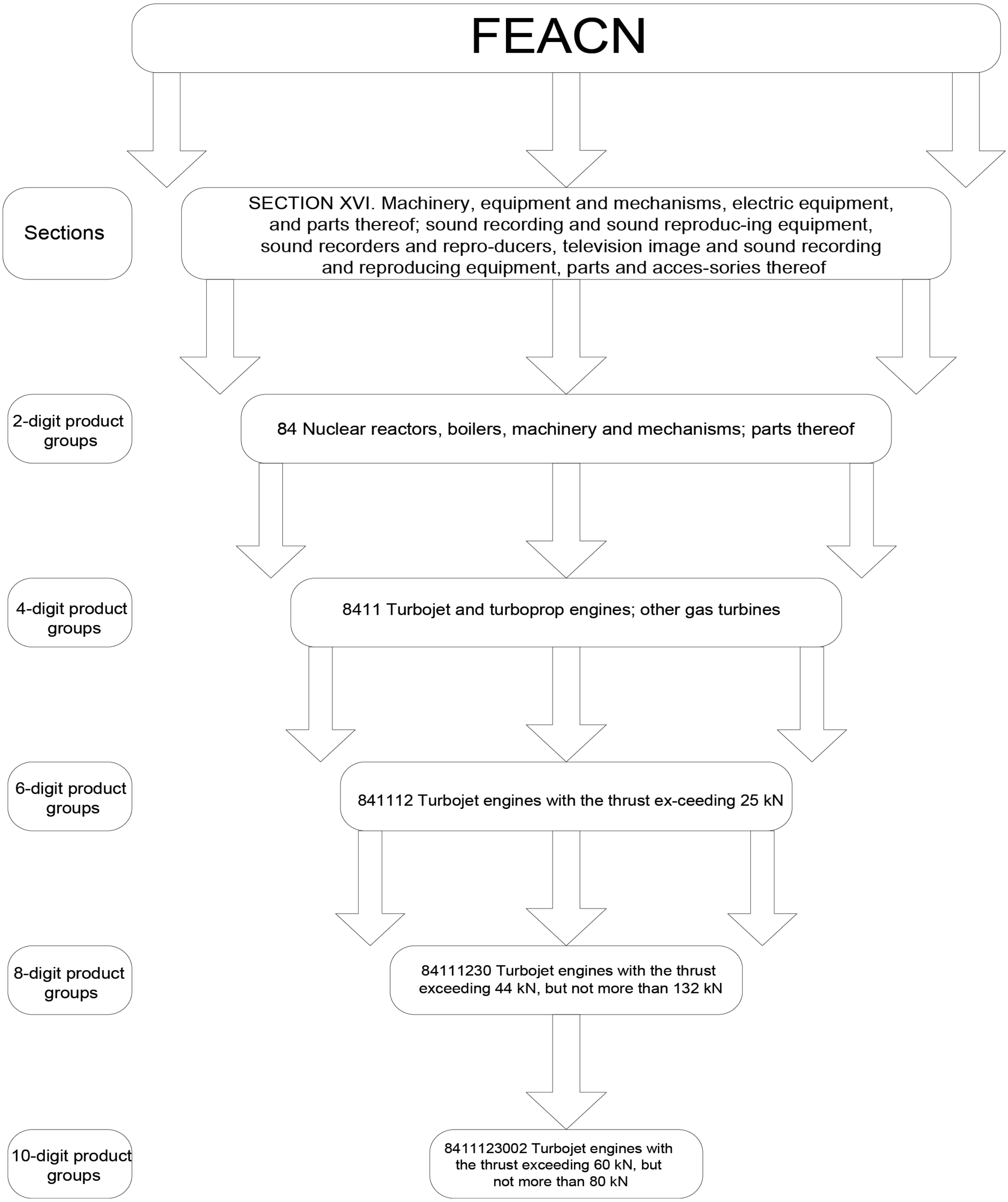
4. Econometric estimates

4.1. Data description

In this study, we use COMTRADE data on the imports of goods to the Russian Federation from the rest of the world under HS 1996 classification[2]. This classification is almost identical to the Russian FEACN (TN VED) classification, at least for sufficiently aggregated product groups. The HS 1996 and FEACN classifications consist of 21 sections. Products are divided into 96 two-digit product groups[3], which, in turn, are divided into four-digit product groups, etc. (see Fig. 2). Data sets are publicly available on the volume and value of imports for the six-digit product groups for 1997-2010. These six-digit product groups are treated as separate goods (hereinafter "the product" means a six-digit product group) each with a separate import demand function.

[2] http://comtrade.un.org/db.
[3] 01-97, except 77; data available for 95 product groups, except for group 88 (aircraft, spacecraft and parts thereof) where the trade data are secret.

