Price and Income Elasticities of Aggregate Import Demand in Estonia

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Abstract

The aim of the paper is to estimate the short and long run models for aggregate import demand in Estonia to understand how changes in the price of domestic goods and services relative to foreign goods and services affect the demand for imports. The models are estimated using the Autoregressive Distributed Lag model and bounds cointegration test. The results indicate that import demand is price elastic in the short run, while the elasticity of income was found to be statistically insignificant. However, contrary to the short-run model, import demand is found to be income elastic, while the elasticity of the price of domestic goods and services relative to foreign goods and services was insignificant in the long-run model. The elasticities found provide useful information for reference in future research on import demand in Estonia as well as other European countries.

JEL classification codes: C12, C32, F14, O24
Keywords: Estonian imports, aggregate import demand, price elasticity, income elasticity, autoregressive distributed lag, bounds test

1. Introduction

Estonia is among the countries with the highest share of imports as a percentage of gross domestic product in the European Union. Although net trade of both goods and services is positive, it is so only marginally which places Estonia in the bottom half among other European Union member countries (OECD, 2018). Net trade in goods has been negative for every year since 1999 and although net trade in services has been positive, the difference between exports and imports of services has been slightly decreasing in the past few years (*Ibid.*), meaning it is entirely possible that at some point in the future, overall net trade will turn negative. Therefore, to keep this from happening, it is necessary to establish the most effective trade policies by understanding how import demand reacts to changes in the relative price of domestic and foreign goods and services and income.

The aim of this paper is to estimate both short and long-run aggregate import demand models for Estonia. Consequently, two research questions have been set:

1. How does the demand for imports of goods and services react to changes in the relative price of foreign goods and services in terms of Estonian goods and services?
2. How does the demand for imports of goods and services react to changes in Estonian income?

To answer the research questions, quarterly data on imports of goods and services, the import price index, the harmonised consumer price index and real gross domestic product is used. The data on real gross domestic product is obtained from the Eurostat database and all other data is collected from Statistics Estonia. The data spans the period between the fourth quarter of 1998 and the fourth quarter of 2017. The econometric software used for the analysis is the 9th version of EViews.

The aggregate import demand function is used, where the dependent variable is import demand and relative price and income are the regressors. The time series of imports of goods and services is divided by the import price index to obtain real imports and the import price index is divided by the harmonised consumer price index to estimate the relative price variable. Income is proxied by real gross domestic product. As in previous studies on aggregate import demand, the Autoregressive Distributed Lag and bounds testing approach to estimate cointegration is used. The Autoregressive Distributed Lag and bounds testing method is fairly new, the main advantages of which over other methods is the fact it does not require variables to be of the same order and that it can estimate both short and long-run elasticities.

The paper is structured as follows: the first chapter provides an overview of imports from a theoretical point of view. Furthermore, the impact of imports on the trade balance is discussed and the chapter ends by describing the findings of previous empirical studies on import demand. Chapter 2 gives an overview of Estonia's foreign trade throughout the period under observation. The trade balances of goods and services are analysed separately and Estonia's most important trading partners are presented. Chapter 3 describes the methodology used in the empirical analysis and also presents the data that is used in the analysis. Chapter 4 is dedicated to the empirical analysis using the Autoregressive Distributed Lag bounds test approach. The findings are presented and diagnostic tests are also conducted on the models. Furthermore, a recommendation will be given based on the results.

2. Imports in macroeconomic theory

The two most well-known theories on international trade date back hundreds of years. The theory of absolute advantage by Adam Smith from 1776 suggests that countries should specialise in producing the goods and services in which they have an absolute advantage over other countries. The countries should then export the produced goods and import others (McCulloch & Smith, 1838). However, David Ricardo argued that even if a country has an absolute advantage in everything compared to others, international trade is still possible. In his view, the necessary precondition for international trade is a difference in comparative costs. In the case of comparative advantage, one country may be more inefficient in producing a specific good compared to another country, but it can produce the good more efficiently than it could produce others (Gandolfo, 2014). A more contemporary view on international trade is that of Eli Heckscher and Bertil Ohlin, who expanded the Ricardian theory in 1919 and 1933 respectively, suggesting that the proportions of factor endowments, and therefore the relative marginal costs of production, are different, making countries produce and export the goods for which the factors of production are more abundant (*Ibid.*).

Based on the level of international trade, an economy can be either closed or open, the main difference in macroeconomic theory being that in the case of an open economy, a country's spending does not have to equal its output of goods and services because such countries can either spend more or less than they produce, and therefore act as borrowers or lenders to foreign countries. On the other hand, closed economies do not import from or export to foreign countries, meaning they are self-sufficient and get by only with domestically produced goods (Mankiw, 2013). Even though closed economy models are often used by economists for certain countries (where exports and imports are small compared to output) to simplify their analysis, in reality, completely closed economies do not exist (Barro, 2010).

2.1. Trade openness and economic growth

Export growth can have a positive effect on a country's economy in several ways. For example, if the foreign demand for a country's domestic goods rises, it positively affects the employment and income of the same sector (Awokuse, 2008). Furthermore, a country with an export-oriented policy, such that the incentives for sales in domestic and foreign markets are similar, can benefit from a more efficient resource allocation, greater capacity utilisation and the boosting of technological improvements due to high competition in foreign markets (Balassa, 1978).

According to the expenditure approach of gross domestic product (GDP), import growth leads to a decrease in aggregate output. However, this is only true if the imported goods replace domestic goods, and hence does not mean that increasing imports could not have a positive impact on a country's economy. For example, the export sector of small open developing countries often uses resources that are provided by imports (Awokuse, 2008). Moreover, access to foreign knowledge and technology through imports – since new technologies often require importing intermediate goods such as computers – can help productivity grow and contribute to economic growth in the long-run (*Ibid.*) Therefore, the effect of imports on economic growth may well be even bigger than that of exports (*Ibid.*); however, since it is indirect, it is much more difficult or may even be impossible to accurately quantify compared to the effect of exports.

There are several studies which support the idea that increasing international trade has a positive effect on economic growth. For example, Sachs and Warner (1995) researched a set of countries using data ranging from 1970 to 1989. They found that real GDP per capita growth is much faster for open economy countries than closed economy countries – even in the case of developed countries, the growth rates are 2.29% and 0.74% respectively. However, the growth in developing countries is found to be noticeably higher – 4.49% and 0.69% for open and closed economy countries respectively – suggesting that within open economy countries, trade openness contributes significantly to income convergence (Sachs & Warner, 1995). Frankel and Romer (1999) conclude that trade – both international and domestic – does indeed raise income by increasing output by the levels of capital given and also through the accumulation of human and physical capital (Frankel & Romer, 1999).

However, Rodriguez and Rodrik (2001) argued that the relationship between trade openness and economic growth is not that simple and felt that many previous studies on the topic have methodological problems. They highlighted the common exclusion of simple trade-weighted tariff averages and non-tariff coverage ratios from the analyses, which are often claimed to give misleading information about a country's trade policy without providing reasoning for such biases or giving explanations for why a different indicator would be preferable, which is in part caused by the effect previous studies have on newer ones (Rodriguez & Rodrik, 2001). Dollar and Kraay (2004) agreed with the critique by Rodriguez and Rodrik (2001) and took it into account in their research. However, their analysis of about 100 countries still led to the conclusion that countries with relatively more open trade policies seem to experience faster economic growth.

2.2. Factors of import demand

The total domestic demand for goods includes both demand for domestic goods and foreign goods, where imports are part of the latter. The first determinant of import demand is domestic income – a country's output. An increase in domestic income results in an overall higher demand for all goods and services, which means that import demand also rises (Blanchard, 2006). The formula for estimating how the demanded quantity of imports reacts to changes in income; that is, the income elasticity of import demand, is the following:

$$E_Y = \frac{\Delta IM_D}{\Delta Y} \times \frac{Y}{IM_D} \tag{1}$$

where
E_Y – income elasticity,
IM_D – quantity of imports demanded,
ΔIM_D – percentage change in quantity of imports demanded,
ΔY – percentage change in income,
Y – income.

The second determinant is the real exchange rate (also called the terms of trade), which describes the relative price of goods between two countries – the rate at which one country's goods can be exchanged for another country's goods – as opposed to the nominal exchange rate which describes the relative price of currencies. However, in addition to the prices of the goods in local currencies, the real exchange rate also depends on the rate at which the currencies of the two countries are exchanged; that is, the nominal exchange rate (Mankiw, 2013). The formula for the real exchange rate is (*Ibid.*):

$$\varepsilon = e \times \frac{P}{P^*} \tag{2}$$

where
ε – real exchange rate,
e – nominal exchange rate,
P – price level in the home country,
P^* – price level in the foreign country.

A higher real exchange rate expresses a relatively cheaper price of foreign goods and services compared to domestic goods and services and vice versa in the case of a lower real exchange rate. Therefore, an increase in the real exchange rate should theoretically have a positive effect on imports. Taking all of the aforementioned into consideration, the determinants of imports can be written as a simple function (Blanchard, 2006):

$$IM = IM(Y, \varepsilon) \tag{3}$$

where an increase in either component brings about an increase in the demand for imports as well.

Due to the different nature of foreign and domestic goods, imports cannot be subtracted from net exports at their nominal value. The value of imports must be expressed in terms of domestic goods, meaning the equation for net exports is the following (Blanchard, 2006):

$$NX = X\,(Y^*, \varepsilon) - \frac{1}{\varepsilon} \times IM(Y, \varepsilon) \tag{4}$$

where
NX – net exports,
Y^* – foreign income,
$\frac{1}{\varepsilon}$ – relative price of foreign goods in terms of domestic goods.

Because of the real exchange rate's negative effect on exports, depreciation of the real exchange rate increases exports by making domestic goods relatively less expensive abroad. On the other hand, imports decrease since foreign goods are relatively more expensive, resulting in an increase in the domestic demand for domestic goods. However, the relative price of foreign goods in terms of domestic goods increases, meaning that in terms of domestic goods, imports cost more. To improve the trade balance after a depreciation, the increase and decrease in exports and imports, respectively, must be enough to compensate for the higher cost of imports. Growth in net exports under these conditions is known as the Marshall-Lerner condition (Blanchard, 2006).

The substitution of goods depends on the differentiation between them. First and foremost, consumers may select one good over another based on their physical differences, with greater differences lowering the elasticity of substitution. However, in addition to physical preferences, the important aspects to preferring one good over others include the convenience of purchase, the time of receiving the product and the perceived quality of the good (Blonigen & Wilson, 1999). In some cases, the latter aspects may even have a bigger impact on the consumer's choices, especially when choosing between domestically produced and imported goods. Since imported goods may also pose higher risks, the consumer may opt for domestic goods. There may also exist a home bias of some domestic goods (*Ibid.*) – a good example for such products would be wine in any of the larger wine-producing countries, where consumers often prefer the local product over imported wine (Friberg, Paterson & Richardson, 2011). But a home bias may also exist among domestic and foreign goods which are otherwise equal. In such cases, the aspects aside from the physical features mentioned in the previous paragraph are even more prevalent, giving the domestic industry an advantage over foreign industries, which can result in a systematic home bias (Blonigen & Wilson, 1999).