Figure 2. FEACN tree structure



The unit cost of purchase is calculated for each specific product as equal to the ratio of the value of imports divided by their quantity. The study applies the unit cost of purchase as a proxy for the own (foreign) price of imported goods. At the same time, high heterogeneity of products can lead to the dynamics of the unit cost of purchase only poorly reflecting the dynamics of foreign prices for the corresponding goods. For example, price changes for specific cars or tractors can cause a change in the structure of imports within this product group, so that the *unit cost* of purchase may remain unchanged or does not change in response to changes in prices. Thus, growth of income may result in domestic consumers switching from cheaper Korean cars to more expensive Japanese cars. This may result in a situation where the same number of cars is purchased, but at a higher price. In this case, the ‘unit cost of purchase’ grows as these are different cars, although the prices of the products themselves have not changed. Similarly, if the price of Korean cars changes, consumers may move to purchase a smaller number of Japanese cars, but at a higher price, so, in this case, the volume of imports decreases, but the ‘unit cost of purchase’ may not change at all. Therefore the calculations may result in offset elasticity estimates. In addition, changes in the structure of imports and corresponding changes in the unit cost of purchase may occur under the influence of changed exchange rates of the exporting countries. Therefore, where there is a sufficiently high equivalence of goods this similarly changes the unit cost of purchase, while at high heterogeneity there may be less effect on unit cost. In what follows, we shall use the term “own (foreign) price” instead of the term “unit cost of purchase”. For more details see (Idrisov, 2010).

The regressions apply data only for 2000-2010 despite the fact that there are also observations for 1997-1999. This is because, in 2000, there was a change of units for some goods which prevents a comparison of the different values of the physical volume of imports over time. In addition, data sets have been selected only for those goods, for which there are observations for all 11 years (2000 to 2010).In all, information on 4,145 products (a total of 45,595 observations, fully balanced panel) was used for the econometric estimates.

The data on real GDP growth were taken from Rosstat statistics[4], and data on the real effective exchange rate — from statistics of the Bank of Russia[5]

4.2. Evaluation of models with time-constant elasticities

So, assuming constant price elasticities over time, an estimation of the import demand function applies the following econometric specification:

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[4] http://www.gks.ru/

[5] http://www.cbr.ru/

$$\ln Im_{j_k,t} - \frac{1}{11}\sum_{t=2000}^{2010} \ln Im_{j_k,t} = \gamma^{(1)}\left(\ln\frac{Y_t}{Y_{t-1}} - \frac{1}{11}\sum_{t=2000}^{2010} \ln\frac{Y_t}{Y_{t-1}}\right) +$$

$$+\beta_j\left(\ln p_{j_k,t} - \frac{1}{11}\sum_{t=2000}^{2010} \ln p_{j_k,t}\right) + \delta_j\left(\ln REER_t - \frac{1}{11}\sum_{t=2000}^{2010} \ln REER_t\right) + \tilde{\varepsilon}_{j_k,t}\,, \tag{7}$$

where $Im_{j_k,t}$ — imports to Russia in terms of the volume of goods j_k (volume of imports of a six-digit product group) related to product group j over the period t; Y_t — income in Russia in real terms over the period t (real GDP at 2003 prices); $p_{j_k,t}$ — own price of the goods j_k from product group j (unit cost of purchase of a six-digit product group, as cost in dollars per unit of volume) imported to Russia over the period t; $REER_t$ — real exchange rate (real effective exchange rate of the Russian ruble relative to the basket of currencies, where currencies are weighted with weights equal to the shares of the corresponding trading partner in total trade, the index).

Thus, either the entire pool (same elasticity for all goods) or FEACN sections (elasticity is equal for goods within the same section), or two-digit product groups (elasticity is equal for goods within the same two-digit product group), or four-digit product groups (elasticity is equal for goods within the same four-digit product group) are used as the product groups represented by j.

The estimated specification should be evaluated with consideration for the two issues below.

Firstly, the specifics of the data used are that the regression analysis uses a data panel structure with a small interval of time (11 years), i.e. so-called short panels. Therefore, the standard procedures associated with the testing of a time series for stationarity and cointegration are limited. However, research on panel econometrics conducted over the last decade indicates that, for panel data with a large number of spatial objects, consistency of coefficient estimates is achieved as the averaging leads to a minimisation of possible false dependence (see, e.g. (Levin et al., 2002; Im et al., 2003; Baltagy, 2005; Mills, Patterson, 2009)).

Secondly, in estimating the import demand function, the supply model is not separately specified. This is a special case of the identification problem which occurs when some observable economic variable is the result of equilibrium at the intersection of the demand function and supply function. In this case, Russia appears as a small open economy, so the supply of exports from the rest of the world can be considered to be absolutely inelastic. It should be noted that instead of the import of a ‘six-digit product group’ from the rest of the world we can apply the import of a ‘six-digit product group’ from each country as the observation unit. For example, assume that the goods from group 848210 (ball bearings) imported from France and imported from the U.S. are different goods. Such an approach would have significantly increased the number of observations, and reduced the problem of heterogeneity of goods, but the assumption of inelastic supply of exports would cease to operate[6]. In the light of this, in this paper we use data on the import of various goods from the rest of the world to Russia.

The hypotheses that are tested in estimates of type (7) equations are described below.

1. Coefficients $\gamma^{(1)}$ of the logarithm of real GDP growth in the Russian Federation are ***positive***. The higher the national income grows, the greater the demand for goods (at fixed prices and with other conditions remaining unchanged).

2. Coefficients β_j of the logarithm of the unit cost of foreign goods are ***negative***. If the dollar price of foreign goods increases, the demand for imported goods decreases in the situation where there is a fixed price for domestic equivalents and other things remain equal.

3. Coefficients δ_j of the logarithm of the index of the real effective exchange rate are ***positive***. If the dollar price of the domestic equivalents of imports increases (and it has a positive effect on the real exchange rate), the demand shifts towards imported goods if the prices of those foreign products remain fixed. Similarly, a fall in domestic prices in exporting countries (which also has a positive effect on the real exchange rate) causes a drop in national costs and increases the number of firms that can supply goods on the international market at such a fixed price, or increases the output without increasing the number of firms, or both.

Table 1 shows the estimated coefficients $\gamma^{(1)}$ of equation (7) for different methods of aggregation of product groups, as well as estimates of the coefficients b and d for the equation, which assumes the same price elasticity of demand for imports for all goods.

Table 1. Empirical evaluation of models of demand for imports (7)

[6] This problem could be solved by adding the demand equation for similar domestic goods and estimating the system by seemingly unrelated equations. Unfortunately, there are no data available on domestic production of goods in such a disaggregated cut, so such an estimate is not technically possible.

	Elasticities are the same for all goods	Elasticities are the same for goods of the same section	Elasticities are the same for goods of the same two-digit group	Elasticities are the same for goods of the same four-digit group
Logarithm of GDP growth in Russia	1.19*** (0.0970)	1.18*** (0.0954)	1.21*** (0.0930)	1.25*** (0.0858)
Logarithm of the unit cost of imported goods	–0.947*** (0.00684)			
Logarithm of the real effective exchange rate	3.29*** (0.0234)			
R^2 within	0.38	0.40	0.44	0.53
Number of goods	4,145			
Total number of observations	45,595 (4,145×11)			

Note. In parentheses are the standard errors corrected for heteroscedasticity. *** - significancy at 1%.

These results suggest the following technical conclusions:

1. The hypothesis on the vanishing of the coefficient of the logarithm of Russian GDP growth is rejected. The coefficient is positive and statistically significant in all specifications at the 1% level. The results are interpreted in favour of the hypothesis that a greater increase in national income causes higher demand for imported goods at fixed prices, all other things being equal. The average effect of size is about 1.2-1.3 depending on the specification, i.e. increase in the rate of growth of national income by 1% causes an increase in imports by an average of 1.2-1.3%.

2. The hypothesis on the vanishing of coefficient β of the logarithm of the price of imported goods, approximated by the unit cost of purchase, is rejected in the first specification (estimations of the other specifications are discussed below). The coefficient is negative and statistically significant at the 1% level, and this is interpreted in favour of the hypothesis of a negative relationship between the price of a foreign product and its import for fixed prices of the domestic equivalents, all other things being equal. According to the estimates, imports of the product decrease by an average of 0.9% at a price movement of 1%.

3. The hypothesis on the vanishing of coefficient δ of the logarithm of the real effective exchange rate is rejected in the first specification (estimations of other specifications of coefficients δ_j are discussed below). This, in turn, is interpreted in favour of the hypothesis that an increase in the prices (converted into dollars) of goods which are domestic equivalents of the imported ones, while the prices of the foreign products remain fixed, causes the substi-

tution of the domestic products by imports. Strengthening of the real exchange rate by 1% causes, on average, an increase in the import of foreign goods by 3.3%.

Let us consider separately the estimated coefficients of the logarithms of the unit cost of imported goods and real effective exchange rate for different methods of aggregation of the product groups.

1) Price elasticities are equal for the products within the same section.

Table 2 shows the estimated coefficients β_j and δ_j of equation (7), which was estimated on the assumption that the price elasticities are equal for products within the same section. The results show that the hypothesis on vanishing of the coefficients of the logarithm of the price of imported goods (coefficients are negative and significant at the level of 1-5%) and the logarithm of the real effective exchange rate (coefficients are negative and significant at the 1% level) are rejected in all cases.