3. Literature review

The main issue with the import demand model described in the previous sub-section is that it is purely theoretical and even though it is used in the context of this paper as well, previous research has found that the components of GDP may separately describe the demand for imports better. For example, Giovanetti (1989) studied the effect of disaggregated expenditure components on aggregate imports in Italy from 1970–1986. In her model, she included private and public consumption, fixed investment, exports and, additionally, stock building, and the relative price of foreign and domestic goods are included as well. Though the relationship between imports and total expenditure is found to be unstable, since the composition of expenditure changes over the trade cycle, she concluded that all the included variables have an impact on import demand. Abbott and Seddighi (1996) also researched the impact of the components of final expenditure and the relative price term on aggregate imports in the UK over the period 1972–1990, finding a long-run relationship between them. In particular, consumption expenditure is found to be a major determinant of import demand, while the effect of changes in the relative price for import demand is rather small.

Hooper, Johnson and Marquez (2000) researched the short and long-run price and income elasticities for both imports and exports in the G7 countries, using the Johansen cointegration method and the error-correction model. The time series for the countries included in the analysis are different, starting from the mid-1950s to early 1960s for Canada, Japan, the United Kingdom and the United States and the 1970s for Germany, France and Italy – all leading up to the 1990s. For France, Germany and Italy, the income elasticities of import demand are found to be similar: 1.6, 1.5 and 1.4 respectively. The price elasticities of import demand are the same for France and Italy (–0.4), but the price elasticity for Germany is only –0.06. They noted that this may be due to the fact that they have included oil and services in their measure of trade volume, as in the research by Hooper and Marquez (1995 referenced in Hooper et al., 2000), the average German import price elasticities excluding services is found to be –0.5. Hooper and Marquez also found that in the case of the US, the average price elasticity of imports excluding oil imports is –1.23, while for total imports it is –0.5, suggesting that including oil lowers the estimate of the price elasticity (Hooper et al., 2000). In the short run, income elasticities are found to be lower for Germany and Italy at 1.0, but higher for France at 1.7. However, regarding the estimated price elasticities, Germany is the only country for which the estimated short-run price elasticity of import demand is found to be statistically significant (–0.2), indicating that changes in relative prices may have a smaller role in import demand in the short run.

Narayan and Narayan (2003) used the Autoregressive Distributed Lag (ARDL) model to estimate the long-run price and income elasticities of import demand for South Africa and Mauritius using data between 1960 and 1996 and 1963 and 1995, respectively. As expected, the price elasticity of import demand is negative: –0.42 in Mauritius and –0.61 in South Africa. Income elasticity is positive in both countries with the long-run values being 0.87 and 1.19, respectively. The error-correction terms for both countries are quite low, –0.34 for Mauritius and –0.12 for South Africa, indicating that a short-term shock in the import demand model would take about 3 and 8 years, respectively, to recover to their long-run equilibrium levels (Narayan & Narayan, 2003).

Kee, Nicita and Olarreaga (2004) have estimated the price elasticities of import demand at the tariff line level and have done so for more than 4,000 goods in 117 countries for the period 1988–2001. They found that the average import demand elasticity across the sample is –1.67 while the median value is –1.08. What is more, they found import demand to be more elastic in large and rich countries, but less elastic for less developed countries (Kee et al., 2004). The average estimated elasticity for Estonia, for example, is –1.09 – nearly identical to the median value across the whole sample, but lower than the price elasticities in Lithuania and Latvia at –1.2 and –1.16, respectively.

Rashid and Razzaq (2010) used the Dynamic Ordinary Least Squares (DOLS) method in addition to the ARDL bounds testing approach to examine the income and price elasticities of Pakistan using annual data for the period 1975–2008, finding that the elasticities found using the DOLS method (1.018 and –1.197) are lower than the estimates found using ARDL. One notable variable they have added in their import demand model is the availability of foreign exchange, the estimated elasticity of which using the ARDL method is 0.472, suggesting that an increase in the availability of foreign exchange also increases import demand.

Aiello, Bonanno and Via (2015) researched the price and income elasticities of both imports and exports in China and 6 countries in the Organisation for Economic Co-operation and Development (OECD) using data from 1990 to 2013. Since using the Pooled Mean Group and Mean Group estimators on panel data for estimating the elasticities of imports yielded inconclusive results, they also analysed each country individually, using the Vector Error Correction Model (VECM), finding that the income elasticities for China, Japan and the USA are 1.07, 1.25 and 2.05, respectively, while price elasticities are 2.05, 0.65 and 0.2, respectively.

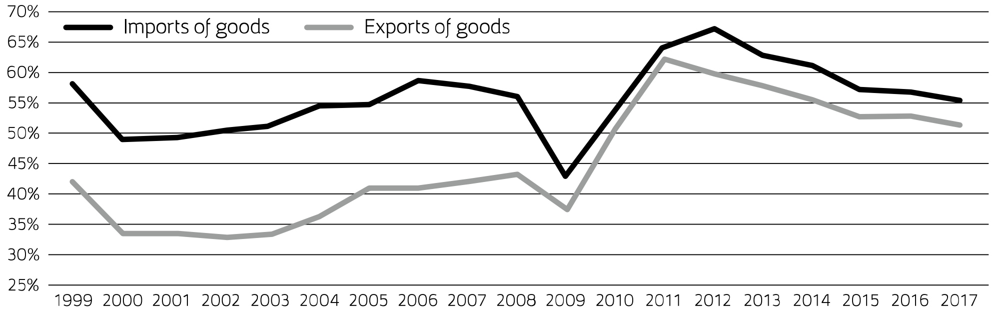
In conclusion, import demand is found to be income elastic in all countries except Mauritius, where it is income inelastic. The empirical studies also show that the income elasticity of import demand can be expected to be higher in more developed countries and lower in less developed countries. Price elasticities, however, are found to be quite different and are found to be statistically insignificant in some countries, hence a generalisation based on the literature reviewed would be arbitrary.

4. Overview of foreign trade in Estonia

4.1. Trade balances of goods and services

The value of total imports of goods and services in Estonia as a percentage of GDP is rather high, exceeding 60% in most years and reaching over 80% in 2012. However, after 2012, there has been a clear downward trend. Figure 1 shows Estonia's imports and exports of goods as a share of GDP from 1999 to 2017. Through all the years, exports have been lower compared to imports, therefore net trade is negative and Estonia acts as a borrower on the world market. The gap between imports and exports of goods was significantly greater before the financial crash, but following the financial crash, the difference has decreased.

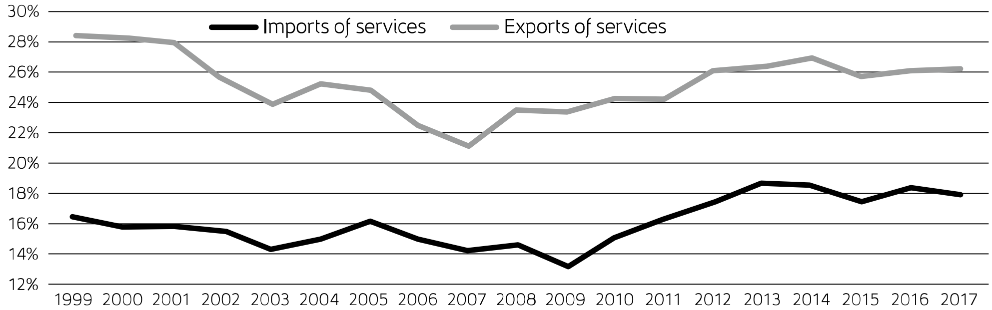
Figure 1. Estonian trade of goods as a share of gross domestic product from 1999 to 2017



Source: Statistics Estonia (2018b), author's illustration

Figure 2 shows that the trade balance of services has been positive during all years between 1999–2017, meaning that on the services market, Estonia acts as a lender. The movement of both imports and exports of services has been similar, both increasing at quite a steady rate, whereas in the trade for goods as a share of gross domestic product, both exports and imports increased at a very fast rate for a few years after the financial crash, but then started to decrease. The smaller impact of the financial crash on trade in services, especially on imports is also noteworthy – while the imports of goods were greatly affected by the financial crash, the impact on imports of services was much smaller.

Figure 2. Estonian trade in services as a share of gross domestic product 1999–2017

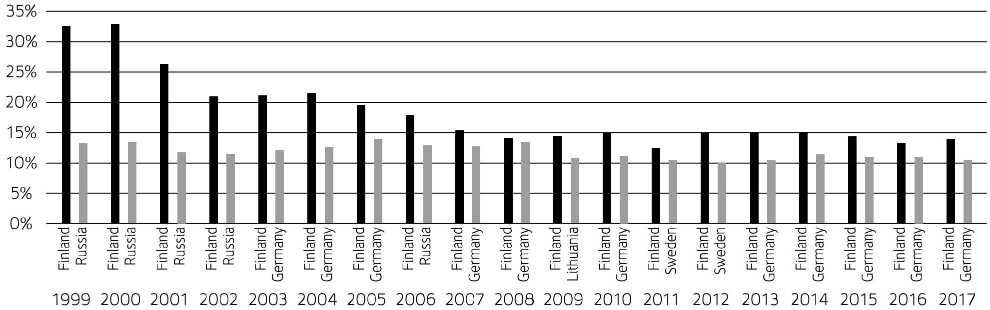


Source: Statistics Estonia (2018b), compiled by the author

4.2. Consignment and destination countries

As can be seen from Figure 3, for all the selected years, Finland has been the most important consignment country. Before accession to the EU in 2004, the percentage of imported goods from Finland made up over 30% of the total amount of imports. Since 2004, the share of imports from Finland has decreased, but still constitutes the largest part of total imported goods. Aside from Finland, other important consignment countries include Russia, Germany, Sweden and Latvia (Statistics Estonia, 1999, 2000, 2001, 2002, 2003, 2018a).

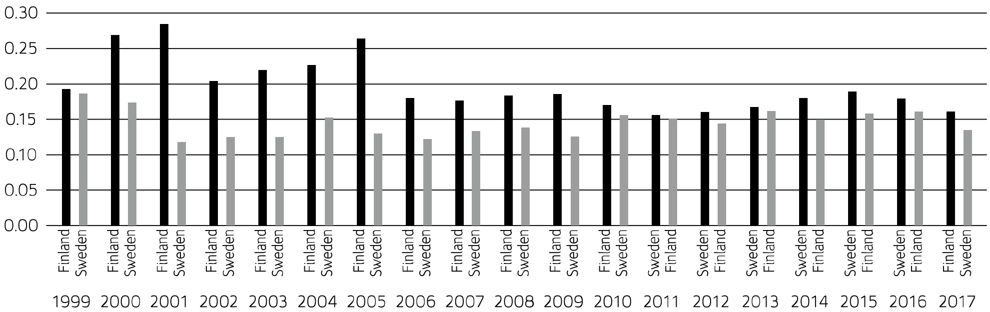
Figure 3. Consignment countries with the highest shares of total imported goods in Estonia 1999–2017



Source: Statistics Estonia (1999; 2000; 2001; 2002; 2003; 2018a), author's calculations

Figure 4 shows that as was the case with imports, Finland is clearly one of the most important destination countries as well. Again, the share of exports to Finland is higher before joining the EU, however, even after joining the EU, exports to Finland still make up the highest share of overall exported goods. Sweden is another important trading partner and the two have been the top two destination countries during the last 18 years. Other destination countries are much like the countries from which Estonia imports goods: Russia, Germany and the other two Baltic states among others (Statistics Estonia, 1999, 2000, 2001, 2002, 2003, 2018a).