As seen from the results, goods of Section XIV – pearls; precious stones and metals; jewellery and coins - are more sensitive to strengthening of the real effective exchange rate: growth of the real exchange rate by 1% increases the import of goods comprising this section by an average of 7%. At the same time, it is estimated that the demand for imports of Section X – wood pulp; paper or paperboard - is less elastic in terms of the real exchange rate: strengthening of the real exchange rate of the national currency by 1% increases imports by an average of 2.6%. As for the mean reaction to changes in the import price, the most elastic is the import of goods of Section III - fats and oils: an increase in import prices by 1% leads to a decrease in the supply of these goods by 1.7% (correspondingly, the growth of customs tariffs for the goods comprising this section will have the most effect on imports); imports of Section XXI - artworks, collectors' pieces and antiques are less elastic in terms of their own price: a price movement of 1% reduces imports by only 0.34%.

Table 2. Estimates of the mean elasticities of demand for imports for products comprising each section by their own (foreign) price and real effective exchange rate (equation (7))

Section	Real effective exchange rate elasticity of demand for imports	Own (foreign) price elasticity of demand for imports	Number of estimated goods of the section
I. Livestock, animal products	3.34***	–0.96***	144
II. Vegetable products	3.37***	–0.94***	213
III. Fats and oils of animal or vegetable origin and their cleavage products; prepared edible fats; waxes of animal or vegetable origin	3.23***	–1.66***	37
IV. Prepared foodstuffs; beverages, spirits and vinegar; tobacco and manufactured tobacco substitutes	2.79***	–1.00***	161
V. Mineral products	3.31***	–1.27***	105
VI. Products of the chemical and related industries	3.12***	–1.17***	617
VII. Plastics and goods made thereof; rubber and goods made thereof	3.64***	–1.03***	190
VIII. Raw hides and skins, leather, fur-skins and goods made thereof; saddlery and harness, travel goods, handbags and similar items, goods made of animal gut (other than silk-worm gut)	2.85***	–0.71***	40
IX. Wood and goods made of wood, wood charcoal, cork and goods made thereof, goods made of straw, esparto or other plaiting materials, basketware and wickerwork	3.85***	–1.28***	55
X. Pulp of wood or other fibrous cellulosic material, recovered paper and cardboard (waste and scrap), paper and paperboard and goods made thereof	2.61***	–1.08***	116
XI. Textiles and textile products	3.24***	–1.00***	677
XII. Footwear, headgear, umbrellas, sun umbrellas, walking sticks, seat-sticks, whips and parts thereof; prepared feathers and articles made therewith; artificial flowers, goods made of human hair	4.59***	–1.03***	45
XIII. Goods made of stone, plaster, cement, asbestos, mica or similar materials, ceramic products, glass and glassware	3.31***	–1.12***	136
XIV. Natural or cultured pearls, precious or semi-precious stones, precious metals, metals plated with precious metal and goods made thereof; jewellery, coins	6.95***	–1.09***	3
XV. Base metals and goods made thereof	3.74***	–1.18***	497
XVI. Machinery, equipment and mechanisms, electric equipment, and parts thereof; sound recording and sound reproducing equipment, sound recorders and reproducers, television	3.48***	–0.76***	687

image and sound recording and reproducing equipment, parts and accessories thereof			
XVII. Vehicles, aircraft, vessels and associated transport equipment	3.92***	–0.50***	110
XVIII. Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and equipment; clocks and watches; musical instruments and their parts and accessories	3.30***	–0.85***	192
XIX. Arms and ammunition, their parts and accessories	6.70***	–0.49**	5
XX. Miscellaneous manufactured goods	2.77***	–0.71***	110
XXI. Artwork, collectors' pieces and antiques	4.39***	–0.34***	5
Mean	3.74	–0.96	197

*Note***.** ***, ** — significant at 1% and 5% respectively.

2) Price elasticities are equal for goods comprising the same two-digit product group.

Estimation of equation (7) under this assumption has produced the following results. The hypothesis on vanishing of the coefficients of the logarithm of own (foreign) price is not rejected in one case (Group 24, Tobacco and manufactured tobacco substitutes) out of the 95 available groups. In other cases, the coefficients β_j are negative and statistically significant, which suggests in favour of the hypothesis of a negative relationship between the price of foreign products and the demand for them. The hypothesis on vanishing of the coefficients of the logarithm of the real effective exchange rate is not rejected in 5 cases out of 95. In the other cases (90 of 95), the coefficients δ_j are positive and statistically significant, this supports the hypothesis that a strengthened real exchange rate leads to an increase in imports.

Statistically significant estimates are interpreted as the mean elasticities of the demand for imports. Imports of Group 46 (goods made of straw, esparto or other plaiting materials, basketware and wickerwork) referring to Section IX (wood and goods made of wood) are most sensitive to changes in their own price (elasticity of -1.99), which is proved by the estimates. The average elasticity of these imports is also quite high (see Table 2). The least sensitive to changes in own price are imports of Group 86 (railway locomotives and track equipment with an elasticity of -0.27), which, again, is characteristic of the goods of Section XVII (surface vehicles, aircraft) with low price elasticity.