Figure 4. Destination countries with the highest shares of total Estonian exports 1999–2017



Source: Statistics Estonia (1999; 2000; 2001; 2002; 2003; 2018a), author's calculations

5. Data and methodology

The variables used to determine the income and price elasticities of aggregate import demand in Estonia are real imports, relative price and income. The variables are obtained as follows: real imports is obtained by deflating Estonian nominal imports (Statistics Estonia, 2018b) using the Estonian import price index (Statistics Estonia, 2018c) values; relative price is obtained by dividing import price index values by the harmonised consumer price index values (Statistics Estonia, 2018d); and income is proxied using Estonian real GDP (Eurostat, 2018). However, before estimating the variables, some adjustments are required – first, the base year for the time series of both total imports and real GDP is 2010; however, the base years for imports and harmonised consumer price indices are 1997 and 2005, respectively, both of which are re-based to 2010. Furthermore, the nominal import time series is seasonally unadjusted and to remove seasonality, the moving average method is used. The data used, spanning the time from the fourth quarter of 1998 to the fourth quarter of 2017, is obtained from the database of Statistics Estonia with the exception of the seasonally adjusted real GDP, which is obtained from the statistical database of Eurostat.

Table 1 below presents the descriptive statistics for real imports, relative price and income. The difference between the minimal and maximum value of real imports is quite large due to imports as a share of GDP rising from the beginning of the dataset. On average, the relative price of foreign goods has been higher than domestic goods. The negative skewness values for both imports and income signal that the left-hand tail values are longer, but in the case of income, the skewness indicates the data is moderately skewed while for imports the data is fairly symmetrical, as is the case with the relative price variable. However, looking at the values of kurtosis, they are significantly different from 0 and are negative; hence, none of the variables are normally distributed but rather the distribution is platykurtic.

Table 1. Descriptive statistics for real imports, relative price and income

Statistic	Real imports	Relative price	Income
Mean	2660.886	107.072	3753.295
Median	2809.620	107.588	3892.600
Standard deviation	708.880	9.773	680.548
Maximum value	3743.794	125.921	4819.600
Minimum value	1333.411	91.466	2386.400
Skewness	−0.360	0.326	−0.556
Kurtosis	−1.163	−0.813	−0.861

Source: Eurostat (table namq_10_gdp) and author's calculations

5.1. Aggregate import demand function

Similar to previous studies, the aggregate import demand function is used, the basic form of which is as follows (Frimpong & Oteng-Abayie, 2008):

$$IM_t = \alpha_0 + \alpha_1 \times \frac{P_{imt}}{P_{dt}} + \alpha_2 \times Y_t \quad (5)$$

where
IM_t – demanded imports,
α_1 – coefficient of relative price,
P_{imt} – price of imports,
P_{dt} – domestic prices,
α_2 – coefficient of income,
Y_t – income.

For import prices, the import price index is used, which is also used to find the value of real imports by deflating the values of nominal imports by the import price index. Since an index for domestic prices does not exist, the consumer price index, similar to Narayan and Narayan (2003), is used to proxy the domestic prices. However, it is important to note that in the context of this paper, the harmonised consumer price index (HICP) is used, which is an indicator of inflation for the European Central Bank. The reason for using the HICP instead of CPI is the possibility of new studies on import demand in other EU member countries, making the findings more comparable. For income, real GDP is used.

A possible method for estimating elasticities is transforming a function to the log-linear model (Gujarati & Porter, 2010). More specifically, Goldstein and Khan (1985) note that the log-linear instead of the linear specification may be preferred for estimating import demand, hence the log-linear form of the aggregate import demand function has been used in this paper as well. Therefore, the final equation is as follows:

$$lnIM_t = \alpha_0 + \alpha_1 \times (ln\frac{P_{imt}}{P_{dt}}) + \alpha_2 x\ (lnY_t) + u_t \qquad (6)$$

where
u_t – error term.

As a result of transforming the equation to the log-linear form, the coefficients now represent the price and income elasticities of import demand, respectively. A positive relationship between import demand and income is expected. However, the relationship between import demand and relative price is presumably negative.

5.2. Autoregressive distributed lag bounds test approach to cointegration

Following previous studies researching the price and income elasticity of import demand, such as Narayan and Narayan (2003) and Rashad and Razzaq (2010), the Autoregressive Distributed Lag (ARDL) bounds test approach to cointegration by Pesaran et al. (Pesaran & Shin, 1998; Pesaran, Shin & Smith, 2001) is used for the empirical analysis. The model being autoregressive means that the current value of a dependent variable is, in part, described by previous values of the dependent variable itself. The distributed lag component refers to the lags of the regressors, which impacts the current value of the dependent variable. The general specification for an ARDL(p, q1, q2,..., qk) model is as follows (Pesaran & Pesaran, 1997, referenced in Narayan & Narayan, 2003):

$$\Omega(L,p)y_t = \alpha_0 + \sum_{i=1}^{k} \beta_i(L,q_i)x_{it} + \delta' wt + \mu_t \qquad (7)$$

where
$\Omega(L,p)y_t = 1 - \Omega_1\delta_1 L^1 - \Omega_2\delta_2 L^2 - \ldots - \Omega_p L^p$,
$\beta_i(L,q_i) = \beta_{i0} + \beta_{i1}L + \beta_{i1}L^2 + \ldots + \beta_{iqi}L^{qi}$, $i = 1,2,\ldots, k$.

In Equation (7), y_t is the dependent variable, α_0 is a constant, L is a lag operator with $Ly_t = y_{t-1}$ and x_{it} is the independent variable where $i = 1,2,\ldots, k$ (Narayan & Narayan, 2003).

The main argument in favour of using this method among multiple other cointegration methods (e.g. Engle-Granger cointegration) is the fact that it is possible to estimate the relationship even when variables are not integrated to the same order, which means they can be either integrated to zero order (I(0)), first order (I(1)) or also a combination of the two (Pesaran & Shin, 1998). However, it is necessary that the variables used in the analysis are not integrated to the second order (I(2)), as in such a case the conclusions reached on a possible long-run relationship would be meaningless. This is due to the fact that the calculated F-statistic in the bounds test is based on the assumption that the variables are I(0) or I(1) (Pesaran et al., 2001). In addition to the aforementioned advantage over other cointegration analysis methods, it is possible to derive the Error Correction Model (ECM) from the ARDL model for estimating the elasticities in the short run without losing any information about the long-run. The 9th version of EViews is used, where the ARDL and bounds test method is a built-in function.

The first step is making sure that the variables used in the analysis are not integrated to the second order, for which unit root tests are conducted. In this paper, the Augmented Dickey-Fuller (ADF) unit root test is chosen. The ADF test's null hypothesis is that there is a unit root and vice versa for the alternative hypothesis.

Before continuing with estimating the cointegrating model, testing for possible structural breaks is also required. Since it is necessary to test for possible structural breaks in the whole sample, the Quandt-Andrews breakpoint test is used. The test is similar to the Quandt likelihood ratio test; however, since the values of the multiple F-statistics are compared, non-standard distribution rather than F-distribution must be used, which is what differentiates the Quandt-Andrews breakpoint test from the Quandt likelihood ratio test.

After making sure that none of the variables are integrated to the second order, it is possible to estimate the long-run relationship using the ARDL bounds approach. This itself is divided into three steps, the first of which is choosing the most suitable order of lags for the ARDL model. For this, the Akaike Information Criterion (AIC) is used – the model with the smallest AIC value provides the best fit. This means that an ARDL(1, 1) model, for example, also includes the first order lags of the variables.

Choosing the lag orders for the variables is followed by conducting the bounds test, which makes it possible to test for a long-run relationship between variables. The null hypothesis of the bounds test states that a long-run cointegration between the variables is not present. For this, the Wald F-statistic is estimated, which is then compared to the lower and upper critical bounds found by Pesaran et al. (2001). If the F-statistic falls below the lower critical bound, a long-run cointegration is not found. If it is above the upper critical value, it is concluded that a long-run relationship is present. However, should it fall between the lower and upper critical bounds, it is not possible to reach a definite conclusion. (Rashad & Razzaq, 2010)

Provided that a long-run relationship exists, the cointegrating long-run model is estimated using ECM. In addition to the long-run relationship, ECM also allows the researcher to derive the short-run relationship coefficients and the error-correction term, which reflects the speed of adjustment to the long-run equilibrium after a short-term shock (Duasa, 2007).

Finally, tests for heteroskedasticity (White's test), autocorrelation (Breusch-Godfrey), the normality of residuals (Jarque-Bera) and goodness of the fit (Ramsey's RESET) are also conducted. Cumulative SUM (CUSUM) and cumulative SUM of squares (CUSUMQ) charts are used to check the stability of the model's parameters.

6. Results

The first step before estimating the ARDL model is testing for unit roots in the variables. Though not actually a requirement since the ARDL bounds test method can be used with variables that are either I(0), I(1) or a combination of the two, it is still important to make sure they are not I(2). The ADF test is used to test for unit roots, using AIC to select the optimal lag lengths. The results are presented below in Table 2, where the variables are as follows: LN_IM is the natural logarithm of real imports, LN_RP is the natural logarithm of the relative price variable and LN_Y is the natural logarithm of income.

Table 2. ADF tests results

	Level			First difference		
	LN_IM	LN_RP	LN_Y	LN_IM	LN_RP	LN_Y
Trend and intercept	0.299	0.612	0.307	0.102	0.000	0.102
Intercept	0.208	0.702	0.492	0.035	0.000	0.025
Without trend or intercept	0.910	0.059	0.950	0.005	0.000	0.005

Source: Author's calculations

Even though the ADF test statistic is significant for imports already in the equation with an intercept, the intercept itself is statistically insignificant, requiring further testing, as is the case with the relative price variable. As seen from the test results, all variables – real imports, relative price and income – are integrated to the first order.

To test for the possible existence of structural breaks in the import demand model to be used later, the Quandt-Andrews breakpoint test is used. The test finds values for the Chow test F-statistics for different breakpoints. The breakpoint with the highest F-statistic value is chosen, the corresponding p-value of which is used to accept or reject the null hypothesis of no structural breaks. The results of the Quandt-Andrews test are presented below in Table 3.

Table 3. Quandt-Andrews breakpoint test results

Test statistic	Value	P-value
Maximum Wald F-statistic (2005Q1)	113.988	0.000

Source: Author's calculations

The highest value of the F-statistic is at the first quarter of 2005, which is statistically significant at 1%, meaning the structural break needs to be accounted for in the ARDL model as well. A possible reason for the break might be Estonia's accession to the European Union in May 2004, making international trading with other member countries substantially easier.

6.1. ARDL model and bounds test

Since the assumption of no variables integrated to the second order is met, the ARDL bounds test method can be used to test for cointegration. Optimal lag lengths need to be found, for which the Akaike Information Criterion is used again, as with the ADF test. The model with the smallest AIC value is ARDL(1, 1, 3) – 1 lag of the import and relative price variables and 3 lags of the GDP variable are included in the model. It is important to remember that as a structural break in the first quarter of 2005 was found earlier, a dummy variable is included in the ARDL model as a fixed regressor, with the value of 0 from 1999Q3 until 2004Q4 and 1 from 2005Q1 onwards.