As estimated, imports of Group 71 (pearls and precious metals of Section XIV with an elasticity of 6.95) and imports of Group 93 (arms and ammunition of Section XIX with an elasticity of 6.70) are most sensitive to changes in the real effective exchange rate. The least sensitive to changes in the own price, are imports of Group 37 (photographic and cinematographic goods with an elasticity of 0.71), which is not typical for Section VI (products of the chemical and related industries which have an elasticity of 3.12), to which this product group belongs.

Figure 3. Histogram estimates of the average price elasticities of demand for imports, obtained using equation (7) under the assumption that they are identical for the products of a two-digit product group

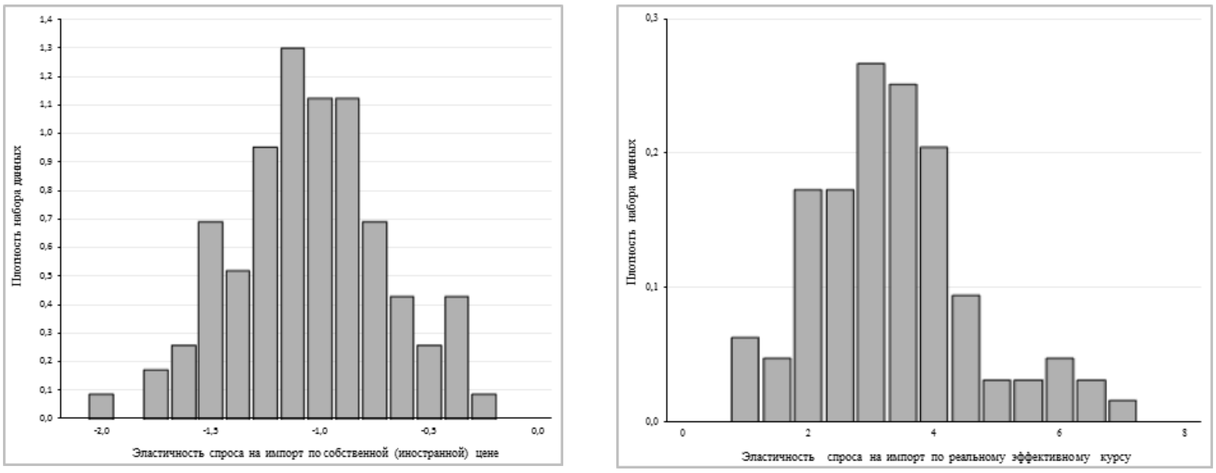


Figure 3 shows the histogram of estimated coefficients. They show that the modes of empirical distribution account for the estimated value obtained for the entire set of goods (from about -0.9 to -1.0 for the own-price elasticity, and from 3.2 to 3.4 for the real exchange rate elasticity).

Table 3 below shows the two-digit product groups with the highest and lowest values of demand for imports by their own (foreign) price and real effective exchange rate.

Table 3. Two-digit product groups most (top 5) and least (bottom 5) sensitive to changes in their own prices and real exchange rate

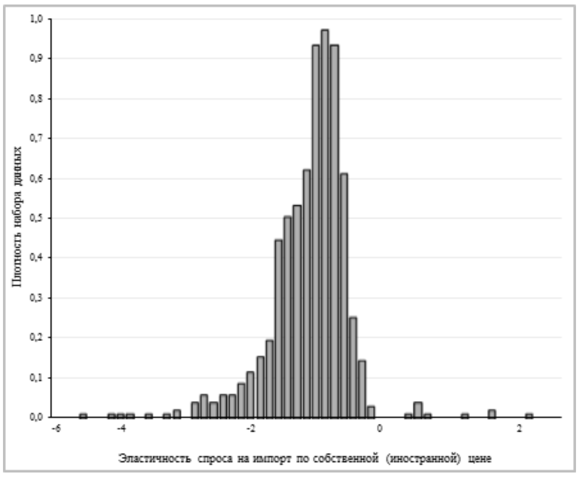
Product group	Own price elasticity of demand for imports	Product group	Real exchange rate elasticity of demand for imports
46 Goods made of straw, esparto or other plaiting materials	–1.99	71 Pearls, precious stones and metals, jewellery, coins	6.95
10 Cereals	–1.73	93 Arms and ammunition, their parts and accessories	6.70
15 Fats and oils of animal or vegetable origin	–1.66	46 Goods made of straw, esparto or other plaiting materials	6.26
22 Alcoholic and non-alcoholic beverages	–1.60	67 Prepared feathers and down and goods made of feathers or of down, artificial flowers	6.19
18 Cocoa and its products	–1.56	61 Clothes and clothing accessories	5.93
21 Various food products	–0.39	21 Various food products	1.32
89 Ships, boats and floating structures	–0.36	53 Other vegetable textile fibres	0.99
97 Artwork and antiques	–0.34	41 Raw hides and leather	0.91
41 Raw hides and skins, leather	–0.33	5 Products of animal origin not specified elsewhere	0.88
86 Railway locomotives or tram-cars	–0.27	37 Photographic and cinematic goods	0.71

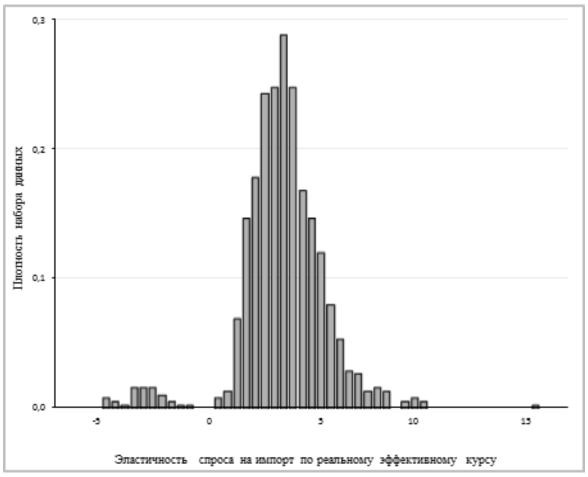
3) Price elasticities are equal for the products within the same four-digit product group.

The hypothesis on vanishing of the coefficients of the logarithm of own (foreign) price is not rejected in 397 cases out of 1,114. In the other cases (717 of 1,114), the coefficients β_j are statistically significant. The hypothesis on vanishing of the coefficients of the logarithm of the real effective exchange rate is not rejected in 282 cases out of 1,114. In the other cases (832 of 1114), the coefficients δ_j are statistically significant.

Figure 4 shows the histogram of estimated coefficients. It shows that the vast majority of estimates have signs consistent with the hypothesis on the negative effect on imports of increasing their own (foreign) price, and with the hypothesis assuming that a strengthened real exchange rate leads to an increase in demand for imported goods. It is also seen that the modes of empirical distribution account for the estimated values obtained for the entire set of goods.

Figure 4. Histogram estimates of the average price elasticities of demand for imports obtained using equation (7) under the assumption that they are identical for products of a four-digit product group





At the same time, there is a set of four-digit product groups, for which the own-price elasticity of demand for imports was positive (i.e. goods of these groups can be called Giffen goods), as well as a set of four-digit product groups, for which the real exchange rate elasticity of demand for imports was negative. Products with both a positive price elasticity of demand for imports and a negative price elasticity of demand for imports in respect of the real effective exchange rate belong to Groups 1005 (corn - 1.25 and -3.73, respectively) and 1204 (broken or unbroken flax seeds - 2.32 and -3.35, respectively).

4.3. Estimates of models with elasticities varying from year to year

Estimates of the import demand function under the assumption that the price elasticities may change over time are derived from the following econometric specification:

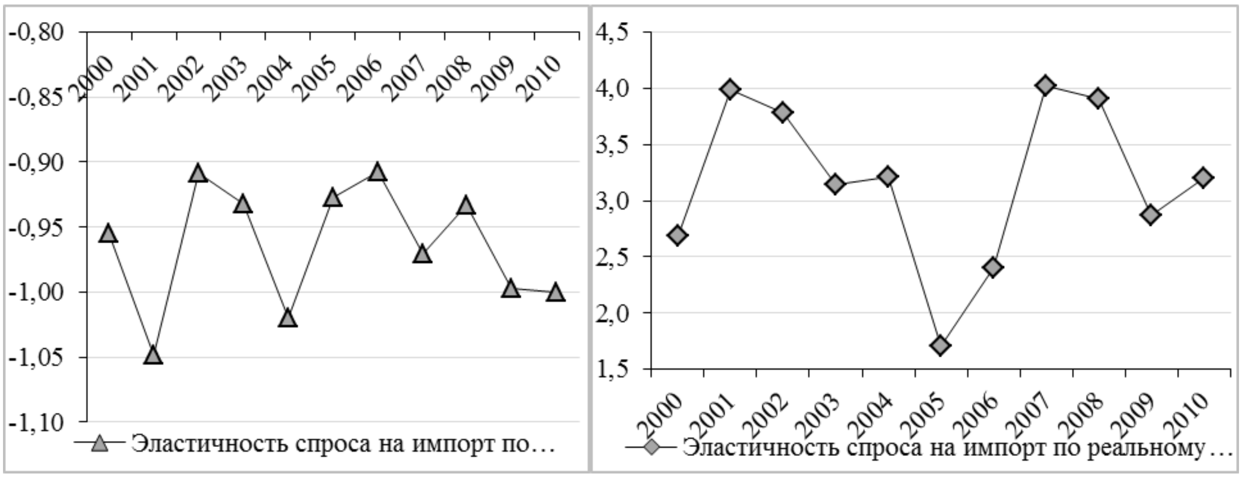
$$\ln Im_{j_k,t} - \frac{1}{11}\sum_{t=2000}^{2010} \ln Im_{j_k,t} = \beta_{j,t}\left(\ln p_{j_k,t} - \frac{1}{11}\sum_{t=2000}^{2010} \ln p_{j_k,t}\right) + \delta_{j,t}\left(\ln REER_t - \frac{1}{11}\sum_{t=2000}^{2010} \ln REER_t\right) + \tilde{\xi}_{j_k,t}\,. \quad (8)$$