Having found the ARDL model with the most suitable lags, the bounds test can be conducted. The F-statistic obtained from the test is then compared to the critical value bounds proposed by Pesaran et al. (2001). Should the F-statistic fall below the lower bound, the null hypothesis of no long-run relationships is accepted, and vice versa if the F-statistic is greater than the upper critical bound. However, if the F-statistic falls between the lower and upper bounds, the result is inconclusive – the null hypothesis cannot be accepted, nor can it be rejected. The output of the test is presented below in Table 4.

Table 4. Bounds test result and the critical bounds

		10%		5%		1%	
Test statistic	Value	Lower	Upper	Lower	Upper	Lower	Upper
F-statistic	6.881	2.630	3.350	3.100	3.870	4.130	5.000

Source: Author's calculations

Since the value of the F-statistic is greater than the upper bound even at the 1% level, the null hypothesis of no long-run relationships is rejected. However, it is important to note one aspect of the bounds test equation: the dummy variable included in the model earlier is statistically highly insignificant. Even though the Quandt-Andrews test for structural breaks conducted earlier found a structural break, including it in the ARDL model possibly gives less reliable results; therefore, it is excluded from the equation. This affects the bounds test F-statistic marginally (6.785 after the exclusion of the structural break dummy), meaning the null hypothesis of no cointegration is still rejected. However, at 0.453, the adjusted R-squared is slightly higher than that of the model with the dummy, whose value is 0.452, confirming the superiority of the equation without the dummy.

Provided the result of the bounds test is positive; that is, the variables are cointegrated, the short and long-run models can be estimated. For the estimation of the short-term coefficients, the error-correction model is used. First differences of the variables in the ECM are the short-term coefficients, while the error-correction term shows the speed of adjustment from a shock in the short run to the long-run equilibrium. The results are presented below in Table 5.

Table 5. Short-run model coefficients

Variable	Coefficient	Standard error	t-statistic	P-value
D(LN_RP)	−1.284	0.309	−4.163	0.000
D(LN_Y)	0.374	0.309	1.155	0.252
ECM(−1)	−0.439	0.082	−5.327	0.000

Source: Author's calculations

The coefficient for the relative price variable is highly significant. In the short run, a 1% change in the relative price of imports causes the import demand to move in the opposite direction by 1.284%. The absolute value of the coefficient is greater than 1; therefore, it can be said that in the short run, imports are price elastic. The error-correction term (ECM(-1) in Table 5 above) is also highly significant and with the expected negative sign. The value of the term is –0.439 (or 43.9%), meaning that a deviation in the short run from the long-run equilibrium adjusts in about two months. As for income, the coefficient is very small and also insignificant, which means no conclusion on the effects of income on real imports in the short run can be made.

The coefficients are statistically significant for both income and relative price variables in the long run, at 1% and 10% respectively. In the long run, import demand is not price elastic as is the case in the short run, but is price inelastic instead. The coefficient is -0.865, meaning a 1% change in the relative price affects import demand in the opposite direction, but the impact on the demand for imports is smaller than 1%. Income, which is statistically insignificant in the short run, is now statistically very significant. The elasticity of income to import demand is 1.228, meaning import demand is income elastic in the long run. The long-run coefficients are presented below in Table 6.

Table 6. Long-run model coefficients

Variable	Coefficient	Standard error	t-statistic	P-value
LN_RP	−0.865	0.469	−1.846	0.069
LN_Y	1.228	0.192	6.393	0.000
C	1.754	3.674	0.477	0.635

Source: Author's calculations

To check the validity of the estimated model, six different tests are used: the Breusch-Godfrey serial correlation test, White's heteroscedasticity test, Jarque-Bera test for the normality of residuals, Ramsey's RESET test for model specification and the CUSUM and CUSUMQ tests to check the stability of the model. The results of the first four diagnostic tests are given in Table 7, the plots for the CUSUM and CUSUMQ tests are presented in Appendices 1 and 2, respectively.

Table 7. Diagnostic tests results

Test	Value of F-statistic / JB test statistic	P-value
Breusch-Godfrey	1.367	0.256
White	8.750	0.000
Jarque-Bera	16.757	0.000
Ramsey's RESET	2.168	0.146

Source: Author's calculations

Serial correlation of the residuals is rejected as the F-statistic for the Breusch-Godfrey test is statistically insignificant. In addition, Ramsey's RESET test confirmed the validity of the functional form of the model. Both the CUSUM and CUSUMQ tests show that the parameters of the model are relatively stable during the sample period. As seen from the table above, White's test for heteroscedasticity and Jarque-Bera test for normality of the residuals have failed. However, since the estimated model is not used for forecasting, the failure of the Jarque-Bera test is not considered such an issue as to dismiss the model completely. Moreover, previous research on the normality of residuals suggests that a sample size under 100 is often large enough to not require normal distribution (Lumley, Diehr, Emerson & Chen, 2002). Secondly, heteroscedasticity does not have an impact on the coefficients of the parameters, but on the effectiveness of the parameters themselves, possibly resulting in considering a parameter as statistically significant even if it is actually insignificant. Therefore, to account for the presence of heteroscedasticity, the ARDL model is estimated again, using White's heteroscedasticity-consistent standard errors and covariance. As a result, the relative price variable which was statistically significant at 10% before, is now statistically insignificant. The long-run coefficients with adjusted standard errors and t-statistics are presented below in Table 8.

Table 8. Re-estimated long-run model coefficients using White's heteroscedasticity-consistent standard errors and covariance

Variable	Coefficient	Standard error	t-statistic	P-value
LN_RP	−0.865	0.555	−1.559	0.124
LN_Y	1.228	0.299	4.098	0.000
C	1.754	4.981	0.352	0.726

Source: Author's calculations

Import demand in Estonia is price elastic in the short run, with the coefficient of the relative price variable being –1.284. At first, the long-run coefficient of the relative price variable is estimated to be –0.865, which would have meant that import demand in Estonia is price inelastic. However, after discovering the issue of heteroskedasticity in the estimated model, the model was re-estimated using White's heteroscedasticity-consistent standard errors and variations. This showed that the relative price variable is unreliable in the long run since the increase in the standard error caused it to be statistically insignificant. On the other hand, income, which is not statistically significant in the short run, clearly has an impact on import demand in the long run, with its coefficient of 1.228 suggesting import demand is income elastic.