The growth variable rate of real GDP in Russia is excluded because of multicollinearity with the real exchange rate variable. This is due to the fact that both variables change only with time; if we use the price of the Russian equivalents instead of the real exchange rate, such problems can be avoided. Thus, we can use either the entire pool (the same elasticity for all goods in each year, but variable from year to year) or FEACN sections (elasticity is the same for goods within the same section in each year, but variable from year to year) as the product groups j.

The hypotheses tested in estimation of type (8) equations are the same as in the estimation of type (7) equations.

When estimating equation (8), assuming the same elasticity for all goods, the coefficients are statistically significant at the 1% level (the adjusted coefficient of determination equals 0.39). Fig. 5 shows the dynamics of the estimated elasticities of demand for imports. As might be expected, some estimates exceed the values resulting from equation (7), and some are lower (for the elasticity of demand for imports at a price of -0.95; for the real exchange rate elasticity of 3.29).

Figure 5. Dynamics of the average estimates of the elasticities of demand for imports by their own (foreign) price and the real exchange rate for each year, obtained under the assumption of constant coefficients for all goods



It should be noted that the Wald test with a zero hypothesis of the equality of elasticities of demand for imports by their own (foreign) price $\mathrm{H}_0: \hat{\beta}_{2000} = \hat{\beta}_{2001} = ... = \hat{\beta}_{2010}$ shows that the zero hypothesis is rejected even at a significance level of 1% ($P_{value} = 0.000$). At the same time, the hypothesis $\mathrm{H}_0: \hat{\beta}_{2000} = \hat{\beta}_{2003} = \hat{\beta}_{2005} = \hat{\beta}_{2006} = \hat{\beta}_{2007} = \hat{\beta}_{2008} = \hat{\beta}_{2009}$ is not rejected at a significance level of 10% ($F(6.45573) = 1.51;\ P_{value} = 0.17$), which favours the hypothesis of the equality of import price elasticities in the years considered.

The Wald test with a zero hypothesis of the equality of elasticities of demand for imports by real exchange rate $\mathrm{H}_0: \hat{\delta}_{2000} = \hat{\delta}_{2001} = ... = \hat{\delta}_{2010}$ also shows that the zero hypothesis is rejected at a significance level of 1% ($P_{value} = 0.000$). The hypothesis $\mathrm{H}_0: \hat{\delta}_{2001} = \hat{\delta}_{2002} = \hat{\delta}_{2007} = \hat{\delta}_{2008}$ is not rejected at a significance level of 10% ($F(3.45573) = 1.60;\ P_{value} = 0.19$), and neither is the zero hypothesis $\mathrm{H}_0: \hat{\delta}_{2003} = \hat{\delta}_{2004} = \hat{\delta}_{2010}$ ($F(2.45573) = 0.15;\ P_{value} = 0.86$).

Estimation of equation (8) under the assumption that the elasticity is the same for goods within the same section for any given year, but varies from year to year, showed that the hypothesis on zero coefficients of the logarithm of own (foreign) price is not rejected in 35 cases out of 231 (21 sections for 11 years). In the other cases, the coefficients $\beta_{j,t}$ are negative and statistically significant, which suggests the hypothesis that there is a negative relationship between the price of foreign products and the demand for them. The hypothesis on zero coefficients of the logarithm of the real effective exchange rate is not rejected in 33 cases out of 231. In the other cases (198 of 231), the coefficients $\delta_{j,t}$ are positive and statistically significant, thus supporting the hypothesis that a strengthened real exchange rate leads to an increase in imports.

Figure 6. Histogram estimates of the average price elasticities of demand for imports obtained using equation (8) under the assumption that they are identical for products within the same section in any given year, but vary from year to year

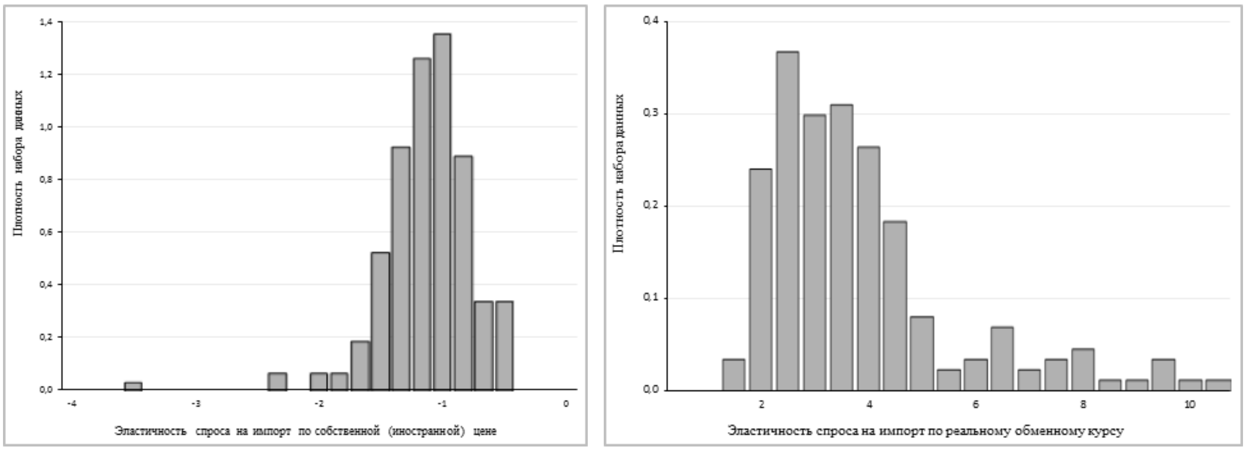


Fig. 6 shows histograms of the estimated coefficients. They show that the modes of empirical distribution account for the value estimates obtained for the entire set of products. Regarding the elasticity of demand for imports related to own (foreign) price, the statistically significant estimates range from -3.68 for Section III (fats, oils and waxes of animal or vegetable origin and related cleavage products) in 2009 to -0.35 for Section II (vegetable products) in 2010. Regarding the real exchange rate elasticity of demand for imports the statistically significant estimates are in the range from 1.38 for Section XI (textiles and textile articles) in 2006 to 10.2 for Section XVII (surface vehicles, aircraft, facilities and equipment) in 2005.

5. Conclusion

This study has analysed the import demand function for Russia, systematised theoretical approaches, developed a specific methodology and provided a quantitative estimation of the model of demand for a full range of foreign goods in the domestic market. The key results are provided below.

1. The developed empirical model shows that the real exchange rate fluctuations as well as fluctuations in own prices of imported goods have a significant impact on the demand for imports. A strengthened real effective exchange rate for the Russian ruble worsens the position of Russian producers, which leads to an increase in imports in terms of value. At the same time, the increased price of imported goods, which may arise, in particular, as a result of an increased customs tariff, increases the competitiveness of domestic producers and leads to

a drop in imports. However, according to our estimates, the average elasticity of demand for imports in GDP growth is estimated at 1.19; by own import price - at -0.95, and by the real effective exchange rate - at 3.3.

2. Based on the estimates, product groups can be ranked by their sensitivity to the effects of fluctuations in the real exchange rate and to changes in the own import prices resulting in an increase (or decrease) of imports in terms of value. The results show qualitatively that unidirectional factors influence the sensitivity, but vary greatly in the range of their effects on the different product groups. With a weakening of the real effective RUR exchange rate, imported pearls, precious stones, arms and ammunition, straw goods; processed feathers and down; and clothes are more susceptible to displacement. At the same time, it is for these product groups that a strengthening of the real exchange rate of the national currency would lead to the highest growth in demand for products from foreign producers. According to the estimates, imports of various food products; vegetable textile fibres; raw hides and leather, photographic and cinematographic goods are least sensitive to fluctuations in the real exchange rate. For these product groups a weakening of the real exchange rate will not apparently be an effective tool for promoting local producers, as it will only lead to a rather small decrease in the supply of imported products. A strengthening of the real exchange rate of the national currency will cause a moderate increase in imports of these goods and will not lead to a significant decrease in competitiveness.

An increase in quantitative trade restrictions, such as an import duty ad valorem, in both specific and combined form, leads to an actual increase in the price of imported products. With the growth of the ad valorem equivalent of any trade barrier (we call it the increased customs tariff), the largest drop in imports is expected for products made of straw; cereals; fats and oils of animal or vegetable origin; alcoholic and non-alcoholic beverages and cocoa. For these product groups a customs and tariff policy is most effective in terms of stimulating the mechanism of import substitution. At the same time, the increased customs tariff for different food products; ships, boats and floating structures; artworks and antiques; raw hides and leather; railway locomotives or tramcars, track equipment and devices for railway or tramway tracks will not lead to a significant reduction of imports: domestic production of the above product groups should therefore be promoted by other means (for example, through subsidies or tax breaks).

3. The methodology used allows us to estimate the dynamics of import demand sensitivity to changes in the real effective exchange rate of the ruble and to changes in the prices of imported products. According to the results, the own price elasticity of demand for imports averaged over the whole range of imported goods varied from -1.05 to -0.90 in the 2000s, and

the real exchange rate elasticity of demand for imports varied from 1.5 to 4.0 during the same period. The explanation for the dynamics of import demand elasticities for all imports as a whole and for individual product groups may be the subject of further research.

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