7. Conclusions

Researching import demand is important, as estimating a model presenting the income and price elasticities helps policy makers formulate more efficient trade policies, which in turn have an effect on the country's trade balance. The aim of this paper was to estimate an aggregate import demand model for Estonia, where imports as a share of gross domestic product have historically been rather high and in the case of imported goods, exceeded exports in all the years under observation here, making Estonia a net borrower on the international goods market. The findings suggest that in the short run, import demand in Estonia is price elastic while it is income elastic in the long run. The latter suggests that the Estonian government should focus on encouraging industries in which there is relatively less demand for imports, which would help increase the trade balance and also domestic output.

To the best of the author's knowledge, the price elasticity of Estonia's import demand has been estimated only in the research by Kee et al. (2004); however, no known research has been conducted on the income elasticity of import demand in Estonia. Kee et al. (2004) found Estonia's import demand to be price elastic as well, with the average value being –1.09. However, the two are not directly comparable as one reflects the short-run elasticity and the other the long-run elasticity. Even though Kee et al. (2004) perform their analysis at the product line level, the main advantage of using the ARDL bounds test method is the possibility of obtaining information about both the short and the long run.

After the sample adjustment due to the lag orders of the model, only 74 observations were included in the analysis, which is the main shortcoming of the analysis. It is therefore not surprising that the models could not be estimated, especially in the long run as the sample spans just 18 years. It is also highly likely that the economic recession of 2007–2008 has a notable impact on the estimated parameters. The elasticities should be re-estimated in a few years when more observations can be included in the analysis. Moreover, price and income elasticities could also be estimated for different sectors. However, the time series of import price indices by economic activity are available from 2010, meaning that at the time of writing this paper, using disaggregated data would make the data sample even smaller. Furthermore, even though the import price indices are estimated monthly, it would be difficult to find a good proxy for monthly income, therefore increasing the risk of incorrect estimates. Having said that, at some point it may provide much more detailed information about the impact of changes in income and price on import demand.

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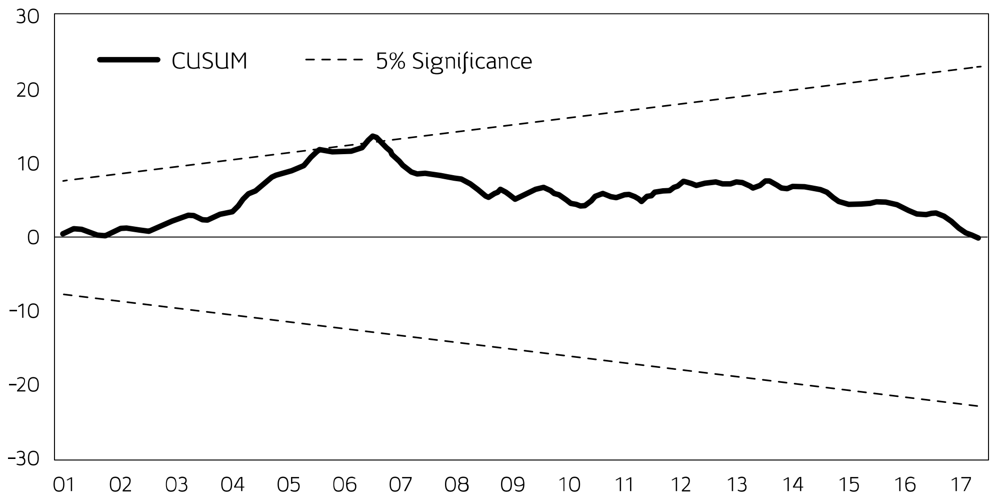
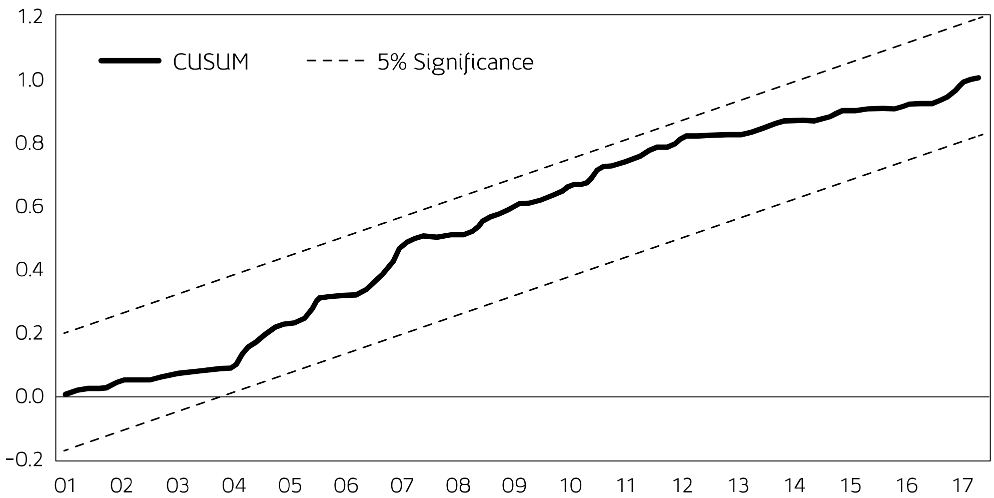
Appendices

Appendix 1. CUSUM test



Source: Author's calculations

Appendix 2. CUSUMQ test



Source: Author's calculations